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The Anthropocene in its Early Scientific Phase (2000-2009): Objects and Objectives

The following paper constitutes a preliminary, yet critically presented assessment of the literature review conducted for my ongoing doctoral research. I became interested in the Anthropocene debate during the writing of my master's thesis and I was surprised to find a lack of in-depth analysis of the literature, and specifically the scientific one, produced during the Anthropocene's first decade of existence. The development and growing interest in the Anthropocene concept among disciplines between the years 2000 and 2009 is often too quickly compressed in remarkable publications and events. These, however, do not utterly synthesize the spectrum of application of the concept, which is moulded, shaped, defined, and applied by scientists in different ways, with different intents. The aim of the paper is thus is providing a preliminary insight on how natural sciences incorporated the concept of Anthropocene during its very first years of existence—that is, after 2000—, and explain why this time frame matters.

Since our panel has been revolving around questions of matter, let me briefly start by asking a simple question. What's the matter with the Anthropocene?

In this context, 'Matter' can be understood both as *objects* of research—namely the ontological characterization of the Anthropocene—and *objectives* of research—the research trajectories and goals. Objects and objectives are defined by fields of knowledge, and as long as the Anthropocene constitutes a matter of multidisciplinary attention, there will be multiple objects and objectives of the Anthropocene. What are the objects and objectives of the Anthropocene at present date?

By using a search engine called *Dimensions.ai*, I've found that during our current decade, roughly 37.000 scientific publications and over 300 grants appear under the keyword 'Anthropocene', investigating, from global to local to micro-scale perspective, the stratigraphic mark that *Homo sapiens* seems to be leaving on the surface of the Earth. There now exist several Anthropocene-related institutions, such as the Leverhulme Center for Anthropocene Biodiversity at The University of York; the Centre for Biogeochemistry in the Anthropocene at the University of Oslo, and a Centre for

Anthropocene Studies at the Korea Advanced Institute of Science and Technology. Several journals appeared as well, investigating this multifaceted nature of the Anthropocene*: Anthropocene, The Anthropocene Review,* or *Elementa: Science of the Anthropocene*, to name a few. This body of multidisciplinary research set a variety of objectives, the most notable being the quest of formalizing the Anthropocene in the Geological Time Scale; Assessing the historical and socio-cultural drivers of the Anthropocene; Assessing the pressure posed by Homo sapiens' collective actions on other species; questioning the 'Anthropos' and its responsibilities, and so forth.

But what happened precisely during the Anthropocene's first decade of existence? What were its objects and objectives? How was the concept being used?

Curiously, this time span is often compressed into a few popular events and publications which I refer to as the 'Big Six'. These are generally the IGBP Science Committee meeting held in February 2000, in Cuernavaca, Mexico, where Paul Crutzen famously coined the term in a moment of 'outburst' against the Holocene; the *IGBP Newsletter* article 'The Anthropocene', published in the same year by Crutzen together with Eugene Stoermer*;* 'Geology of Mankind', in 2002; *Nature'*s article 'Welcome to the Anthropocene' in 2003 (one of a long series of welcomes to the Anthropocene); Will Steffen and others 'The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature' in 2007; and finally Zalasiewicz and others 'Are we now living in the Anthropocene?' in 2008, which set the theoretical foundations of what the following year became the Anthropocene Working Group (Crutzen & Stoermer, 2000; Crutzen, 2002; Nature, 2003; Steffen, Crutzen & McNeill, 2007; Zalasiewicz & al., 2008).

How were scholars using this term? Which disciplines seemed most interested in it? How was it being implemented? To answer these questions, I looked at the literature produced between the years 2000 and 2009. I framed the Anthropocene as a 'boundary object,' a popular term in sociological analysis describing objects both plastic and hard enough to adapt to different social worlds while retaining a central, commonly understood meaning.

I addressed these questions by doing some simple online research through mainly three search engines—*ScienceDirect*, *WorldWideScience*, and mostly *Dimensions.ai*. I looked for results using the keyword 'anthropocene' in the time span between 2000-2009. I ended up with roughly a thousand pieces of data made of articles, newspapers articles, encyclopaedias, books, abstracts, conference proceedings, presentations, manuals, and research projects. Since I focus on the scientific literature, and considering that humanities interest in the Anthropocene had yet to fully develop, I tried to avoid including early humanities approaches to the Anthropocene. I partially succeeded, nevertheless I did notice a few interesting publications to which I will come back at the end of the paper.

The preliminary literature review I conducted reveals a variety of ways in which the concept was used, defined, and interpreted by scientists. There was an interdisciplinary understanding of the meaning conveyed by the notion, representing a global state of affairs caused by *Homo sapiens*. The fields of research where the Anthropocene mostly spread were Earth sciences, biological sciences,

marine sciences, oceanography, and geology. The concept's semantic was still blurred, far from its present-day, stratigraphy-based definition. Mostly, the Anthropocene was used as a sort of framework notion, often introducing the bigger picture in specialized research articles; in other instances, it was used as an epistemic tool, defining an event or delineating time boundaries defined by remarkable changes in one or more features of the Earth. What I find extremely compelling is how the concept immediately posed challenges to standard models of knowledge-making among scientific disciplines. Here are some examples.

In a study on the global carbon cycle and its role and functioning in the Earth system (Falkowski & al., 2000), the Anthropocene is defined, within the context of Earth system science, as a new Earth system domain. This is one of the very first instances of adoption of the concept in scientific publications. Despite "the debate about distinguishing human effects from natural variability" (p. 295) did not utterly abate, as the authors suggested, we witnessed an "increased understanding of climate and biogeochemical cycles" (ibid.) through new lends of inquiry. This "increased understanding" became clear among the recent tasks set by the Anthropocene Working Group in identifying the biogeochemicals markers of the Anthropocene.

The IGBP—International Geosphere-Biosphere Programme—was the first research programme that considered the Anthropocene a discrete phenomenon/state of affairs requiring focused scientific attention. An entire chapter is dedicated to the Anthropocene in their 2001 publication *Global Change and the Earth System: A Planet Under Pressure*. This work constitutes a preamble to the research program's (probably most famous) 2004 publication that goes by the same name. The Anthropocene is referred to as a new geological epoch/era, although the quotation you see here hints that the concept is inserted into an Earth system science framework. Aspects of dominance are stressed with a warning tone that anticipates later anthropocene debates on the interaction between science and society (IGBP, 2001; Steffen & al., 2004b).

A further interesting example is a an article published in 2001 by a team of experts in marine sciences and oceanography (Codispoti & al., 2001). Here, the concept is implemented in an epistemically functional way, that is, it is adopted in the research conceptual framework to bring new knowledge. Simplified, the authors challenge the widely shared belief in oceanography and marine science of a steady-state ocean, a hypothesis based on models that neglect human time scale. They do so by suggesting that we might be entering a transition state (the Anthropocene) where anthropogenic changes could alter the oceanic Nitrogen cycle, influencing turnover times in much shorter time spans than assumed by existing models. Ocean studies should thus better account for anthropogenic impact on the oceanic fixed Nitrogen regime. This study is one of the most quoted studies in marine science and oceanography implementing the Anthropocene in an epistemically functional way.

Additional data on early use of the notion can be found in what looks like a very ambitious research proposal, where the authors promoted the establishment of an observation instrument for the Anthropocene: The Sustainability Geoscope (Lucht & Jaeger, 2001; Lotze-Campen & Lucht, 2002;

Lotze-Campen, Lucht & Jaeger, 2002). Such an instrument would have integrated natural scientific and economic data through an information system (the authors claimed) a generation ahead of the European global information system of that time, the Global Monitoring for Environment and Security. Although the project never saw light, it is fascinating to witness how after only one year since its appearance, the Anthropocene was already being implemented for space-magnitude research proposals. What is also interesting is the process of conceptualization of the notion. The authors define the Anthropocene as the state "where there are no longer distant places to refer to as 'fully natural'" (p. 2), a post-natural state where "human and the natural systems are inseparably intertwined in one earth system" (ibid.).

What the authors noticed was the emergence of a phenomenon or state of affairs requiring new, technologically advanced, and scientifically built lens of inquiry. The Sustainability Geoscope would have been "an instrument for observing the emerging anthropocene and the sustainability transition" (p.3). This initiative witnesses the early merging of the Anthropocene and sustainability at the intersection of science and society.

One last example of early applications of the notion in scientific contexts is once again in marine sciences. In an article published in the one of the Dahlem Workshop Reports, *Science and Integrated Coastal Management*, the authors interpreted the Anthropocene as a set of new 'conditions' under which river basins exist and operate. Such conditions are brought about by the presence of xenobiotic substances, meaning synthesized by humans and not naturally produced in river ecosystems. Epistemologically, this implies reconsidering existing models of river fluxes accounting for anthropogenic factors, a very common practice nowadays that was still a work-in-progress in the early 2000. Another interesting point about the article is how it anticipates the present-day stance of the Anthropocene Working Group regarding the onset of the Anthropocene, placing its beginning not to the Industrial Revolution, as it was understood at that time, but rather to the 1950: "Although these authors [Crutzen & Stoermer] assign Watt's invention of the steam enginge (1784) as the starting point of the Anthropocene, I prefer to refer to 1950 as the key date for its full development" (p. 276).

This glimpse into the earliest scientific literature implementing the concept of Anthropocene bundles only the first two years of its existence, namely 2000 and 2001. This constitutes a small fraction of my research scope, nevertheless, one can already draw some patters if we look at further publications in the following years. The literature adopting the Anthropocene started growing, slowly bust steady, throughout the decade, and new and existing research programmes and institutions started embracing the powerful epistemic utility and semantic horizon that the notion seemed to possess.

The interest in the Anthropocene in marine science and oceanography expanded through the 'Land-Ocean Interactions in the Coastal Zone' project, also known as LOICZ, a joint IGBP and International Human Dimensions Programme initiative. In May 2001, the project held a conference in Miami named 'Coastal Change and the Anthropocene,' addressing the necessity of accounting for anthropogenic forces in studying and modelling coastal fluxes and processes. This generated field-specific research patterns in identifying key anthropogenic activities influencing coastal change. Since

2003, LOICZ has expanded its research areas to include economic, political, and social aspects of coastal change (LOICZ, 2002; Liana, 2004).

A further step was taken with the establishment in 2005 of SOPRAN (Surface Ocean Processes in the Anthropocene), a German-based research programme studying the atmosphere-ocean interaction. Here again, the Anthropocene is perceived as a global, human driven condition requiring novel ways of conducting research (Kock, Gebhardt & H. W. Bange, 2008; Bange, 2015).

The International Geosphere-Biosphere Programme, which I have mentioned repeatedly during the presentation, was probably pioneering in conceptualizing as well as spreading the notion among scientific communities. It made use of the word Anthropocene systematically in the various reports they published, addressing both the necessity of including anthropogenic factors in studying the Earth system, and promoting proactive efforts in the socio-political arena (IGBP, 2001; Alverson, Bradley & Pedersen, 2003; Brasseur & al., 2003; Finnegan, 2003; Kabat & al., 2004; Steffen & al., 2004b, 2004a; Crossland & al., 2005).

As part of a series of reports from workshops originally held in Dahlem from the Freie University of Berlin, the Dahlem University Press published in 2004 a report by the name of *Earth System Analysis for Sustainability* (Schellnhuber & al., 2004). Here the Anthropocene is understood as an Earth system-scale state of affairs, and is linked to the question of sustainability. This collection of contributions documents the early application and the opening of disciplines to the Anthropocene. At the same time, the Earth system science grew into the main Anthropocene conceptual framework. This research trajectory took an important step in Eckart Ehlers and Thomas Krafft's 2006 work, *Earth System Science in the Anthropocene* (Ehlers & Krafft, 2001, 2006), which witness the strengthened of the link between the Anthropocene as an Earth system concept.

These are all projects and research programmes that somehow anticipated—not merely chronologically—the present leading voice in the Anthropocene debate, the Anthropocene Working Group. With the establishment of this research programme in 2009, the Anthropocene as boundary object took a stratigraphic and geological turn that has permeated the scientific debate up to present day.

However, the stratigraphic turn had a precursor in the famous research conducted by William Ruddiman, who claimed the Anthropocene to have begun thousands of years prior to the Industrial Revolution (W. F. Ruddiman & Thomson, 2001; W. F. Ruddiman, 2003; W. Ruddiman, 2005; W. F. Ruddiman, 2007; W. F. Ruddiman & Ellis, 2009). He was undoubtedly a crucial figure in the growth and spread of the Anthropocene idea during its early scientific phase, and more importantly in the development of the Anthropocene as a stratigraphic-geological object of inquiry. He published extensively on the topic throughout the first decade of the Anthropocene, and he is still fighting his case for an early Anthropocene hypothesis today. His questioning the beginning of Anthropocene set the path for today's AWG most compelling task of locating a 'golden spike' or GSSP—that is, the

beginning of a geological unit. This is a necessary step in the quest of formalizing the epoch within the Geological Time Scale (Waters & al., 2017).

Let us now direct us towards the conclusions by discussing the few findings I hope I managed to deliver in this paper.

Some features of the Anthropocene as boundary object emerged from analysing this early scientific literature. First, the concept is mostly used in scientific contexts, it is overall informally used, and has little political connotation. Whereas today's definition of the Anthropocene in the scientific arena is mostly framed within stratigraphy, no specific discipline had either attempted to formalize it, or to establish a centralizing research paradigm, during the concept first steps in the academic world. This is quite a different situation from today, where the Anthropocene Working Group has, if criticism is allowed, somehow centralized the scientific debate by focusing on the quest for geological recognition.

Being mostly implemented as a framework notion further proves its original informal, plastic nature. In most cases, the word fits the introduction or conclusions of a determined research article, introducing the reader to the 'bigger picture'. However, as I have shown, early epistemic uses of the concept existed as well, in some instances leading to a call for improved models and practices of research. In April this year, I was in Vienna for a conference named 'The Anthropocene: Challenging the Disciplines' (Luciano, 2019). It is interesting to see how early these challenges arose, and how the spectrum of disciplines has broadened in the past 20 years. This is perhaps one of the most significant aspects of the Anthropocene in scientific scholarly.

I've briefly shown the context in which the concept was first implemented. Disciplines such as Earth system science, oceanography, marine sciences, geology, and biology were among the first to explore and test what new knowledge this concept could bring about. This tells something about the origins, and thus the meaning and trajectory of the Anthropocene as a boundary object—trajectories that were drawn early on by epistemic communities in the Western societies, such as the IGBP, SOPRAN, the Dahlem Workshop series, and of course the Anthropocene Working Group.

To sum it up. At the beginning of my paper I asked what the matter with the Anthropocene was. I defined matter as those objects and objectives that inform the Anthropocene research. During its early scientific phase, objects begun to arise connected to the Anthropocene in the discourse of *Homo sapiens* and its impact on the Earth. Such objects identified as the set of conditions that our species poses, the perturbation of the Earth's biogeochemical cycles, our role in driving the ongoing 6th major extinction event, or what makes us a geological force. The objects of study begun to synchronize with the overarching idea of *Homo sapiens* as a major variable in the functioning of the Earth system. This led research to establish prototype objectives, most of which directed towards the analysis of scale and time of the Anthropocene. Questions arose, such as how can we study this state of affairs, set of conditions, phenomenon, event, or epoch that we name Anthropocene? What proxies would best represent it? How long is this been going on? And ultimately, what can be done in a normative way?

This last question (which was far from being new within the bigger environmental discourse) was soon to be tackled by humanists. As I've mentioned at the beginning of my presentation, humanistic scholarly started growing only at the beginning of our present decade. However, some extremely interesting instances of early humanistic approaches are found in a handful of authors (Caesau, 2002; Turner, 2005; Grinevald, 2006; Crist, 2007; Robin & Steffen, 2007; Rose, 2008; Chakrabarty, 2009). These contributions set early criticism to some aspect of the notion that are today major focus areas in the humanities and social sciences. These are: which Anthropos is being represented in the word Anthropocene? Is the notion brining back forms of anthropocentrism? Or what is the historical importance of determining a beginning to the Anthropocene?

Our panel discussed matter and ideology: the Anthropocene has been heavily criticized as a product of ideological and politically guided agendas (Finney & Edwards, 2016); on the other side, interested natural scientists have been striving to prove the Anthropocene to constitute a 'matter of fact.' In a chaotic time where the Anthropocene has been touched, stretched, and moulded by virtually every discipline in humanities and Earth sciences, going back to its first steps is perhaps one way of rediscovering its epistemic utility, and setting a ground base for transdisciplinary debate. Sometimes, one step back may lead to one step forward.

In conclusion: much attention has been given today to the genealogy of the Anthropocene, and the process of formalizing it within the Geological Time Scale. In doing this, an in-depth analysis of the birth and early adoption of the notion has been unrightfully neglected. Although this presentation provided just a glimpse (and a rather chaotic one) of the Anthropocene in its early scientific phase, I believe this time span to be crucial in understanding the usefulness, trajectory, and meaning of one of the most discussed and perhaps impactful words of our times.

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