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The Anthropocene Belongs to Earth System Science

- At 23 August 2016
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The idea of the Anthropocene was conceived by Earth System scientists to capture the very recent rupture in Earth history arising from the impact of human activity on the Earth System as a whole. (1,2)

Stop. Read that again. Take special note of the phrases “very recent rupture” and “the Earth System as a whole”. Understanding the Anthropocene, and what humanity now confronts, depends on a firm grasp of these concepts arising out of the very new discipline of Earth System science. (3)

Much of the literature on the Anthropocene – its essential idea, its causes, its starting date – is bedeviled by readings of the new concept through old disciplinary lenses, readings that fail to understand the revolutionary implications of humankind taking the Earth into a new geological epoch. (4)

In the canonical statement of the Anthropocene, the proposed new division in the Geological Time Scale is defined by the observation that the

human imprint on the global environment has now become so large and active that it rivals some of the great forces of Nature in its impact on the functioning of the Earth system. (5)

The Anthropocene is not defined by the broadening impact of humans on “the environment”, “ecosystems” or “the landscape”, that is, as an extension of what humans have been doing for centuries or millennia. It is defined by human interference, over recent decades, in the functioning of the Earth System, that is, the planet as a whole understood as a unified, complex, evolving system beyond the sum of its parts. (6)

The components of the Earth System are integrated so that climate change, for example, affects not just the atmosphere but also the functioning of the hydrosphere, the cryosphere, the biosphere and even the lithosphere. (Arguably, anthropogenic climate change is more of an oceanic than an atmospheric phenomenon.) Only in recent decades, or at most the last two centuries, have humans begun to change the way the Earth System operates.

The starting date

Most of scientific misinterpretation of the Anthropocene has emerged in claims about its starting date. Crutzen and Stoemer initially nominated the end of the 18th century, with the European industrial revolution’s large-scale coal-burning triggering rising concentrations of CO₂ in the atmosphere. (7) More recently, members of

the Anthropocene Working Group have proposed 1945 as an unambiguous beginning of the shift in the Earth System's functioning. (8)

Peering through the lenses of landscape ecology, some have interpreted the new geological epoch as another name for the continued impact of humans on the landscape or ecosystems. Ellis claims that since humans 'have been reshaping the terrestrial biosphere' for millennia "the entire past 11,000 years of the Holocene might simply be renamed the Anthropocene", (9) despite the fact that for Earth System scientists the new epoch is presented *in contrast* to the Holocene.

Ellis recruits to his cause the work of palaeoclimatologist William Ruddiman who argued that the Holocene-Anthropocene shift occurred 5,000-8,000 years ago with the onset of forest clearing and farming, which led to enhanced levels of CO₂ and CH₄ in the atmosphere. (10) However, human impact on the Earth System (as opposed to the landscape) 5,000 to 8,000 years ago is not discernible, and certainly was not large enough to upset the stability of the Holocene Earth. (11,12)

None of the leading exponents of Earth System science believes that changes in the terrestrial biosphere alone can bring about a new geological epoch, and even less so if we are thinking of vegetation and landscape ecology;

the terrestrial biosphere, in isolation, is not the right place to be looking for a planetary-scale tipping point; one must consider the coupled dynamics of the Earth system as a whole ... (13)

Looking through the lenses of archaeology, two analysts misconstrue the question from the outset when they write that the Anthropocene's starting date depends on "when human societies first began to play a significant role in shaping the earth's ecosystems." (14) The very last letter, the "s" in ecosystems, gives it away. The Anthropocene did not begin when humans first play "a significant role in shaping the earth's ecosystems"; it began when humans first changed the functioning of the Earth System.

Yet the misconstrual is necessary if they are to insert archaeology into the debate, so that "the beginning of the Anthropocene can be usefully defined in terms of when evidence of significant human capacity for ecosystem engineering or niche construction behaviours first appear in the archeological record on a global scale". These behaviours are then traced to the domestication of plants and animals beginning 10,000 years ago.

In another misreading two other archaeologists see the Anthropocene as no more than a part of a "single complex continuum" over 50,000 years due to "human geographic expansion". (15)

Not geography or pedology either

Looking through the lenses of social geography, two analysts have come up with the "pre-Columbian Anthropocene hypothesis", locating the start of the new epoch in 1610 based on a complex narrative covering the colonization of South America, introduced diseases, depopulation, forest regrowth, trans-continental trade, species exchange and pollen counts, all of which are said to be associated with a small dip in the atmospheric concentration of carbon dioxide in that year. (16)

However, the analysis failed to show numerically that the dip (sic) in CO₂ changed the functioning of the Earth System or was caused by human activity. Earth System scientists pointed out that in the pre-industrial Holocene there were many comparable dips in atmospheric CO₂ concentration and that a change of 10 parts per million is well within the range of natural variability in the Holocene and pales into triviality beside the jump in concentrations from 280 ppm in 1800 to 400 ppm today. (17,18)

Finally, soil scientists have viewed the Anthropocene through the lenses of pedology to claim that evidence of anthropogenic modification of soils going back 2,000 years defines the start of the Anthropocene. (19) This too begins from a total misconception. The Anthropocene is decidedly not "the period when human activity acts as a major driving factor, if not the dominant process, in modifying the landscape and the environment". The new geological epoch does not concern soils, the landscape or the environment, except insofar as they are changed as part of a change in the functioning of the Earth System as a whole.

A common feature of each of these misreadings of the Anthropocene through the lenses of landscape ecology, social geography, archaeological and pedology – that is, the treatment of the new epoch as reflecting the same kind of landscape or ecosystem change that has been occurring for centuries or millennia – is that they divorce

it from modern industrialisation and the burning of fossil fuels. In this way the Anthropocene no longer represents a rupture in Earth history but a continuation of the kind of impact humans have had for millennia. It is thereby rendered benign.

That so many scientists, often publishing in prestigious journals, can misconstrue the basic definition of the Anthropocene as nothing more than a measure of the human footprint on the landscape is a sign of how far Earth System science has to go in changing the way many scientists still think about the Earth.

This is a longer version, with references, of a comment piece published in [Nature](#) today. With thanks to Jacques Grinevald for stimulating many of the ideas here.

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