

Chapter 11

Epilogue: The Iberian Way into the Anthropocene

Helge Wendt

Why Combine the Anthropocene and Iberian Colonial History?

The debates in the historiographies dealing with knowledge and science in the Iberian world from the sixteenth to the nineteenth centuries are well known. They dominate most publications that seek to evaluate the status of cultural, colonial and epistemic differences. This volume offers a collection of heterogeneous case studies that respond to this tradition. In this Epilogue, I aim to develop an idea that in a way summarizes the results of the contributions. I propose the rather innovative approach of combining research in the history of the Anthropocene with the history of globalization of knowledge in the Iberian colonial world. The relatively new research of the Anthropocene investigates the current and very recent impact of human-caused transformations in the Earth's processes. It also considers the long-term consequences of human interference in natural processes in terms of millennia, focusing on changes that can be described and analyzed in different disciplines, such as geology, biology and climatology. Human impact on the planetary system can be accidental in the sense that the techniques used by some societies caused and continues to cause unintentional effects on natural systems. Some changes, however, are intentional, as, for instance, works in infrastructure, mining or deforestation.

This volume offers a perspective on the Anthropocene that researches more short-term historical developments. Concentrating on one special object of knowledge or on one person during a relatively short period of time, this method is closer to traditional historiography but can nevertheless illustrate an Iberian approach to the Anthropocene. Because the Anthropocene as a research field is still developing, this approach is useful since studying this field in history involves an investigation of historical and historiographical traditions of disciplines that now forms a part of the Anthropocene, which in turn can enrich historians' understanding of the human past. Likewise, this emerging but imposing research field is thus able to develop a more critical approach to the traditions it depends on.

To that effect, the present volume contributes a new perspective from the marginal countries of the Anthropocene epoch, not the usual perspectives from England, France, Germany and the United States. Research into the Anthropocene needs this approach from the so-called peripheries to avoid merely retelling the history of modernization and industrialization. Both the natural history and the history of knowledge of the Iberian colonial powers offer a multitude of alternative points of view for an understanding of the history and epoch of the term “Anthropocene.”

An explanation is required as to why the Iberian empires are situated rather at the peripheries of the Anthropocene epoch. The Iberian colonial system, based both in Europe and in the colonized domains, encompasses European and non-European types of proto-industrialization. For a long time it permitted both a unique type of communication and offers an example of engagement in economics by the state, which in its time could hardly be compared to systems of power in Europe and Asia. It is fair to say then that from the end of the fifteenth to the mid-eighteenth century, neither the Spanish nor the Portuguese power systems were situated at the periphery. Also, as Immanuel Wallerstein (1974) already argued in the 1970s, the European and overseas territories of the Spanish and Portuguese lie less on the margins when certain features of early capitalist production and commerce are taken into account. This “World System” perspective places the Iberian system at the periphery when compared to England, the Netherlands, certain areas of Germany and the United States during the eighteenth and nineteenth centuries, when considered in conjunction with the acceleration and streamlining of industrial processes and the accumulation of capital (Luca and Sabatini 2012, 20). It is at this point that a strong devaluation of the whole Iberian systems occurs: the Iberian countries are seen as only partly freed from medieval power structures, economy and thought. The dominance that the Catholic Church held in these countries severely slowed the modernization that might otherwise have been possible. Authors defending this point of view argue that industrial development did not occur in these countries (Bakewell and Holler 2010, 357).

Proto-Industrialization and Proto-Anthropocene

The problem with this analysis is that it is based on a system of evaluation that uses the political, economic and intellectual processes of northwestern Europe as its standard of modernization (Wehler 1975; Eisenstadt 2002). This is where studies of the historical evolution of the Anthropocene can offer a new interpretation of the histories of the Spanish and Portuguese colonial empires, as long as it avoids falling into conventional narratives of industrialization and modernization. Since

the Anthropocene era is normally related to the industrialization process rather than the pre-modern period, it is suggested here to focus on changes in production processes as one of the markers of the Anthropocene and to employ the term proto-Anthropocene in relation to processes that have been nominated firstly for the European historical context.

The term proto-Anthropocene pays tribute to a number of criticisms concerning the periodization of the Anthropocene. Jason W. Moore (2014), for instance, rejects the whole concept for various reasons: he sees a necessity of inclusion of the separated spheres of the human world and the natural environment, like research on social metabolism and any of the “old Green” movements, that the Anthropocene fails to realize. His favorite issue, the development of world capitalism during the early modern period, should be included in studies dealing with transformations of the natural environment because it is the logic of developing and expanding capitalism that has instigated those transformation processes since the beginning of the so-called long sixteenth century, starting around 1450. During this era, important processes began such as the industrialization and mechanization of production, which were less thoroughly examined by historians compared to the concept of capitalism. Transformations in energy supply systems (Weissenbacher 2009; Wrigley 2010) and the increasing standardization in production processes (Vries 1994) also play a role in defining a more inclusive and a *longue-durée* perspective on human-nature-transformation processes.

Another critical perspective toward the Anthropocene comes from archaeology. Archaeologists like Michael Balter (2013) argue that the human capacity for transforming nature on a large scale dates back to well before the beginning of the nineteenth century. The extinction of mammals by human action or the transformations of regions by agriculture are arguments that extend the period of the Anthropocene to before 1800.

The discussion of when the Anthropocene began evokes debates similar to those following the appearance of the first volume of Immanuel Wallerstein’s “The Modern World System” (Wallerstein 1974; Lippman Abu-Lughod 1995) or the debates on the beginnings of globalization (Bayly 2004; Gruzinski 2004; Osterhammel 2009). Those debates are characteristic for historiography but reduce this discipline to the function of chronicler. A way out of such debates is to create alternative chronologies. Bayly (2004) suggested distinguishing between archaic and proto-globalization, as well as the “modern world.” Beyond the possibility of rejecting the concept altogether, proto-Anthropocene suggests an enlargement of the perspective of human transformative action in its natural environment and the long history of relations between humans and nature. Besides an underlying chronicity, proto-Anthropocene emphasizes the long-term development of social behavior and cognitive models, as well as the historicity of

epistemological structures (Renn 2012), before the complete transformation from an agriculture-based society into an industrialized society.

Based on definitions of the Anthropocene, proto-Anthropocene encompasses a variety of different domains of human action. One domain includes the production modes, industry and the consumption of goods that led to a transformation of the Earth system. This complex domain is important to the Anthropocene, as these activities affect pollution and the extraction of natural resources from the environment. This point is elaborated in Helge Wendt's contribution to this volume. He looks at the short history of coal mining in early nineteenth-century Cuba. In the context of inner imperial and transcolonial exchange of knowledge, some actors in that episode created, out of the extraction of coal, the possibility to industrialize the island's economy.

Another factor of the Anthropocene is the "advancement of science." Knowledge deals directly with nature and natural phenomena and causes immediate human action. Geology, for instance, is directly related to the exploitation of minerals by mining.¹ Biology is associated with the use of plants for medicine,² agriculture or textile industries. Medicines can be prepared without Western biological scientific knowledge about plants, but some knowledge is needed to define which plants should be used.³ Thus, any form of knowledge about nature brings with it the exploitation of natural resources.⁴ The difference between proto-Anthropocene and Anthropocene lies in the dimension of the exploitation of natural resources and in the dimension of an all-encompassing use of knowledge to an economic end.

Diminishing Distances: Proto-Anthropocene and Cultures of Science

Will Steffen, Paul Crutzen, Jacques Grinevald and John McNeill describe the long duration of humans acting on natural processes and the development of knowledge connected with human actions:

The history of interactions between humans and the environment in which they were embedded goes back a very long way, to well before the emergence of fully modern humans to the times of their hominid ancestors. During virtually all of this time, encompassing a few million years, humans and their ancestors influenced their environment in many ways, but always by way of modification of

¹ See chapter 9 by N. Valverde.

² See chapter 2 by J. Pardo-Tomás, chapter 8 by M. Sánchez Menchero and chapter 6 by T. D. Walker.

³ See chapter 7 by A. Morales Sarabia.

⁴ See chapter 10 by H. Wendt.

natural ecosystems to gain advantage in gathering the vegetative food sources they required or in aiding the hunt for the animals they hunted. Their knowledge was likely gained by observation and trial-and-error, slowly becoming more effective at subtly modifying their environment but never able to fully transform the ecosystems around them. They certainly could not modify the chemical composition of the atmosphere or the oceans at the global level; that remarkable development would have to wait until the advent of the Industrial Revolution a few centuries ago. (Steffen, Grinevald, et al. 2011, 846)

Studies on the development of knowledge in the proto-Anthropocene concentrate on knowledge production and on social processes of altering “nature.” For these studies, any time limit seems futile when another important issue has to be solved: proto-Anthropocene as an analytic term has to prefigure in a more strict sense the time period it deals with. Proto-Anthropocene used in a more descriptive mode enables an adaptation to different historical contexts and more flexible employment. Thus, developments in the field of human-nature-interactions can happen to be placed in the Anthropocene and in the proto-Anthropocene synchronically.

The Iberian example is a good case for employing such a flexible notion of the proto-Anthropocene. When the industrialization and the capitalistic economy were already flourishing in some regions of the empire, other regions still showed features of a very small territorial market-oriented economy and small-scale craftsmanship (Lockhart and Schwartz 1997, 363–366). Both forms of economies were conjoined with state interventions in markets and economies to control and restrain private investments, and to collect the highest possible amount of taxes and capital (Bakewell 1971). Such forms of economic organization were partly established in the Spanish-American mining sector, where the Spanish Crown conceded licenses to mine silver, gold, mercury and other metals. In the Spanish-American mining sector, state investment of joint private capital, and capital profit coincided with the private interests of leading administrators as well as the necessities of political organization. Enormous numbers of workers migrated to work in the mines, water works were constructed and slag-heaps multiplied in the mining regions.

The concept of the proto-Anthropocene considers the developments in more or less capitalistically organized economies and unites them into a single mode of description. For instance, in the Iberian economies of knowledge, nature played an important role for institutions, epistemological traditions and possibilities of voyaging in the seventeenth and eighteenth centuries (Simões et.al. 2010), as Ana Simões, Ana Carneiro and Maria Paula Diogo have stated in reference to the situation in enlightened Portugal:

The knowledge of Nature, associated with the ideas of happiness and progress linked to the science-technology axis, was seen as a means for the exploitation of Nature and for the improvement of life. New technical practices developed, in particular, in the military, milling industry, sawing and draining. (Simões, Carneiro, and Diogo 1999, 8)

This refers to the point of scientific divide mentioned earlier. When dealing with the concept of Anthropocene and Proto-Anthropocene, we have to insist upon the fact that different knowledge economies have different ways of developing. In present debates, alternative ways of understanding the present situation are often ignored, as are alternative ways of dealing with problems related to climate change. It is therefore useful and necessary to reconsider different scientific traditions, including those that are either subsumed by Europeans or ignored because of the predominance of others.

Consciousness of the pre-eminence of the moderns over the ancients had more than one manifestation in the Iberian Peninsula. Unlike their Italian peers, local humanists were not easily dazzled by the virtues of Latin and other classical languages and consciously set out to develop their own vernaculars. The literatures on metallurgy, medicine, agriculture, surgery, meteorology, cosmography, cartography, navigation, and fortifications studied by Maravall are peppered with comments both on the ignorance of the ancients and on the technical superiority of the moderns. (Cañizares-Esguerra 2004, 89)

Cañizares-Esguerra shows that the workings of Iberian knowledge economies in the early modern period differed from Italian ones. Furthermore, knowledge production in the Iberian countries included not only idealistic but also very practical issues—the production of knowledge went hand in hand with the production of goods and consequently had far-reaching repercussions on the environment.

The understanding of the concept of Anthropocene as a process in which sustained human influence on the environment is irresolvable when combined with natural processes is therefore not necessarily tied only to the smoke stacks of Manchester, or other areas. The use of black coal, for instance, in the Iberian empires never attained the dimensions that it did in the British Empire. In the Iberian peninsula, coal was only used marginally in comparison to organic fuels. In the colonies, only a few sectors used coal, as was the case for the Cuban sugar industry in the first third of the nineteenth century. Equally, in the transport sector, a few steamboats were employed, but the large dockyards continued

to build sailing vessels from wood, and the mining industries continued to use charcoal and wood for fuel. In the colonies—even in the eighteenth century—no large-scale iron smelting industry had developed, nor did households start to heat with pit coal. These differences to the English industrialization process did not mean that there was no change in the production processes in the Spanish and Portuguese world. Here, a proto-industrialization evolved—also called domestic industry (Torrás 1998)—that is comparable to many other regions in Europe, America or Asia (Thomson 1996). Catalonia, for instance, had a long-term integration of its cotton industry into different markets (Martínez-Galarraga and Prat Sabartés 2013). In the eighteenth century, these developments relied less on fossil fuel than in the English production processes, but nevertheless had a lasting impact on the environment.

The question of whether or not the development of production in the Spanish colonies should be designated by proto-industrialization is open question. This very European concept is intended to describe changing patterns of production in the organization of labor, spaces of production in factories and in managing profits. This concept has only been hesitantly adapted to the Iberian colonial systems of production as some historians underline differences to the European context. The variety of organized human labor in the Americas, from slavery to non-capitalistic forms of free labor (Stern 1988), presents one argument against applying the concept of proto-industrialization to the Americas. Another argument is the different ways of achieving centralized places of production, as Bulmer Thomas (2014, 139–140) argues. He and other historians of economy consider the development in most of the regions of the Spanish and Portuguese Americas to be incomplete in comparison to the European model of proto-industrialization.

Comparable to the Latin American discussion about proto-industrialization, Indian historians of economy have asked whether this term and concept could be useful to Indian history. Abhay Kumar Singh (2006), for instance, argues that if proto-industrialization is applied to the economic and social history of the subcontinent, some important changes in the concept should be considered. In his study, he focuses on the process of changing production modes in Bengal and reasons to modify the concept in the sense that more regional variations of economic and social development can be considered to be of a “proto-industrial” nature. This perspective does not imply the transfer of an European historical concept to a non-European context, neither does it imply “reading” Indian history merely as an annex to European historical developments. Frank Perlin (1983) has argued that by adopting the concept, using European examples, it could even be used to explain some of the processes in pre-colonial Indian history.

As in the case for India, some historians of economy have argued in favor of a colonial and post-colonial proto-industrialization of some regions in Spanish

and Portuguese America, pointing to some important factors such as employment rates, circulation of money (Ouweneel and Bijleveld 1989), production modes and employment strategies.

The textile industry in Spanish America was, in the words of Manuel Miño Grijalva (1993), a factor of proto-industrialization. This branch of economy comprised as much the production of cotton as it did the production of fabrics and clothes. He states repeatedly that the way this industry was organized and integrated into the regional and transregional commercial networks confirmed its proto-industrial character. For the Brazilian case of textile home industry in the last decades of the eighteenth century, Douglas C. Libby (1997) employed and adapted the concept of proto-industrialization to the Minas Gerais case. He argues that during this time an important and independent household industry had developed that was very market-oriented and that profoundly changed the organization and division of labor.

Besides social-economic considerations, the impact that different branches of industry had on the environment could indicate the character of proto-industrialization. From an Anthropocene point of view, changing modes of production in the colonies often had a disastrous impact on the natural environment. Elinor G. Melville (1990) has shown how strong an effect the colonial Spanish proto-industry could have on the environment. After Spaniards had settled the Mezquital Valley to the north of the Mexican capital in the mid-sixteenth century, overstocking and thoughtless grazing of sheep had degraded the original vegetation leaving behind arid and deforested land. After only a few decades, Spanish proto-industrial agriculture had changed the biogeography and the biochemical processes in the Mezquital Valley forever (Melville 1990).

Yet another example is the use of mercury in the silver mining industry. Jason Moore (2003) for instance, addresses the relation between deforestation and Indigenous mining methods. When the quality of the mined silver ores decreased, an increasing amount of wood was needed to extract the silver. Now, new methods—stemming from Europe and employed by Europeans—which used mercury as the main agent in the silver extracting processes were employed, causing two kinds of change in the Peruvian silver industry. The first change consisted of the demotion of the Indigenous from master-processors to mere subworkers. A second change came about with extensive environmental damage caused by the mercury employed and by the higher demand for wood. Wood now was needed to extract the mercury from the ore at the Spanish mercury mines at Huancavelica (Peru) and Almadén (Spain) (Lockhart and Schwartz 1997, 149), and for separating the lethal mixture of silver and mercury once the extraction process was accomplished (Moore 2003). Thus, in order to extract a higher percentage of sil-

ver from the silver ore, the deforestation of some regions of the Andes continued and the new polluting process of amalgamation was introduced.

The Andean silver mining industry is furthermore a good indicator of Anthropocenic changes in environmental conditions, as a paper by Uglietti et al. (2015) points out. An important increase in mining related pollution of the atmosphere can be detected from ice-core analysis. This indicates a growing output of different air polluting elements resulting from expanding silver mining activities in the Andean region. The analysis of the Quelccaya North Dome ice core was able to detect lead, silver, bismuth, chromium, copper, molybdenum and antimony, increasing considerably with the beginning of Spanish colonial domination. Hylander and Meili (2003) argue that Spanish mercury mines have contributed to one third, and mines in the Americas to nearly one fourth of globally mined mercury. Cooke et al. (2013) underline the importance of the legacy of mercury deposits in some regions of the Andes where industries using mercury developed from the late pre-Columbian era. The analysis of Hg isotopes suggests that different uses of mercury, for amalgamation or for cinnabar mining, for instance, could have different effects on regional environments and societal evolution.

Furthermore, the expansion of the sugar industry has also been shown to be an example of the proto-Anthropocene process: environmental changes occurred through the expanding monoculture of sugarcane fields. Sugar exploitation in a proto-industrial style demanded significant energy expenditure, which was only possible through the use of slaves. Moreover, specialized technologies often stemming from other countries—such as the steam engine—were developed or adapted to the needs of the sugar production processes. Here, an increasing need for black coal arose, connecting the Spanish colonial sugar industries with the coal producing regions of England and North America (Fraginals 1978).

Lastly, in the Philippines during the Spanish colonial period, a huge population growth took place that went hand in hand with serious deforestation. In the vicinity of Spanish towns, mainly in the region of Manila, nearly all the surrounding forests had disappeared by the mid-nineteenth century. Contemporaries took this development seriously and urged the Spanish Crown to found the Royal Mountain Inspection Service. This helped to both realize projects of reforestation and convince the people in charge to study the fauna, botany and climate of the archipelago in more detail (Bankoff 2011). Thus, a co-evolution of degradation of nature, of scientific explanation and of action taken against the consequences of human induced devastation took place in, for instance, in the nineteenth-century Philippines.

This example of the Philippines confirms what Christophe Bonneuil and Jean-Baptiste Fressoz have recently stated:

Although only a first analysis, it is certain that modern people had their own forms of environmental reflexivity. It is persuasive, though truly confusing, to conclude that our ancestors destroyed the environment, knowing well the reason why. The industrialization and radical transformation of environments caused by pollution took place despite the environmental medicine, and the ever more intensive use of natural resources despite the concept of economy of nature and knowledge of their limited availability. The historical problem, then, is not of an emerging consciousness of environmentalism but rather the opposite: [it is about] understanding the schizophrenic nature of modernity which continues to envisage the human being as a product of the environment and at the same time allows him to change and destroy it. (Bonneuil and Fressoz 2013, 221)⁵

The evolution of *Anthropocenic* knowledge described and systematized the environmental changes in ever-higher numbers and in ever more detail. Scientists took into consideration that the changes were due to the impact of human behavior on the natural sphere, thereby allowing analysts to recognize just how related the human and non-human spheres of life were.

Some areas of proto-industrial developments are studied to determine how they relate to the generation and transfer of knowledge. This is the case for the proto-industrial production of silver, which used the amalgamation process. This process, using mercury as the main material for extracting the silver from the ore, was transferred from the context of the Hungarian-Austrian silver industry to the Americas. In Huancavelica, Potosí or Zacatecas, it profoundly changed the social order of mining and had devastating and long-lasting effects on the environment. This case differs from most of what is known about other early industrialization processes, where a disjunction between practice and theory reigns.

The Anthropocene and Its Legacy of “Scientific Colonialism”

Acquisition of Data in the Colonial World

The current project in the history of the Anthropocene deals with traces of knowledge, communication of knowledge, organization and systematization, as well as bodies of knowledge reaching back to the period of European colonialism. During the same era, which according to current understanding is when the Anthropocene began, an immense part of the world was under European colonial domination. During the colonial eras, from the fifteenth to the early twentieth centuries, data

⁵The translation is by the author.

was systematically collected in the name of scientific advancement, for better administrative control and for economic activities in a context of reduced contingency or, as it has been called, “economy of thinking” (Mach 1976 [1933]). But colonization exceeds the settings of the beginning of the Anthropocene. In order to connect the previous era with the later one, we must therefore use the related concept of proto-Anthropocene. Furthermore, this approach helps to investigate how certain features of the Anthropocene, which are taken for granted, developed over long periods of time and in different geographical areas. Nuria Valverde shows in her contribution to this volume, for instance, how the lack of a uniform approach to systematizing information in mining maps could lead to legal problems and finally compromise mining activities. But despite this lack of knowledge, making mining maps in the Spanish colonial context enhanced the abstraction of geographical and topological representations and provided new knowledge about nature and new possibilities for exploiting natural resources.

It was during the eighteenth century that data was collected in the French, British and Spanish colonies. This data was then compared, also to data collected in a much more contingent manner during previous decades. Data on temperature, for instance, stands in a long tradition of archiving climate-related information. The counting of population, which became less of a merely administrative and locally organized practice and evolved into the discipline called demography. Countries were now topologically, geographically and geologically measured, trees in forests were counted, meteorological occurrences were described and compared and conclusions were drawn. Globally important phenomena, such as the so-called Humboldt Current, oceanic warm water currents and wind systems could be observed. Migration movements of humans and animals around the globe were considered and provided an explanation for changing habitats and population patterns throughout the Earth’s history.

To a higher degree, this data relied on the opportunities provided by the colonial situation for the scientific exploratory voyages of, for instance, Louis Antoine Bougainville (1729–1811), James Cook (1728–1779) or George Forster (1754–1794). All of these exploratory voyages, which represent only one form of how knowledge could be gained in the colonial period, had an enormous impact on the European public and European scientific communities (Safier 2008). Their reports were published, translated and circulated, providing readers with exotic accounts of countries, people, flora and fauna. An interesting point of view depicted in these reports was that even presumably isolated groups of people were connected to sometimes, remote neighbors. The voyagers, who were often believed to be the original discoverers of knowledge, admitted that they often encountered already existing bodies of knowledge and ignored many more (Thomas 1991).

These scientific explorations of the eighteenth and nineteenth centuries belonged to a tradition of comparable Spanish and Portuguese voyages by Ferdinand Magellan (1480–1521) or Francisco Hernández.⁶ These provided proof that such enterprises were valuable for the expansion of European states. In a globally competitive economy of knowledge, the outcome represented additional goods, values and knowledge and were beneficial for transterritorial relationships. As José Pardo-Tomás points out in his contribution, voyages of scientific exploration were part of an economy of knowledge that was manifested in different social and cultural praxis.

The voyages had to gather large amounts of information. This they could only achieve by establishing access to innumerable informants and networks of circulating knowledge, as Angélica Morales Sarabia, Sonja Brentjes and Tim Walker mention in their contributions to this volume. Here we have another connection to times of high imperialism, the first half of the twentieth century when European colonizing countries needed so-called local or native expertise in order to establish systemized data collections. In any case, the center, where all information was not only gathered but also put into frameworks of interpretation considered scientifically valid, was mostly located in Europe. The interpretations varied and thus different competing systems of scientific encoded knowledge from the colonies circulated. This sometimes depended on national traditions of interpretation, the kind of information being circulated, the networks of knowledge, the importance one body of knowledge was given over another.

Systematizing Colonial Knowledge

Thus in the eighteenth century, a new aim of reducing the contingency of how knowledge was gathered arose, information was processed and interpretations were generated. More systematically organized systems to gather information were required and installed throughout the colonial empires. Starting with meteorological stations, data on temperature, rainfall, days of sun, and so forth, was collected, counted, measured and communicated to centers of data processing. Daniela Bleichmar (2009) gives the example of the botanist José Celestino Mutis, who lived and worked mostly in Bogotá. As many other botanists of that time, he and a great number of his colleagues collected data and objects on scientific voyages during the second half of the eighteenth century.⁷ She argues that botany and explorative voyages during that time had manifold functions: “they were concerned with economic botany, with political economy, with Linnaean taxonomy, and with visualizing the empire” (Bleichmar 2009, 446). Well-trained elites

⁶See chapter 2 by J. Pardo-Tomás.

⁷See also Lafuente and Valverde (2005).

established themselves in the colonies after studying at Spanish universities and executed the imperial task of data collection in several scientific fields (Berquist Soule 2014; Cabello Carro 2011). The same holds true for many of the eighteenth- and nineteenth-century British and French scientists who travelled throughout the colonial world measuring and quantifying while collecting data and objects (Bleichmar 2009). From that perspective, José Celestino Mutis remains in the same tradition of Louis Antoine Bougainville, Charles Darwin (1809–1892) or even David Livingstone (1813–1873), who all undertook explorations in different parts of the world with a comparable approach. Mauricio Sánchez Menchero in his book on Alzate and Bertolache has shown that in Mexico Creole erudite elites were able to gather the most advanced European knowledge in private libraries and make use of it by transforming it to Mexican medical practices (Sánchez Menchero 2012). Likewise, in his contribution, Sánchez Menchero identifies knowledge and objects from the colonies that were transformed and adapted for European demands.

The entanglement of theoretical and practical knowledge is part of this history: of proto-Anthropocene turning into the Anthropocene of industrialization. Historians of science have found some evidence of exchange between engineers and scientists in the early industrialization process, such as between John Smeaton (1724–1792) or James Watt (1736–1819) and the Royal Society (Buchanan 1985). During the late eighteenth century, all across Europe and in some of the European colonies, specialized schools, philanthropic societies and economic societies taught young men and experienced workers new technologies that made the exploitation of natural resources more effective (Harwood 2006). This can be considered as being part of an educational movement, producing several reformations of educational systems (Inkster 1980; Watts 1998) or as a reaction to the needs of increasing industrial activities (McLeod 1986; König 1998). Cross-European networks of education arose during these decades, and in Spain a similar movement emerged to those in England and in France.⁸

More than these personalities or single institutions, what really makes these colonial undertakings part of the Anthropocene are the long-term effects they have had on scientific outcomes. In addition to the images of men traveling the world under harsh conditions, which are still present in our collective memory today, scientists are still using what was brought back from the colonies to museums, universities and research laboratories in the Western metropolises. The educational institutions dealing with technology and its development often became parts of technical universities. Issues of scientific interest were formulated during the long colonial period and contributed to the formation of modern sci-

⁸See Anduaga (2011). For Spain, see Carbonell i Bravo (1805); Howe (1949); Llordén Miñambres (1994) and for England, see Foreman-Peck (2004); Inkster (1980).

ences, which today in turn contribute to the Anthropocene research and provide basic knowledge for how and where humans have exploited nature and natural resources.

Anthropocene and Global History: Integration of Different Knowledge Cultures

The long prehistory of the concept of Anthropocene and its issues and goals directly connect to global history issues such as dealing with different cultural systems and intercultural spheres, taking a *longue-durée* perspective and coming to concise conclusions, despite a diversity of facts. When a historical perspective was added to the concept, Will Steffen and some of his colleagues argued that the Anthropocene had every capacity to play an important role in new global history writing (Steffen, Crutzen, and McNeill 2007). They argued that the Anthropocene was not confined to the Western world.

World history is not just about past connections in the human community, any more than it is about Earth systems independent of people. In the geological epoch of the Anthropocene, it must be about ‘humans and the rest of nature’ taken together at scales appropriate to the questions of history. (Robin and Steffen 2007, 1712)

This large-scale history responds to approaches to history writings that narrate the history of humankind from its beginning as a culture producing species in so-called prehistory up until the very recent past. This kind of narrative is often organized by phases or steps in sociopolitical development from the agrarian societies, skipping over more complex formations of supra-local forms of organization to empires and modern nation states (von Sivers, Desnoyers, and Stow 2012). Stages of development, mostly from a non-evolutionary perspective, also helped to structure global history. World history writings standing in the tradition of universal history act on the assumption of stable concepts in history writing, such as, for instance, modernity (von Sivers, Desnoyers, and Stow 2012, 1017).

Another example of how period-based ordering of larger timescales can be managed is given by Christopher A. Bayly (2004), who proposed an order for the history of globalization of the last three hundred years, passing from an ‘archaic globalization’ to a ‘modern globalization.’ Bayly intended to make global history intelligible by giving it a structure of time, not by merging any aspect of the histories he dealt with into one single interpretative scheme. Thus, there is a challenge in global history writing and any other enterprise dealing with broad subjects and large periods of time, and with a large variety of issues from different historical backgrounds.

In contributing to such a debate, there is an urgent need to consider non-European data to understand what the Anthropocene aims for: historical narratives that not only serve to clarify the human past but also shed light on the ways humans have developed in responding to environmental challenges. Such insights might help humans to generate new forms of living in the future when the global climate change will have a stronger impact on human forms of organization.

Anthropocene From a Global History Perspective

In this context, the above-mentioned questions of intercultural exchange also return in debates surrounding the Anthropocene. One string of research will further investigate questions of cultural foreign data, of exploitation and expropriation, of misunderstanding or ignorance. Changing the perspective opens up the possibility to study processes of exchange and the incorporation of knowledge that was, for instance, of non-Iberian origin but that had gained a certain importance in some fields of Iberian or European knowledge systems. Knowledge about plants, social organization, religion and mining were reinterpreted and transformed in the Iberian context in the frame of colonial sciences, where the reconfiguration of bodies of knowledge constantly took place. Anthropocene here means to acknowledge these often asymmetrical exchanges of knowledge and the fact that foreign data has a place in the steadily evolving systematizations of Iberian and European knowledge. An Anthropocenic approach also encourages a closer look at how these processes were organized, which people took part, what kind of outcomes they produced, which long-term consequences they had and how new studies can proceed to frame intercultural processes of knowledge exchange in the future. This responds to the observation that these types of processes may provide assumptions and general conclusions with more detailed knowledge. Furthermore, local non-Western scientific knowledge can make available a more complex perspective on developments in the Anthropocene. Thus, the Anthropocene can help to diminish the divide between different scientific cultures. It has the potential to encourage acceptance and the acknowledgement of data from other scientific backgrounds. And finally, the Anthropocene might create a perspective in historiography that is more conscious of its own traditions.

References

- Anduaga, Aitor (2011). The Engineer as a “Linking Agent” in International Technology Transfer: The Case of Basque Engineers Trained in Liège. *Engineering Studies* 3(1):45–70.
- Bakewell, Peter John (1971). *Silver Mining and Society in Colonial Mexico 1546–1700*. Cambridge: Cambridge University Press.

- Bakewell, Peter John and Jacqueline Holler (2010). *A History of Latin America to 1825*. Chichester: Wiley-Blackwell.
- Balter, Michael (2013). Archaeologists Say the ‘Anthropocene’ Is Here—But It Began Long Ago. *Science* 340:261–262.
- Bankoff, Greg (2011). The Science of Nature and the Nature of Science in the Spanish and American Philippines. In: *Cultivating the Colonies: Colonial States and Their Environmental Legacies*. Ed. by Christina Folke Ax, Niels Brimnes, Niklas T. Jensen, and Karen Oslund. Athens: Ohio University Press, 78–108.
- Bayly, Christopher A. (2004). *The Birth of the Modern World, 1780–1914: Global Connections and Comparisons*. Oxford: Blackwell.
- Berquist Soule, Emily (2014). *The Bishop’s Utopia. Envisioning Improvement in Colonial Peru*. Philadelphia: University of Pennsylvania Press.
- Bleichmar, Daniela (2009). Visible Empire: Scientific Expeditions and Visual Culture in the Hispanic Enlightenment. *Postcolonial Studies* 12(4):441–466.
- Bonneuil, Christophe and Jean-Baptiste Fressoz (2013). *L’événement Anthropocène. La Terre, l’histoire et nous*. Paris: Seuil.
- Buchanan, R. Angus (1985). The Rise of Scientific Engineering in Britain. *The British Journal for the History of Science* 18(2):218–233.
- Bulmer-Thomas, Victor (2014). *The Economic History of Latin America Since Independence*. Cambridge: Cambridge University Press.
- Cabello Carro, Paz (2011). Spanish Collections of Americana in the Late Eighteenth Century. In: *Collecting Across Cultures: Material Exchanges in the Early Modern Atlantic World*. Ed. by Daniela Bleichmar and Peter C. Mancall. Philadelphia, 217–235.
- Cañizares-Esguerra, Jorge (2004). Iberian Science in the Renaissance: Ignored How Much Longer? *Perspectives on Science* 12(1):86–124.
- Carbonell i Bravo, Francisco (1805). *Discurso que en la abertura de la Escuela Gratuita de Química establecida en la Ciudad de Barcelona por la Real Junta de Comercio del Principado de Cataluña dixo el Dr. Dr. Franciso Carbonell i Bravo*. Barcelona: Roca and Gaspar Compañía de Jordi.
- Cooke, Colin A., Holger Hintelmann, Jay J. Ague, Richard Burger, Harald Biester, Julian P. Sachs, and Daniel R. Engstrom (2013). Use and Legacy of Mercury in the Andes. *Environmental Science & Technology* 47:4181–4188.
- Eisenstadt, Shmuel N. (2002). Some Observations on Multiple Modernities. In: *Reflections on Multiple Modernities: European, Chinese and Other Interpretations*. Ed. by Dominic Sachsenmaier, Jens Riedel, and Shmuel N. Eisenstadt. Leiden: E. J. Brill, 27–41.
- Foreman-Peck, James (2004). Spontaneous Disorder? A Very Short History of British Vocational Education and Training, 1563–1973. *Policy Futures in Education* 2(1):72–101.
- Fraginals, Manuel Moreno (1978). *El ingenio, complejo económico social cubano del azúcar*. La Habana: Editorial de Ciencias Sociales.
- Gruzinski, Serge (2004). *Les quatre parties du monde. Histoire d’une mondialisation*. Paris: Édition de La Martinière.
- Harwood, Jonathan (2006). Engineering Education between Science and Practice: Rethinking the Historiography. *History and Technology* 22(1):53–79.
- Howe, Walter (1949). *The Mining Guild of New Spain and its Tribunal general 1770–1821*. Cambridge: Harvard University Press.
- Hylander, Lars D. and Markus Meili (2003). 500 Years of Mercury Production: Global Annual Inventory by Region until 2000 and Associated Emissions. *Science of the Total Environment* 304: 13–27.
- Inkster, Ian (1980). The Public Lecture as an Instrument of Science Education for Adults—The Case of Great Britain, c. 1750–1850. *Paedagogica Historica* 20(1):80–107.

- König, Wolfgang (1998). Zwischen Verwaltungsstaat und Industriegesellschaft. Die Gründung höherer technischer Bildungsstätten in Deutschland in den ersten Jahrzehnten des 19. Jahrhunderts. *Berichte zur Wissenschaftsgeschichte* 21:115–122.
- Lafuente, Antonio and Nuria Valverde (2005). La producción de objetos y valores científicos: tecnología, gobierno e Ilustración. In: *Actas de la VIII Reunión Científica de la Fundación Española de Historia Moderna: (Madrid, 2–4 de junio de 2004)*. Ed. by Fundación Española de Historia Moderna. Vol. 2. Madrid, 333–362.
- Libby, Douglas C. (1997). Reconsidering Textile Production in Late Colonial Brazil: New Evidence from Minas Gerais. *Latin American Research Review* 32(1):88–108.
- Lippman Abu-Lughod, Janet (1995). The World-System Perspective in the Construction of Economic History. *History and Theory* 34(2):86–98.
- Llordén Miñambres, Moisés (1994). *Desarrollo económico y urbano de Gijón en los siglos XIX y XX*. Oviedo: Universidad de Oviedo.
- Lockhart, James and Stuart B. Schwartz (1997). *Early Latin America: A History of Colonial Spanish America and Brazil*. Cambridge: Cambridge University Press.
- Luca, Giuseppe de and Gaetano Sabatini (2012). Genealogies of Economic Growth in the Spanish Empire (Sixteenth–Eighteenth Centuries): Back to History. In: *Growing in the Shadow of Empire: How Spanish Colonialism Affected Economic Development in Europe and in the World, XVth–XVIIIth Centuries*. Ed. by Giuseppe de Luca and Gaetano Sabatini. Milan: F. Angeli, 11–25.
- Mach, Ernst (1976 [1933]). *Die Mechanik: historisch-kritisch dargestellt*. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Martínez-Galarraga, Julio and Marc Prat Sabartés (2013). *Wages and Prices in the Early Catalan Industrialization*. URL: <http://www.ehes.org/PRAT%20e1%20al.pdf> (visited on 10/14/2014).
- McLeod, Donald (1986). Practicality Ascendant: The Origins and Establishment of Technical Education in Nova Scotia. *Acadiensis* 15(2):53–92.
- Melville, Elinor G. K. (1990). Environmental and Social Change in the Valle del Mezquital, Mexico (1521–1600). *Comparative Studies in Society and History* 32(1):24–53.
- Miño Grijalva, Manuel (1993). *La protoindustria colonial hispanoamericana*. Mexico: Colegio de México.
- Moore, Jason W. (2003). “The Modern World-System” as Environmental History? Ecology and the Rise of Capitalism. *Theory and Society* 32(3):307–377.
- (2014). *The Capitalocene*. URL: http://www.jasonwmoore.com/uploads/The_Capitalocene_Part_I_June_2014.pdf (visited on 10/14/2014).
- Osterhammel, Jürgen (2009). *Die Verwandlung der Welt. Eine Geschichte des 19. Jahrhunderts*. Munich: C. H. Beck.
- Ouweneel, Arij and Catrien C. J. H. Bijleveld (1989). The Economic Cycle in Bourbon Central Mexico: A Critique of the Recaudación del diezmo líquido en pesos. *The Hispanic American Historical Review* 69(3):479–530.
- Perlin, Frank (1983). Proto-Industrialization and Pre-Colonial South Asia. *Past & Present* 98:30–95.
- Renn, Jürgen (2012). The Place of Local Knowledge in the Global Community. In: *The Globalization of Knowledge in History*. Ed. by Jürgen Renn. Berlin: Edition Open Access, 369–397.
- Robin, Libby and Will Steffen (2007). History of the Anthropocene. *History Compass* 5(5):1694–1719.
- Saifer, Neil (2008). *Measuring the New World. Enlightenment Science and South America*. Chicago: University of Chicago Press.
- Sánchez Menchero, Mauricio (2012). *El corazón de los libros. Alzate y Bartolache: Lectores y escritores novohispanos (s. XVIII)*. Mexico: UNAM, Centro de Investigaciones Interdisciplinarias en Ciencias y Humanidades.
- Simões, Ana, ed. (2010). *Travel of Learning. A Geography of Science in Europe*. Boston: Springer.

- Simões, Ana, Ana Carneiro, and Maria Paula Diogo (1999). Constructing Knowledge: Eighteenth-Century Portugal and the New Sciences. In: *The Sciences in the European Periphery during the Enlightenment*. Ed. by Kostas Gavroglu. Dordrecht et al.: Springer, 1–40.
- Singh, Abhay Kumar (2006). *Modern World System and Indian Proto-Industrialization: Bengal 1650–1800*. New Delhi: Northern Book Centre.
- von Sivers, Peter, Charles A. Desnoyers, and George B. Stow (2012). *Patterns of World History. Combined Volume*. New York: Oxford University Press.
- Steffen, Will, Paul Crutzen, and John McNeill (2007). The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature? *AMBIO* 36(8):614–621.
- Steffen, Will, Jacques Grinevald, Paul Crutzen, and John McNeill (2011). The Anthropocene: Conceptual and Historical Perspectives. *Philosophical Transactions of the Royal Society* 369:842–867.
- Stern, Steve J. (1988). Feudalism, Capitalism, and the World-System in the Perspective of Latin America and the Caribbean. *The American Historical Review* 93(4):829–872.
- Thomas, Nicholas (1991). *Entangled Objects. Exchange, Material Culture, and Colonialism in the Pacific*. Cambridge: Harvard University Press.
- Thomson, James K. J. (1996). Proto-Industrialization in Spain. In: *European Proto-Industrialization*. Ed. by Sheilagh C. Ogilvie and Markus Cerman. Cambridge: Cambridge University Press, 85–101.
- Torras, Jaume (1998). Small Towns, Craft Guilds and Proto-Industry in Spain. *Jahrbuch für Wirtschaftsgeschichte* 2:79–96.
- Uglietti, Chiara, Paolo Gabrielli, Colin A. Cooke, Paul Vallelonga, and Lonnie G. Thompson (2015). Widespread Pollution of the South American Atmosphere Predates the Industrial Revolution by 240 y. *PNAS* 112(8):2349–2354.
- Vries, Jan de (1994). The Industrial Revolution and the Industrious Revolution. *The Journal of Economic History* 54(2):249–270.
- Wallerstein, Immanuel (1974). *The Modern World System I: Capitalist Agriculture and the Origins of European World-Economy in the Sixteenth Century*. New York: Academy Press.
- Watts, Ruth (1998). Some Radical Educational Networks of the Late Eighteenth Century and Their Influence. *History of Education* 27(1):1–14.
- Wehler, Hans-Ulrich (1975). *Modernisierungstheorie und Geschichte*. Göttingen: Vandenhoeck und Ruprecht.
- Weissenbacher, Manfred (2009). *Sources of Power. How Energy Forges Human History*. Santa Barbara: ABC, Clio.
- Wrigley, E. Anthony (2010). *Energy and the English Industrial Revolution*. Cambridge: Cambridge University Press.