

Getting the Anthropocene so wrong

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Abstract

Rather than clarifying it, a recent paper by Simon Lewis and Mark Maslin (2015), ‘Defining the Anthropocene’, adds to the confusion about the new epoch. The paper does not recognise that a paradigm shift has occurred, one in which environmental science has been displaced by Earth System science. The story tells of an Anthropocene beginning in 1610. It is not credible, as it is not based on an accurate understanding of the Earth System. In addition, in its determination to find a ‘golden spike’ the paper confuses stratigraphic markers for the epoch itself. It finds a marker when there is no event and ignores an event when it cannot find a marker.

Keywords

Anthropocene, Earth System science, new paradigm

‘Defining the Anthropocene’, written by Simon Lewis and Mark Maslin (2015) and recently published in *Nature*, does nothing to advance the definition of the new epoch. Each of the paper’s misinterpretations can be reduced to two essential mistakes.

The first is soon apparent: Lewis and Maslin’s text fails to recognise that a paradigm shift has occurred, one in which ecology or environmental science has been displaced by Earth System science. Ecology is the science of the relationship between organisms and their local environments, whereas Earth System science is the science of the whole Earth as a complex system beyond the sum of its parts. The gulf between the two remains, even if the local environments of ecological thinking are aggregated up to the ‘global environment’. The global environment is not the Earth System.

In the paper the object in question is variously described as ‘the environment’, ‘the Earth’, ‘geology’ (as in ‘human geology’) and ‘the Earth system’. When considering the Anthropocene only the last is correct, yet it is used in the paper as if it were synonymous with ‘the environment’,

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which itself takes on various forms, from ‘vegetation’ to ‘biogeochemical cycles’. So when Lewis and Maslin begin their paper by reviewing ‘human geology’, summarizing ‘geologically important human-induced environmental impacts’, we suspect instantly that they are on the wrong track.

The Earth System is not the environment

Let me spell this out because it is the fundamental point that most commentators on the Anthropocene, including Lewis and Maslin, have not grasped. The Anthropocene concerns human impacts on the Earth System, not on the environment, and one cannot understand the emergence of the concept of the Anthropocene without an understanding of the radically new conception of the Earth System that emerged with Earth System science in the 1980s and 1990s.¹ This is explained in a recent paper by Jacques Grinevald and myself (Hamilton and Grinevald, 2015). In their recent textbook, Charles Langmuir and Wally Broecker provide a concise definition of the Earth System.

The various parts of the Earth system – rock, water, atmosphere – are all involved in interrelated cycles where matter is continually in motion and is used and reused in the various planetary processes. Without interlocked cycles and recycling, Earth could not function as a system. ... In the last fifty years or so we have come to recognize the movements in all Earth’s layers, including the plates at the surface, the mantle and the core as well as the atmosphere and ocean. (Langmuir and Broecker, 2012: 20, 22)

It is worth rereading this definition carefully. The Earth System is not ‘the landscape’, it is not ‘ecosystems’, and it is not ‘the environment’.

When we read the seminal works of the early advocates of the Anthropocene as a new geological epoch it is plain that they are all steeped in Earth System science. They always speak of the Earth as a total system, and humans as a ‘force of nature’ like the other great forces of nature that determine the evolution of the Earth System. They speak of humans as a force of nature because we have changed the *functioning* of the Earth System.

It is significant that, in the year 2000, Paul Crutzen first blurted out the word ‘Anthropocene’ at a meeting of the International Geosphere-Biosphere Programme (IGBP), the institutional heart of Earth System science, of which he was Vice-Chair (Steffen, 2013: 486).² Crutzen linked his advocacy of the Anthropocene explicitly to human-induced climate change, and he nominated the end of the 18th century as its starting point because, and only because, ice core data show ‘the beginning of growing global concentrations of carbon dioxide and methane’ (Crutzen, 2002).³

Before others began to appropriate and distort its meaning, the standard-bearers of the Anthropocene – mainly Paul Crutzen, Will Steffen, John McNeill and Jan Zalasiewicz –repeatedly reminded us that the Anthropocene concept holds water only if it can be shown that humans have had a detectable impact on the functioning of the Earth System. Yet this seems to have passed by most published authors, including Lewis and Maslin, who persistently write the new concept into the old concepts of environmental science.

It is necessary to belabour the point: the fundamental test of the Anthropocene is whether human activity *affects the Earth’s global functioning*, does so *discernibly* and *is outside the range of natural variability* (Steffen et al., 2007). It is on this basis, and this basis alone, that Steffen, Crutzen and McNeill have reassessed the evidence to conclude that the beginning of the new epoch is better set at the beginning of the Great Acceleration.

Only beyond the mid-20th century is there clear evidence for fundamental shifts in the state and functioning of the Earth System that are beyond the range of the Holocene and driven by human activities. (Steffen et al., 2015)

Nothing happened to the Earth System in 1610

It is a clear statement whose words are judiciously chosen. Yet many scientists who have leapt into the Anthropocene debate fail to grasp its simple but fundamental lesson. As a result, Lewis and Maslin develop a story that is a patchwork of dubious claims leading to the conclusion that the new epoch ought to be dated from 1610.

Although the paper's storyline was striking enough to generate extensive media coverage, the 1610 Anthropocene starting date is an arbitrary one without scientific basis. So how did they come up with it? The authors noticed a small (7–10 ppm) dip in the global concentration of CO₂ then wove around it a complex story about colonization of South America, depopulation, forest regrowth, trade, species exchange and pollen counts. It is an explanation that does not meet the criteria of correlation let alone causation. No attempt is made to show numerically that the dip changed the functioning of the Earth System or was caused by human activity, other than the mention of some historical events that occurred at roughly the same time.

The dip was, in all likelihood, the result of natural variability⁴ and the fact that it ended after a few decades is not explained in the paper. The argument for 1610 is no more than speculation built on speculation. When other scientists and historians begin to examine more closely the historical correspondences and the scales of the various claims about colonization, population decline, the spread of crop varieties from Europe to South America and back the other way, pollen in marine sediments, rates of forest regeneration, atmospheric CO₂ and the course of the 'Little Ice Age', the Lewis–Maslin story will surely fall apart.

Yet the authors believe that this small, temporary and unexplained dip in atmospheric CO₂, which was not enough to change the functioning of the Earth System and was probably not due to human activity, should trump the 120 ppm increase in CO₂ emissions since the Industrial Revolution, an increase that is very large, is definitely caused by human activity and is virtually certain to be the cause of rapid global warming that will last for many centuries.

In order to defend it Lewis and Maslin must engage in some intellectual gymnastics to dismiss the other main contenders for the start date. There are only two that are robust, the onset of the Industrial Revolution⁵ and the beginning of the Great Acceleration. They reject the Industrial Revolution by arguing that 'humans have long been engaging in industrial-type production'. This is a gross distortion of the argument. The point about nominating the Industrial Revolution is not that there was more industry but that it marked the beginning of the burning of coal on an industrial scale, which had a discernible effect on the functioning of the Earth System. As I will show, this is another example of Lewis and Maslin's persistent confusion of an event in Earth history with a historical marker for it.

After pointing out that the Industrial Revolution did not happen everywhere at once they go on to claim that the rise in CO₂ concentrations was slow in the 19th century and the absence of an abrupt change rules out the Industrial Revolution as a Global Stratotype Section and Point (GSSP) marker. Well, yes, and this is the reason that Earth System scientists are now inclined to nominate the beginning of the Great Acceleration as a more decisive and unambiguous start date (Zalasiewicz et al., 2014). To compound the confusion Lewis and Maslin later claim that one advantage of their 1610 date is that the colonization of South America made possible industrialization in Britain 150 years later! Many events made industrialization possible, including the Enclosure Laws, the rise of the British merchant class and the invention of the Spinning Jenny, so to pick out colonization of South America is mere fancy. To repeat, what matters in locating the beginning of the Anthropocene is the time at which human activity changed the functioning of the Earth System.

The golden spike fetish

For consistency we would expect the unambiguously rapid increase in CO₂ emissions from the end of the Second World War to persuade Lewis and Maslin to accept, say, 1945 as a suitable start date. But to dismiss this contender they go down a different track, one that causes them to reject 1945 and pick out the date of 1964. To understand what they are doing I need to comment on their second big mistake, their misplaced preoccupation with the GSSP or the golden spike.

The fixation arises not, as before, because Lewis and Maslin confuse Earth System science with environmental science but because they confuse Earth System science with traditional geology or, more precisely, with stratigraphy. They write: ‘Defining the beginning of the Anthropocene as a formal geological unit of time requires the location of a global marker of an event in stratigraphic material, such as rock, sediment, or glacier ice, known as a Global Stratotype Section and Point (GSSP) ...’. Typically, the marker is the global emergence of new species uncovered as fossils in rock strata. Lewis and Maslin ignore the new species requirement but cling to the idea that we must have a global marker in rock strata; for them, no GSSP means no new epoch.

Dropping the new species test is an obvious move (and not just to Lewis and Maslin) as there are no new species appearing with the arrival of the Anthropocene, although plenty are disappearing. This ought to signal that identification of the new geological epoch can be like no previous one and the conventions will have to change (something the Anthropocene Working Group is wrestling with). From the viewpoint of traditional geology, the Anthropocene markers have to be imagined or ‘backcast’ by projecting oneself forward a million years or so. Lewis and Maslin, however, are not happy with a GSSP that *will be* apparent; they must be able to find one now.

Short of stratigraphers turning their traditions upside down, the Anthropocene Working Group (AWG) will also have to provide a clear, datable marker for the new epoch if it is to persuade the International Commission on Stratigraphy to accept the proposed addition to the Geological Time Scale. Jan Zalasiewicz and others (including several members of the AWG) have recently published a paper nominating 1945 as the Anthropocene’s starting date because ‘it was from the mid-20th century that the worldwide impact of the accelerating Industrial Revolution became both global and near-synchronous’ (Zalasiewicz et al., 2014). They argue that this is an appropriate year because the first nuclear bomb tests at Alamogordo, New Mexico were staged then and the effects will show up in the rock strata as a layer of radionuclides.

However, Zalasiewicz and his co-authors understand that *the marker is not the epoch*; it is just a marker. The Anthropocene is defined not by nuclear blasts but by a human-induced change in the functioning of the Earth System, one mainly due to climate change from the burning of fossil fuels. The nuclear explosions did not in any way change the functioning of the Earth System; the layer of radionuclides that geologists in a million years will detect are merely a signifier, and have nothing directly to do with the Anthropocene. They do, however, have a great deal to do with it indirectly, because they signalled unambiguously the dawn of the era of global economic domination by the United States of America, which was intimately tied to the economic boom of the post-war years and so the rapid increase in greenhouse gas emissions and associated warming.

Lewis and Maslin, however, are fixated on the marker at the expense of what is marked. And so they play around with data on nuclear isotopes and pick out 1964 as the beginning of the Anthropocene – it was, apparently, the year in which ¹⁴C shows up as a maximum in some tree ring data⁶ – completely forgetting what this ‘golden spike’ is supposed to signify, a change in the functioning of the Earth System due to human activity. In fact, that change is *detectable* 20 years (if not 120 years) before their arbitrary selection. The 1964 peak in ¹⁴C may ‘provide an unambiguous global change in a number of stratigraphic deposits’, but it has absolutely nothing to do with the Anthropocene. The marker is not the epoch. It makes no sense to replace 1945 with 1964 as the

start date of the Anthropocene when 1964 cannot be linked in any way to any point of inflection in the functioning of the Earth System, human-induced or otherwise.

It is worth noting here that to support their claim of a 1610 start date Lewis and Maslin write that the transoceanic movement of species is ‘an unambiguously permanent change to the Earth system’. In support they cite a paper by Zalasiewicz et al. (2011). Zalasiewicz et al. do not suggest that species movement at that time changed the Earth System. The paper simply lists biostratigraphy as one of the kinds of evidence used to determine transitions in the Geological Time Scale. The referencing of Zalasiewicz et al. is used by Lewis and Maslin to defend their choice of a 1610 start date ‘because the transoceanic movement of species is a clear and permanent geological change to the Earth system’, a crucial claim for which they adduce no evidence. Yet it nicely encapsulates the dual misconceptions that underpin their paper – a lack of understanding of what the Earth System is, and the ‘spike fetish’ that causes them to find a marker when there is no event and to ignore an event when they cannot find a marker.

A paradigm shift

All of this raises the question of why *Nature* would publish the Lewis-Maslin paper. The short, and rough, answer is that the Earth sciences are undergoing a paradigm shift, from environmental science to Earth System science. Historically, this kind of shift is rare and takes a long time to take hold because it requires communities of scientists to change radically the way they think about the world. Against sustained resistance, it took some 40 years before the theory of plate tectonics became accepted (Oreskes, 1999). The problem is that those who have not made the shift do not accept that a shift is needed either because the evidence contradicts their firmly held theory or principles (as in the ‘Wegener revolution’) or because they absorb the new paradigm into the existing one, reinterpreting it so that it seems to fit into familiar concepts (as in this case). The elision of the Earth System and the environment is the first sign of this failure to understand. Attempting to shoehorn the Anthropocene into changes in the landscape or ecosystems is the second.

By applying a different, and outdated, paradigm, various geographers, archaeologists and ecologists have ‘falsified’ the claims about the Anthropocene put forward by the Earth System scientists (Hamilton, 2014). For their part, the Earth System scientists have not argued that the old paradigm is ‘wrong’, only limited and now superseded, because it cannot properly understand and explain how the Earth is changing. The problem is that the ‘war’ between the old paradigm and the new one has not yet been declared, because only a handful of scientists have become aware that there is one underway, a hidden battle now unwittingly being fought through the journals.

In mitigation of Lewis and Maslin’s paper and the editors of *Nature*, the idea that human beings could be responsible for changing the trajectory of the Earth System presents a profound challenge to the conventions of the Geological Time Scale, a challenge that everyone is trying to come to grips with, some more consciously than others. The truth is that traditional stratigraphy is unsuited to making a judgement about the Anthropocene. Finding new species (or other signs) in rock strata is not the same as identifying a change in the functioning of the Earth System. (A retrospective examination of the correspondence between the transitions from one interval to the next in the Geological Time Scale and episodic changes in the functioning of the Earth System is an important study yet to be done.⁷) Moreover, while geologists will find markers of the Anthropocene in the rock strata in a million years’ time, they cannot do so now. A range of above-ground indicators is needed and that is why the membership of the AWG includes not only geologists and palaeontologists but, among others, an atmospheric chemist, a climate modeller, an Earth System modeller and a forest ecologist. It was bold of the International Commission on Stratigraphy to create the

Anthropocene Working Group. The question now is whether it can accept the consequences of its decision to appoint such an eclectic mix of expertise.

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Notes

1. I agree with Will Steffen that both words in ‘Earth System’ should be capitalized. The Earth System is a unique entity, like the Sun, and deserves a proper noun.
2. The role of the IGBP in the development of the Anthropocene concept is discussed by Hamilton and Grinevald (2015).
3. It is true that Crutzen opens himself up to misinterpretation by referring to ‘the effects of humans on the global environment’.
4. This is the argument made by Waters et al. (2015) in a brief response to Lewis and Maslin by Earth System scientists.
5. By which I mean the first period of industrial transformation in Britain in which coal became the dominant source of energy gradually in the 19th century.
6. A fact already noted by Zalasiewicz et al. (2014).
7. A point made by Jan Zalasiewicz in an email to the author.

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