social sciences

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Precursors and Antecedents of the Anthropocene

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Abstract: There seem to be two sorts of debates about precursors and antecedents to the Anthropocene. One concerns the question whether the concept of the Anthropocene was captured by earlier terms, such as "noösphere" or "the Anthropozoic Era". The other concerns whether the full-scale transformation of Earth systems was already, at least partially, triggered sometime prior to the 19th century Industrial Revolution. This paper takes a *wider* perspective, which may be seen as orthogonal to these debates, by enquiring whether there are *other biological agents* in Earth history who may have generated a new Epoch, and also by seeking to identify historical and prehistoric antecedents in human–nature relations that may *foreshadow the Anthropocene*. One conclusion is that humans are certainly *not* the first biotic agents becoming drivers of planetary system changes. Another conclusion, ironically, is that some cultural innovations that were *adaptive* under earlier conditions presently have become collectively *mal*-adaptive and contributory to the hazards of our new Epoch. Finally, it is suggested that while it may be unclear whether we can manage the socio-political challenges of our times, our adaptive versatility in principle ought to suffice to successfully manage the climate challenges of the Anthropocene.

Keywords: precursors; anticipations; Anthropocene; adaptation

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Citation: Heyd, Thomas. 2022. Precursors and Antecedents of the Anthropocene. *Social Sciences* 11: 286. https://doi.org/10.3390/socsci11070286

Academic Editor: Manuel Arias-Maldonado

Received: 4 June 2022
Accepted: 27 June 2022
Published: 30 June 2022

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1. Introduction

While discussions regarding precursors of the Anthropocene generally are focused either, on the one hand, on previous conceptualizations of a novel, overarching human influence on the planet, or, on the other, on the likely starting point of the new Epoch, there are still other ways to think about Anthropocene precursors and antecedents. For instance, we may consider whether the level of impact on functioning Earth systems represented by the Anthropocene may have occurred in previous geological epochs, prior to the existence of the human species. Furthermore, we may explore whether the type of human environmental engagements generating this new Epoch has had forerunners in earlier times of our sojourn on the planet.

I propose that geological history shows that there *indeed* have been several phases in which biotic agents have significantly changed Earth system functioning (even if those biotic agents were not endowed with the type of cognitive-behavioral capacities characteristic of humans). Moreover, I take up the suggestion, increasingly offered by anthropologists and archaeologists, that our extraordinary capacity for adaptation to, and for transformation of, environments evident in the Holocene probably is a heritage of our species' multiple confrontations with the hardships experienced during repeated, profound, climatic changes in the Pleistocene. This latter point will serve as the basis for an analysis of the contemporary global exploitation overshoot by which we are generating the Anthropocene. It is suggested in conclusion that, while it precisely is our special adaptive versatility which, finely honed throughout the Pleistocene to address a great diversity of often rapidly changing environments, has led us into our present troubles, this same adaptive capacity in turn may also give us *hope* that we may be able to find ways to address the new challenges of our present Epoch.

1.1. Questioning the Concept of "the Anthropocene"

Increasingly, the concept of "the Anthropocene" seems to be gaining traction more widely in society than strictly among those who are directly concerned with environmental matters. In the present global environmental situation, in which a multiplicity of human endeavors interact with natural processes, thereby creating knock-on effects across large distances in time and space, the concept of "the Anthropocene" is more to the point than related concepts, such as "environmental crisis". The reason for this is that its scope is *neither* limited to a particular locality *nor* to a particular time, as the term "environmental crisis" typically is. That is, even if particular environmental crises, such as the "forest death" events in central Europe and Eastern North America in the 1970s, may have had some global repercussions, as such, those crises were perceived as based in particular locations with relatively narrow geographical and temporal consequences. Our present environmental problems, such as species extinctions, nanoplastic pollution, and climate change, however, have origins in multiple locations and planet-wide consequences.

In other words, the concept of the Anthropocene clearly points toward the fact that, even if we might be able to escape certain localized environmental crises, for example, by moving away from an area affected by industrially produced toxins, we *cannot* escape the sum of present, hazardous, anthropogenic effects, even if it may still be open to us to modulate them. So, while environmental crises of this or that sort often provoke mitigation and adaptation efforts sufficient to allow a more or less complete return to normality, as in the prevention of "forest death", the Anthropocene rather stands for an entirely new mode of functioning of our entire Earth envelope. And, since, unfortunately, this new planetary state will make life considerably *harder* for our own and many other species than during the relatively benign conditions prevalent in the Holocene, which the planet is now rapidly leaving behind, it may be valuable to have a way of naming it.

Moreover, it may seem advantageous that the "Anthropocene" concept directly speaks to the question of authorship and responsibilities for the new, troubling state of affairs, since it suggests that every member of the "Anthropos" species is a culprit.[1] In comparison, concepts, such as "environmental crisis", always lead to with the nagging question concerning who exactly ought to be blamed for troubling environmental conditions: is it the fault of certain industries, certain consumers, capitalism as a system, or perhaps particular historical coincidences? However, while it may be convenient to be able to straightforwardly pinpoint a culprit, questions may be raised regarding both the originality of the concept and the attribution of responsibilities entailed by it.

1.2. How Original Is the Concept and Who Is Responsible for the Anthropocene?

With regard to its originality, it has been suggested that thinkers, such as Antonio Stoppani, Vladimir Vernadsky, and Pierre Teilhard de Chardin, anticipated the concept (for Stoppani see Rull (2017); for Vernadsky see Guillaume (2014); for Teilhard de Chardin see Zwart (2022)). Teilhard de Chardin, for example, coined the term "noösphere" for a new world shaped by the advancement of humanity to a new stage of cognitive evolution, while Stoppani proposed the "Anthropozoic" as the name of a new Earth-historical period impacted by "human relicts", such as tools, weapons, buildings, and so on (Rull 2017, also see Trachtenberg 2015). Such conceptual anticipations are, nonetheless, contested by those such as Hamilton and Grinevald (2015), who argue that "the Anthropocene" is distinct from previous conceptions because it has only recently been possible to provide evidence that directly links anthropogenic transformations to Earth-systemic changes.

When the focus shifts to the attribution of responsibilities to "Anthropos" for causing our rush into this new period, the question may be posed whether all humans of all places, times, origins, and so on, are responsible for the new Epoch (also see Crutzen 2002), and whether, if it were so, there may not at least be differences in degrees of responsibility for it among diverse human groups. The concern is somewhat similar to the concern raised by the question whether *all* individuals governed by some nation-states (or all members of other segmentations of our societies, as defined by religious, political or other affiliations) ought

to be blamed or praised for the harmful or beneficent actions, respectively, in the present or past, carried out by some of their members. This kind of question becomes especially critical, for example, in cases in which immigrants or new generations are expected to share the blame for injustices perpetrated by present or past governments of the countries in which they reside.

So, in the case of the Anthropocene, one may ask whether individuals and collectivities who merely endure the decisions of those who have the power to impose their economic and technological decisions also are to be held responsible for the hardships of our new Epoch. For instance, up to what point are ordinary working people struggling to make ends meet in Canada, Greece or Indonesia, or, even more starkly, tribal people in India, marginalized by industrial development, to be held responsible for present climate change, nanoplastic pollution, rapid biodiversity loss, or any other of the unwelcome features of the Anthropocene? And, what about the new generations that continuously are born and end up as students in our classrooms? Are they to be held responsible for the Anthropocene, even if the processes engendering it started quite some time prior to their births? After all, insofar as human, all people are being targeted by the term "Anthropos" inherent in the term "Anthropocene".

Of course, it may be argued that, insofar as the problems of the Anthropocene are systemic, almost everyone, even the ordinary person struggling to make ends meet, is contributing, even if only in small ways, to the totality of effects that heaves us into the new Epoch. And it is possible, and even likely, that many if not most members of the younger generations will fall into the behavioral patterns of their elders that helped to generate the Anthropocene. But what if, in turn, there are systemic barriers that make it difficult to live differently? Such questions suggest that the term "Anthropocene" is highly problematic if it is directly associated with the attribution of responsibilities to humans as such. So, who then *is* the Anthropos responsible for the Anthropocene? Should attributions of responsibility for the new Epoch perhaps be restricted to those humans who clearly have direct causal responsibilities for it?

This sort of question has led some to suggest that the term "Anthropocene" be replaced by terms such as "Capitalocene", the Age of Capitalism (Moore 2016), "Plantationocene", the Age of Plantations, or "Chthulucene", the Age of "Staying with the trouble" (Haraway 2015). In support of the term Capitalocene, for example, there certainly are reasons to think that what has been called "The Great Acceleration" (Mcneill 2014) is at least partially the result of capital accumulation since the Industrial Revolution. The idea being that such capital, re-invested in the development of ever more expansive methods of resource exploitation, brought about rapid increases in impacts on the natural environment, which, cumulatively, have led to our present quandary.

Questions have also been raised about whether the concept indicated by the term "Anthropocene" does not paradoxically express a misplaced sense of accomplishment by naming this new Epoch by the name of our own species, as if our impacts on the planet were something to take pride in. It is true that some have spoken of this new epoch in self-laudatory terms (cp. Chakrabarty 2016), on the supposition that humans have finally wrested sufficient control over nature, so as to take over planetary functioning, and that humans should now complete the project by means of grand, unprecedented, geoengineering projects (Lynas 2011). This kind of pride, of course, is rather quixotic, given that, in reality, the forces unleashed by human actions are neither benign nor truly under human control, and the attempt to take-over planetary functioning, if it were possible, would entail new, unforeseeable consequences that likely would further compound present problems.

But, even granting the point that humans have become the new Earth-shaping gods, we may again wonder whether all humans share in this self-attributed power over the planet. Do Amazonian Indigenous farmers, Mongolian pastoralists, and Andean potato farmers share in this, all of whom continue with ways of living that have little changed over thousands of years? It seems that, on the contrary, for the most part, such groups of

people are still maintaining cooperative—rather than interfering—ways of living with the Earth, and hence are *not* participating in the supposed take-over of planetary functioning that our species is to take pride in. In this context, we may note that there also has been a debate about the proper starting point of the Anthropocene.

1.3. How Far Back Can the Anthropocene Be Pushed?

Should it be assumed that the Anthropocene started with the largescale industrialization of European countries around 1750 (Balter 2013, p. 261)? Some of those critical of this view have suggested that the starting point of the Anthropocene be pushed back to pre-industrial times, for example to the beginnings of agriculture around 5000 years ago, or perhaps even to the moment of the acquisition of fire by our hominin predecessors, way back in the Pleistocene (Glikson 2013). If persuasive, these kinds of responses would also have the effect of diluting the blame to be accorded to present generations for the troubles of our new Epoch.

In support of the idea that the start of the Anthropocene may be pushed back to a point in time previous to the Industrial Revolution, recent research has shown that earlier anthropogenic environmental impacts have sometimes been quite important (for discussion, see Lewis and Maslin 2015). For instance, as will be discussed shortly, the increase in lead in the atmosphere during the heyday of the Roman Empire was of such dimensions that a detectable record of it can be found in Greenland ice cores (McConnell et al. 2018). Occasionally, it seems that historical events may even have provoked short-term, global, climatic effects. It has been argued, for example, that, consequent on the tragic die-off of Indigenous populations in North Americas as a result of war and disease after contact with Europeans, the cessation of their traditional land management practices may have substantially contributed to the global cooling now recognized as "The Little Ice Age" (Koch et al. 2019).

Proposals for pushing back the beginning of the Anthropocene to a period preceding the Industrial Age have, however, encountered resistance, for example, from those who insist that the definition of the Anthropocene Epoch be strictly based on geologically perceptible markers or on whether Earth systems are being affected in measurable ways (Zalasiewicz et al. 2011). In other words, from the geological and Earth system perspective it is seen as irrelevant whether there have been more or less important anthropogenic impacts on the planet previous to the present. What counts from those perspectives, rather, is whether, as a result of certain human actions, there will be a future geologically detectable record that evidences changes in Earth-systemic functioning.

That is, the objection of physical scientists, such as Zalasiewicz et al. (2011), in part is that anthropogenic effects prior to the industrial age either were minor disturbances or merely short term blips in the functioning of Earth systems. In contrast, the consequences of the present-day collective behavior of now nearly 8 billion people *will* continue to affect Earth systems in measurable ways for thousands of years, due to the long-term effects of climate change, nanoplastics, and so on. It has been argued, moreover, that the recent human impact on the planet since the start of the Industrial Age is such that it already is leaving a trace in the geologic record (Zalasiewicz et al. 2011; Bennett et al. 2018), for example, through the use of nuclear weapons and nuclear power.

1.4. Uniqueness of the Anthropocene and Its Etiology

In addition to the questions posed above, we may ask two questions regarding the uniqueness and etiology of the Anthropocene. The first one concerns the trace of human action in relation to the rest of geologic history, while the second concerns the foreshadowing in previous times of the present, humanly provoked environmental transformations. Starting with the first, the common supposition seems to be that the Anthropocene constitutes an unprecedented transformation of our planet. Certainly, the actions of humans in the past have not had, up to now, such momentous repercussions, but are we as unique as all that for provoking a new geological epoch? Might there have been previous biotic

agents that equally would deserve to be considered "geological forces"? If, in fact, there had been other biotic agents in Earth history who generated Earth-systemic changes this might provide us with a little better understanding of where we are heading presently.

The second question is about whether the historical and archaeological record contains helpful hints on what it is about our species' engagements with the environment that may explain the present, rapidly accelerating trajectory into the new Epoch. In other words, whether the record of the past may give us a clue to what it is it about "the Anthropos" that is propelling us into the Anthropocene—even while insisting on differentiated levels of responsibilities among humans for providing the propellant. This enquiry may not only satisfy our curiosity but perhaps also help us better understand why we have been slow in addressing the urgent need to decelerate our mad rush into this new Epoch—despite the immense, foreseeable, and already evident, disadvantages to humans and other species that it entails.

In answer to the first question, whether the Anthropocene is as unique as all that, geological history shows that there have been many times at which biotic agents have provoked Earth-system transformative processes, the most notable being the so-called "Great Oxygenation" event (Goldblatt 2018, p. 5). On that occasion, the consequence of the enrichment of the atmosphere with oxygen was such that nearly all previous life forms, for whom oxygen was poisonous, became extinct. The totality of geological and planetary history was marked by this event.

More generally, as stated by Witmore (2014), summarizing a point made by Clarke (2014, pp. 103–4), " . . . both life and death biota always have been geological forces . . . just look to the fossilized skeletons of coral and other microorganisms that comprise so many mountains" (Witmore 2014, p. 130). The second question, regarding foreshadowings of the present, humanly provoked, environmental transformations, may be addressed in diverse ways, depending on distinct theoretical frameworks. Here, I propose to engage with this question based on new, pathbreaking insights regarding our species' ecological niche.

While our attention is mostly focused on the present, rapid, environmental changes provoked by our own species, it is to be remembered that, during the 200,000 to 300,000 years of the existence of anatomically modern humans, climates have been in constant upheaval, thereby almost continuously generating sometimes very significant environmental changes (Burroughs 2008). That is, first of all, there was a constant back and forth from generally cold and dry glacial to relatively warm and wetter interstadial phases, while there also was very high climate variability throughout this period (see Burroughs 2008). The fact that our species made it through these abruptly changing climatic phases —while none of the other hominins did—points toward our extraordinary adaptive flexibility. This point has been further developed by the recent hypothesis of Roberts and Stewart (2018) that humans are "generalist specialists", by which they mean that, particularly thanks to our cultural capabilities, we are enabled to specialize our adaptations to a great diversity of environments.[2]

As evidence for this thesis, Roberts and Stewart (2018) point out that already in the Pleistocene humans colonized all sorts of extreme environments, including high elevations, the paleoarctic, deserts and tropical forests, in addition to riverine and lacustrine areas, which had until recently been assumed to be the standard niches for our species. It should, hence, be of little surprise that, during the subsequent Holocene, our species has been successful at colonizing nearly all available niches on our planet, and continues to seek out new ones, even beyond the planet. What this ultimately means for humans in the Anthropocene is to be seen, of course, but at least it points toward the likelihood that *qua* species, even if not at the individual level, we do have the capacity to adapt to the rapidly changing environments that we are now generating in conjunction with pre-existing Earth systems.

This being said, it should remain an extremely worrisome fact that we are collectively moving our world into unknown conditions that are already proving to be a serious challenge for a growing share of the world population. This fact urgently calls for an

analytical framework that may allow for the development of clear guidelines on how anthropogenic causes of this problematic transformation can be limited, and the impact of the hazards provoked may be cushioned for vulnerable populations.[3] Regarding climate change, certain terms with which the two aims of limiting anthropogenic causes and cushioning hazardous consequences described have already entered common usage, namely, "mitigation" for decreasing the size of causal factors, and "adaptation" for taking measures to limit harm arising from those hazards that are already under way. However, more needs to be said about what makes a process contributory to the Anthropocene or, as we may say, "*anthropocenic*" in its consequences, rather than merely "*anthropogenic*" in origin.

My proposal here is, first, to apply a three-phase analysis to the processes and events contributory to the Anthropocene (see Heyd 2020/2021). Second, equipped this way, I propose to consider possible exemplary precursors or anticipations of the Anthropocene, even if those previous events and processes may not themselves be traceable in the future geologic record nor measurably contribute to Earth systems change, as the concept of the "Anthropocene" is often understood to suggest.

2. Three-Phase Analysis of *Anthropocenic* Processes and Events

2.1. An Analogy between COVID-19 and Climate Change

It is evident that realities pertaining to the Anthropocene, such as climate change, nanoplastic pollution, or nuclear radiation, are *risky* for many populations and have *global* dimensions. My proposal is that such realities may be further analyzed by (1) a phase of intensified human engagement with processes or events originating in the non-human natural world, (2) global dissemination of hazards consequent on that engagement, and (3) impacts on vulnerable populations. For the development of this model, I take my cue from an analogy between the COVID-19 pandemic and climate change, both of which represent significant risks for humans because of the global dissemination of initially limited natural hazards, which now reach vulnerable populations (Heyd 2020/2021; also cp. Wisner et al. 2003).[4]

In the case of COVID-19, the hazard likely was generated, at some point in time and space, by human encounter with non-human species (possibly bats, with pangolins or palm civets as intermediaries) who were carriers of the SARS-Cov2 coronavirus (or a predecessor of it, perhaps magnified in power by human manipulation). In the case of present-day climate change, the hazard of global warming ultimately is a result of the human magnification of a naturally existing process, namely the combustion of fossil carbon. (Under natural conditions the combustion of fossil carbon happens, for example, when lightning strikes coal seams, some of which may burn for very long periods (see Krajick 2005)).

In both cases, moreover, there is global dissemination of the hazard after the initial human engagement with, or intensification of, a naturally occurring process or event. In the case of COVID-19, the dissemination of the SARS Cov-2 virus is by human vectors, whose trans-continental travel is greatly magnified by modern modes of transport. In the case of climate change, the dissemination results from the insertion of large quantities of greenhouse gases into the atmosphere resulting from human activities, such as the operation of combustion engines, and their subsequent rapid, global, dissemination by air movements in the atmosphere.

Finally, in both cases the respective hazards can become seriously dangerous for *vulnerable* human populations. In the case of COVID-19, those populations include the elderly, the economically disadvantaged sectors, and the immuno-deficient. In the case of climate change, populations located in certain geographically exposed areas, such as low-lying deltas and seashores, are especially vulnerable to increases in intensity of flooding, for example. Generally speaking, in relation to both COVID-19 and climate change, the poor are particularly vulnerable since, by definition, they only have limited means to absorb significant costs of whatever sort (material, financial, person-hours) arising from exposure to important hazards, and, consequently, less adaptation potential.

So, while many human-nature encounter processes and events may create significant local hazards, some of those hazards may be subject to dissemination to the point of becoming globalized, thereby threatening vulnerable populations in many other places. If the processes and events in question are sufficiently large, they may even measurably affect Earth systems, and possibly leave a record in geological strata; but, even if not, the proposal here is to call them "*anthropocenic*" as long as they present the three-phase pattern described.

2.2. Risk of "Anthropocenic" Processes

If we were to put the three-phase pattern discussed above into a formula we could adapt Wisner et al.'s (2003) "pseudo-equation" about risks from disaster, which they describe as "a compound function of the hazard and the number of people, characterized by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard event." (p. 45) Their risk pseudo-equation is

$$R = H \times V,$$

where R stands for risk, H for hazard and V for vulnerability. Without going into details here, it is of relevance that Wisner et al.'s analysis reminds us that risk is not only dependent on the size of hazard but also a function of vulnerability of populations affected.[5]

The three-phase pattern of anthropocenic processes or events proposed above similarly serves to analyze risks, incorporating, however, the fact that those risks get exacerbated when there is wide dissemination of hazards, combined with wide susceptibility to those hazards, especially if reaching global dimensions. So, while we may initially suppose that $R = H \times V$, *anthropocenic* processes or events generate a heightened risk R*, which results from the global dissemination of, and susceptibility to, the hazard. Consequently, anthropocenic events may be characterized by a *modification* of Wisner et al.'s risk pseudo-equation

$$R^* = H^* \times V^*$$

where H* stands for hazard, as a function of dissemination, and V* for vulnerability, as a function of susceptibility to that hazard, respectively. The point being that, while localized hazards may generate important risks for vulnerable populations nearby, to the degree that dissemination increasingly approaches global dimensions, those hazards may generate both new kinds and degrees of risk.

Cases in point are, for instance, epidemics and pandemics, which may entail all sorts of new societal risks (including the rise of populist forces and general *anomie*) that endemic virus conditions do not. Similarly, while the localized generation of greenhouse gases in small quantities is inoffensive, once massified and disseminated globally, such greenhouse gas emissions generate important new risks for societies.

2.3. Moments for Active Intervention

It should be evident that, aside from its explicative value, the three-phase conception of anthropocenic processes and events may constitute a useful heuristic by representing the realities of the Anthropocene in a new way. Our rush into this new period, especially the acceleration toward ever greater climate change, is perceived by many as something that we need to accept with a certain fatalism, on the assumption that the processes unleashed by humanity have become too complex and interwoven to mitigate or even to understand. The three-phase conception of anthropocenic processes and events, however, clearly lays out *three distinct moments* for active intervention, each of which may be instrumental in considerably lowering risks.

First, it suggests that in order to identify anthropocenic processes and events we need to consider our engagements with, and intensifications of, potentially hazardous non-human natural processes. Once we know how those processes and events have been magnified by human actions we may be able to find particular leverage points to reduce the

risks that they generate. In the case of disease-provoking pathogens, such as COVID-19, the focus is on reducing contact with those non-human species that are likely vectors (see, e.g., Petrovan et al. 2021), while, in the case of climate change, the way to reduce the risks at the source primarily consists in rapidly reducing the utilization of fossil fuels ("mitigation").

Second, it proposes that, even if hazards have been generated at their points of origin, we still may be able to find ways to limit their dissemination. In the case of pathogens that may be disseminated by humans, such as COVID-19, this means reducing and controlling travel across borders and regions and restricting exposures in community contexts. In the case of climate change, this means, among other things, sequestration of greenhouse gas emissions either directly at the point of production or subsequently (even if this option comes at a significant cost and with much greater difficulty than reducing their generation at origin), by drawing those gases back out of the atmosphere.

Third, insofar as such hazards are not sufficiently blocked at the points of origin nor in their dissemination, there may still be options to lower risks by protecting populations vulnerable to those hazards. In the case of epidemics and pandemics, such as COVID-19, the elderly, the immunodeficient, discriminated minorities and the poor can be given special support, to protect them from falling prey to such pathogens. Recognition of such populations as vulnerable should lead us to mobilize resources both before and during such eventualities.

In the case of climate change, given that our world population is larger than ever and has increasingly moved into areas exposed to weather hazards, such as in the vicinity of coastal areas, onto floodplains, or onto the unstable slopes of hills and mountains, the size of populations vulnerable to sea level rise, flooding and landslides, correspondingly has much increased in comparison to previous times. As a result, many sectors of populations in the contemporary world are subject to heightened risks in relation to climate change, not only because of the increases in intensity of many hazards but also because of increases in vulnerability. This situation urgently calls for thoroughgoing adaptation measures at all levels, personal, local, regional, national, and global.

In short, the three-phase conception of *anthropocenic* processes and events allows for a clear distinction among three moments in which we may deflect or reduce risks. Furthermore, insofar as certain periods of the past exhibit some of these three phases or moments, even if to a lesser extent than we are witnessing presently, they can be seen as "precursors" or "antecedents" of the Anthropocene, as has been proposed by some researchers. Some have even gone so far as to call such periods of the past by terms such as "Early Anthropocene" (Glikson 2013) and "Paleoanthropocene" (Foley et al. 2013; also see Albert 2015).

3. Pre-Historic and Historic Precursors or Antecedents of the Anthropocene

As noted already, the prevailing view seems to be that the Anthropocene takes its start around the time of the heightened industrial utilization of coal and the development of the steam engine. Others have argued for an earlier start, going back to the clearing of land for agriculture (Ruddiman 2003), to the extinction of megafauna (Braje and Erlandson 2013; Malhi et al. 2016; Smith and Zeder 2013), and even to the invention of fire. As Braje has suggested, though, "Rather than continuing to argue over thresholds, golden spikes and boundary markers", intended to set the exact starting point of the new Epoch, we ought to think of it as a reality that calls for us "to focus on scientific, political and interdisciplinary solutions" (Braje 2016, p. 509).

Certainly, strictly seen from the geological point of view, there cannot be "solutions" for the Anthropocene. However, when considered in terms of its impact on human and non-human lives, a focus on "solutions", or at least on ways of engaging productively with the givens of this new state of affairs seems to be imperative. My proposal is that such a "focus on solutions" may be supported by considering cases from the past that illustrate how "generalist-specialist" humans (Roberts and Stewart 2018) applied their ingenuity in the adaptation to, or in the construction of (Boivin et al. 2016), their ecological niches. Of key

interest is to consider under which circumstances those efforts at fitting into or constructing suitable ecological niches ironically bring about more or less *hazardous consequences* that foreshadow present troubling developments, even if the cases under discussion do *not* achieve the global dimensions of our present anthropocenic processes and events.[6]

3.1. Pleistocene Adaptations to and Construction of Niches

Albert (2015) introduces, if accepted as such, what possibly would constitute some of the earliest types of *anthropocenic* processes and events, by proposing that human–environmental interactions in Olduvai Gorge (Tanzania) set "the baseline for the Anthropocene" (p. 1).[7] She considers likely human modifications of a Pleistocene landscape 1.75 million years ago, realized for the optimization of resources. Her starting point is that the difference between human and non-human modifications of environments consists in that the former are achieved by explicit cognitive-behavioral strategies in hunting and other food procurement activities.

The application of such strategies would not only lead to direct adaptive advantages, by increasing survival success, but also that "hunting large mammals as regular practice as well as active scavenging (through confrontation with other predators) would strengthen social bonds" (Albert 2015, p. 6), which would, in turn, proffer additional adaptive advantages. She suggests, moreover, that such advantages may have been further magnified once *homo erectus* needed to increase in group size in order to survive in non-arboreal spaces and population density increased (Albert 2015, p. 8 and *passim*).

Food procurement activities, tool making, and the possibly deliberate use of fire (which, however, still requires confirmation in relation to its application in Olduvai Gorge), illustrate "the learning and accumulation of knowledge associated with an increasing control on the landscape and the acquisition of resources" (Albert 2015, p. 8). She concludes that the human impacts at this location already anticipate their full-blown development in the Holocene and give us reason to extend "the term Anthropocene . . . back in time to include these early cognitive-behavioral strategies and their impact on the landscape" (Albert 2015, p. 8).

Albeit Albert's thesis may seem to require stretching the concept of Anthropocene way beyond current usage, her point is well-taken insofar as she shows that human strategies of adaptation are much more interventionist and niche-constructive than those of other species, even if compared to those of other tool-using species. In this sense, humans in the Pleistocene are already magnifying certain natural factors, which, once undertaken much more intensively, constitutes the first of the three phases of anthropocenic processes.

3.2. Amazonian Earthmovers

Some archaeologists have been quite reticent to accept the proposed standard starting dates of the Anthropocene noted earlier, such as 1750, coincident with the development of large-scale industrial production, or even later dates, as, for example, the post-Second World War "Great Acceleration" (see Trachtenberg 2015, p. 213). As Balter (2013) points out regarding the reactions at a session of the Society for American Archaeology meetings in 2013, the view held there seems to have been that the Anthropocene is only an exacerbation of *anthropogenic* processes. In their view, "Humans have been modifying ecosystems for a long period of time" (quoting Bruce Smith of the Smithsonian, Balter (2013, p. 261)), and that the Anthropocene should, consequently, be assumed to have started much earlier.

Echoing Albert's case regarding anthropogenic landscape changes in Olduvai Gorge, one suggestion has been to set the beginnings of the Anthropocene to the period in which the planet begins to experience dramatic impacts on land and vegetations through the development of agriculture. As indicated above, it is not my intention to enter into the debate regarding starting dates of the Anthropocene. It is striking, however, that humans have successfully adapted even in areas that seem unlikely candidates for largescale occupation by our species.

A case in point is the transformation of landscapes in the Western Amazon about which it had long been assumed that it could only support a low-density population because of its limited basic resources. Nonetheless, research is showing that 4500 years ago pre-historic people created extensive earthworks, including raised fields and causeways, supporting important agricultural productivity, as well as large, still little understood geoglyphs (Mann 2008, pp. 1148–49; Costa 2018; also see, for example, Riris 2020).

Moreover, as in other regions densely populated by our species, apparently human interventions changed the local biota of the area, and likely led to the selection of a number of useful crop species, including peanuts, Brazilian long beans, two species of chili peppers, and possibly others (Mann 2008, pp. 1150–51). Also, near this area, *terra preta*, which is an artificial soil that significantly increases fertility, generated by the addition of charcoal to low-nutrient soils, quite possibly had its origin (Mann 2008, p. 1151; also see Stahl 1996).

So, insofar as contemporary high intensity agriculture is the result of significant manipulation of basic natural ingredients (soil, seeds, water availability, etc.), the case of agriculture in the Western Amazon basin may serve as a notable (even if relatively small scale) antecedent of Anthropocene food procurements. We do not, however, have any good reason to suppose that at the time their approach to food production would have had the problematic consequences that it has in the present times, in which there is a high dependency on pesticides, herbicides, fungicides, and so on, that leave toxic residues in the land.

3.3. Deforestation, Mining and Metallurgy in Ancient Greece and Rome

While it is not evident either in Olduvai Gorge or in the Western Amazon that human interventions in the environment were such as to produce significant negative consequences for humans or other species, certain types of engagements with environments, intended to be adaptive, *did* end up generating important hazards in Ancient Greece and Rome. As such, those developments and consequent problems could be understood as more explicit antecedents of the Anthropocene than the cases discussed so far.[8]

It is remarkable, for example, that the large estuary of the Bay of Miletus (located in today's Turkey) completely filled in with sediment primarily caused by deforestation in the upper reaches of the Meander River (Brückner et al. 2017; Brückner 1986; also see Giaime et al. 2019). Erosion occasioned by the transformation of forested land to upriver agricultural uses was such that important Ancient Greek maritime cities, such as Miletus, as well as Myous, Priene and Herakleia, lost their harbors and eventually became completely landlocked. Interestingly, the process of siltation and accumulation caused by erosion in the upper reaches of rivers was "already understood in ancient times, as demonstrated by statements by the historian Thucydides (5th century BCE), the geographer Strabo (1st century BCE—early 1st century CE), the natural historian Pliny (1st century CE), and the travel writer Pausanias (2nd century CE)." (Brückner et al. 2017, p. 892)

Similarly, deforestation in the headwater areas of the Tiber River eventually led to the siltation of Rome's harbor of Ostia (Hughes and Thirgood 1982), necessitating the building of Portus, inaugurated by Emperor Nero in 64 CE (Giaime et al. 2019, p. 151). Portus itself eventually silted up by the same process and was also affected by coastal progradation (Marriner and Morhange 2007, passim). Furthermore, the siltation of lowlands due to deforestation did not only bring about negative economic consequences for Rome, but also contributed to the transformation of formerly productive agricultural areas, such as the Pontine region, into swampy land that became a breeding ground for malaria (O'Sullivan et al. 2008). Though the connection between disease and the water-logging of the area was recognized in ancient times, and attempts at draining the area were undertaken, the Pontine marshes eventually became uninhabitable, and continued to be so until modern times.

Another human activity that, during Roman times, turned out to be fraught with hidden hazards was mining and metallurgy. The resulting lead and mercury pollution was significant enough in certain regions, such as in southwest Spain (for example in Río Tinto

and Tharsis, see Nriagu (1983, p. 107)), that it has been detected in human skeletons of the time (López-Costas et al. 2020). Lead contamination during the Roman Empire even reached remote areas, such as Scandinavia, where it has been traced in Swedish lake core studies (Renberg et al. 1994; also see Hillman et al. 2017). Recent research with Greenland ice cores furthermore confirms that significant amounts of lead were emitted into the atmosphere, especially during periods of political stability in Rome that were accompanied by economic expansion (McConnell et al. 2018). Again, curiously, Ancient Roman writers knew of the toxicity of the metal (Retief and Cilliers 2005, p. 157), and, despite significant evidence of widespread lead pollution in certain human groups, its widespread use was not curtailed in Ancient Rome.

3.4. Expansion and Decline of Ancient Maya Civilization

There have been quite a few discussions of factors that may have been responsible for the decline of ancient civilizations (e.g., see Tainter 1988; Diamond 2005), and, presently, some researchers are considering what we can learn from those events for our present times. Kennett and Beach (2013) suggest that "Lessons from our past embedded in the archaeological and historical records indicate that unintended consequences of human action have influenced environmental productivity and destabilized sociopolitical systems before." (Kennett and Beach 2013, p. 88)

They describe how, with intensification of agriculture over time, "people became important geomorphic agents . . . in the complex interplay between environmental change, societal resilience and political integration or collapse." (Kennett and Beach 2013, p. 94) Kennett and Beach's case study of the decline of Maya societies shows that widespread land use change to agricultural uses, which initially helped to support the growth of population and urban centers, eventually became a driver of the decline of many Maya polities, and the displacement and severe shrinkage of their populations due to multiple forms of environmental degradation.

They also caution, however, that sociopolitical responses to such changes need to be factored in, in order to understand what ultimately caused the decline of this culturally sophisticated society. In the Maya case, the response of its leaders to environmental stress, hardship for their populations arising from erosion, waterlogging of formerly productive lands, and so on, generally was to go to war against their neighbors. As a consequence, the hardships for the populations of the defeated kingdoms increased even further.

Kennett and Beach further suggest that the severity of societal reorganization of the Maya world may be explained in part by "the rigidity trap" (Hegmon et al. 2008), according to which relatively more rigidly organized societies will tend to have "greater population decline, degree of cultural change, and physical suffering" in times of crisis (Kennett and Beach 2013, p. 97). They note that "the rigidity trap was imposed largely by the hierarchical structure of Maya society that amplified as the landscape was transformed and impacted during the Classic Period . . . " (Kennett and Beach 2013, p. 97). Importantly, "its rigidity likely contributed to the suppression of innovation in the face of environmental change and stability" (Kennett and Beach 2013, p. 97) and, as a consequence, Maya society went into a spiral of decline.

Their account of the decline of the Maya world, which explains the transformation of initially *adaptive* into *mal*-adaptive practices as in part due to sociopolitical choices, aligns well with the analysis of Kearns (2017) regarding certain socio-environmental changes in Mediterranean Antiquity. She suggests that political and social dimensions of human-environmental relationships need to be foregrounded as much as environmental change drivers, and that transformations in the historical record cannot be directly read off the environmental changes that took place in the "varied climates and ecologies of the Mediterranean" (Kearns 2017, p. 9).

On the basis of the archaeological record and written histories, Kearns suggests that, for a better understanding of how anthropogenic environmental drivers influenced historical transformations, "the dynamism of human-nonhuman interactions changing over time

and at different scales" needs to be taken into account (Kearns 2017, p. 9). Drawing on her research in Cyprus, Kearns concludes that the wealth of insights in Mediterranean Studies "opens up possibilities to explore the ways that climatic conditions—experienced, imagined, and constructed—differentially grouped people within dynamic landscapes made up of shifting matter such as water, soil, wood, and ore" (Kearns 2017, pp. 9–10).

4. Discussion

Applying the three-phase conception of anthropocenic processes and events to the cases described above shows that some of them only constitute precursors or antecedents insofar as certain human engagements with natural givens became *hazards* for particular, localized, vulnerable populations. They lack, however, the globalized dissemination that we observe in anthropocenic processes of the present. So, while in the cases of the silting up of the estuaries and harbors in Ancient Greece and Rome, as well as in the case of the Maya decline, there were geographically distant and time-delayed hazardous consequences resulting from the intensification of agriculture in respective up-river areas, those hazards usually did not extend beyond regional boundaries. Only in the case of the Roman contamination, caused by mining in southwest Spain, has the consequent contamination been measurable as far away as Sweden and Greenland.

The cases considered here do suggest, nonetheless, that, insofar as "generalist-specialists" (Roberts and Stewart 2018), humans have increasingly set aside mere strategies of adaptation to preexisting environmental niches and, instead, engaged in the construction of new niches to provide for ourselves the means to flourish (Boivin et al. 2016). The development of new adaptation strategies by our hominin ancestors, evident in Olduvai Gorge, may be considered an intermediate point between seeking a fit to existing environmental niches and shaping those environments. After all, better tools, more effective weapons, and more intensified social coordination would already act as selection pressures on prey and predators in their environments, thereby modifying those environments.

The development of agriculture, the invention of *terra preta*, the creation of earthworks, such as causeways, raised fields, and so on, as found even in the environments of the Western Amazon, also serves as an example of the drift toward the construction of adequate niches and away from mere adaptation to pre-existing environments. This is equally evident in the cases of deforestation for agriculture in the catchment areas of rivers, such as the Meander and the Tiber, which lead to the siltation of downstream estuaries and harbors, as occurred in the Bay of Miletus and in the harbors of Ostia and Portus, respectively. These events neatly demonstrate that certain constructions of niches of immediate *adaptive* value to populations at certain places may turn out to be of *mal*-adaptive value to other populations at later times and other places.

This kind of linkage of localized short-term adaptive advantages to some people, on the one hand, bringing about unanticipated longer term mal-adaptive consequences to others, on the other, becomes exacerbated in the case of mining and metallurgy in Ancient Rome. As noted, the apparent practical benefits arising from the development of pipes and other utensils made from lead brought along toxic contamination that directly affected people's health, both among the miners and among the end users of the metal products. Similarly, the intensification of agriculture among the Maya at first facilitated a complex, sophisticated civilization, which, however, had unanticipated ecological consequences that later led to the reorganization and decline of that society.

The major factor that seems to have modulated the degree of harm observed in those cases seems to have been the *amplitude* or *degree* of the human engagement with non-human natural systems. While the small-scale interventions aimed at procurement of foodstuffs in Olduvai Gorge seem not have caused subsequent harmful consequences, the much larger-scale interventions in Ancient Greece and Rome, and in the Maya region, respectively, had consequences that can still be followed up today.

However, as already noted, Kearns (2017) points out that anthropogenic, environmental changes do *not* determine outcomes as such, since a multiplicity of other geographical

and sociopolitical factors also come into play. The cases considered here generally support her view. For example, the suggestion by Kennett and Beach (2013) that the decline of the Maya civilization was a result of falling into "the rigidity trap" suggests that the fate of these societies could have been otherwise if, in light of the changed environmental conditions to which they were exposed, their leaders had only acted with more flexibility.

Generally, it may seem that it is due to *lack of awareness* of the risks that individuals and societies engage in hazardous activities, but some of the cases surveyed throw some doubt on this view. After all, the connection between deforestation in the catchment areas of rivers, and erosion and the siltation of estuaries, as well as the toxicity of lead, were already known by contemporaries of those events in the Ancient World. Nonetheless, nothing was done to prevent the continuation of the activities in question (respectively, deforestation and lead mining). This points toward the need of further consideration of the conditions required so that awareness of risk *does* effectively lead to mitigative and protective actions.

5. Concluding Thoughts

Bonneuil suggests that "narratives of the Anthropocene" of "how we got there" tend to fall into four types (Bonneuil 2015, p. 18). Two of them, the "naturalist" and the "post-nature" narratives, are more or less celebratory of where humans have taken our planet, even if troubled by the uncertain consequences that come with having grasped for the godly powers of re-terraforming earth. The other two accounts, "the eco-catastrophist" and "the eco-Marxist" narratives, are rather critical of humans, or of a subset of humans, for the catastrophic and uncertain consequences that the planet now has to face (Bonneuil 2015, p. 18). All four types of narratives discussed by Bonneuil seem imbued with the supposition that human history may be described as *moving toward* more or less prescribed new global states, either better or worse than earlier states. Accordingly, this new Epoch either is to be optimistically welcomed as "progress" or pessimistically regretted as "regression".

In this paper I have taken a different approach. Instead of supposing that human history is directed either toward a progressive or a regressive end state, the narrative underlying my analysis does not suppose that history has a direction. Rather, it simply notes that humans, as other species, adapt to changing environmental conditions, albeit, however, with *extra-ordinary* adaptive capacities. Moreover, it grants that these capacities have been honed throughout our sojourn in the Pleistocene (Burroughs 2008), precisely for and by the kind of extreme environmental and climatic changes that we are again facing now. As argued by Roberts and Stewart (2018), given changing conditions, we re-deploy those general adaptive capacities so as to specialize again and again—developing new culturally transmitted tools and practices to settle into new niches as they become available.

The Anthropocene constitutes a set of rapidly evolving environmental conditions that we may or may not master as a species. The oddity about this new set of conditions is that humans themselves are creating many of the hazards that our own species and all other living things are forced to live in. In principle, judging from our ability to live with the environmental disturbances that arose due to repeated climatic changes and continuously high climate variability during the Pleistocene, present humanly provoked environmental problems should *not* be an insurmountable problem for our species.[9] In light of the three-phase conception of anthropocenic processes and events, there *are* ways to find effective ways to coordinate limits to our problematic engagements in the non-human world that are provoking new hazards, to prevent their global dissemination, and to protect vulnerable populations. That is, we need to become aware of our collective, hazard-generating interventions, develop sufficient coordination capacity to consider collective options, and to act on those options.

Up to a point, some of the necessary mitigative and adaptive actions have been and are being taken, both in reaction to the COVID-19 pandemic and to climate change, even if much more is needed to contain pandemics and the continued acceleration of climatic change. However, many of the other conditions generated by contemporary modes of life, such as multiple sociopolitical conflicts, a very large and still growing world

population, territorial barriers and property relations that are restrictive of free movement (thereby blocking access to needed resources), cultures of violence that lead societies and their members to pursue their interests by aggressive competition more than by mutually beneficial collaboration, the tendency to externalize environmental costs, the legitimation of unchecked wealth accumulation, and so on, raise a different set of difficulties, which we may not yet have sufficient experience to master.

So, even if our ancestral experience with major environmental changes should make us *optimistic* about our future in the Anthropocene, contemporary human-created obstacles to coordinated collective actions leave the matter *uncertain*. In conclusion, while we may question as the new label for our times the introduction of the concept of the "Anthropocene", which so obviously puts humans in the center, perhaps this new focus will be useful in our attempt to translate awareness of human troublemaking on the planet into mitigative and protective strategies, as urgently called for by our present collective rush toward increasingly challenging future times.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The author wishes to thank two anonymous reviewers for their helpful comments. Among other things, I am indebted to one of the reviewers for a useful suggestion regarding my proposed modification of Wisner et al.'s risk pseudo-equation.

Conflicts of Interest: The author declares no conflict of interest.

Notes

1 It is clear, however, that the question of which part of the species is responsible has been an issue ever since the inception of the term (see Crutzen 2002).

2 It may be suggested that the human species is subject to cultural as well as to biological evolution (see, for example, Renn (2020) and Guillaume (2021)). In a general way, this would seem to be true, insofar as, in the short run, it commonly is on the basis of new cultural—rather than on the basis of new biological—innovations that humans create adaptations that allow them to flourish in new niches. However, one would want to be cautious about declaring any particular cultural innovation as evolutionarily adaptive for our species, as long as we lack sufficient hindsight to know whether they have effectively been such in our species history.

3 Certainly, we may add that we also need to cushion the impact of anthropogenic causes for vulnerable non-human species, both for the sake of human benefit and for their own sake. That perspective adds a further dimension to the whole discussion regarding the Anthropocene that has only been addressed recently by some, for example, in the archaeological context, by Kearns (2017). She favors "re-empowering 'land' in landscape to include investigations . . . on things such as trees, soils or pollen that participate in expected and imagined conditions or ecological challenges in flux." (Kearns 2017, p. 4) In this essay, however, I will not be able to pursue this line of discussion further, due to limitations in space.

4 While climate change is considered a central factor of the new Anthropocene Epoch, the COVID-19 pandemic generally has not been associated with this new Epoch. Nonetheless, it makes sense to think of these two processes in parallel since they both fit the general pattern described here. By definition, while epidemics, such as the so-called 'Spanish flu' of 1918–1919, involve exposure to a pathogen in a more or less limited geographical area, in the case of pandemics the sickness-producing pathogen spreads across large territories, thereby becoming globalized. This makes it akin to contemporary climate change, which does not only bring about localized climatic changes (for example, generated by local deforestation) but has globally distributed, harmful, consequences.

5 As noted by one of the reviewers, this is a standard way of assessing risk. Among other things, it is a common starting point in IPCC-related work (see, for example, Cardona et al. 2012).

6 While the cases of potential 'precursors' or 'antecedents' of the Anthropocene discussed here generally feature the engagement with non-human processes or events generating hazards, and their consequences for more or less vulnerable populations, they do not evidence the kind of global dissemination of those hazards typical of the present times. In this sense, it is clear that, from the geological point of view, the cases surveyed do not qualify as standard contributors to the Anthropocene, since they do not provoke significant, global, consequences. I propose considering these cases nonetheless since offer us reason to reflect on the type of conditions that seem to mediate anthropogenic hazards.

[7] As one of the reviewers of this article has mentioned, to speak of the Anthropocene within this mid-Pleistocene point of time would be confusing from the geological point of view. Another reviewer commented that, while humans in Olduvai and elsewhere modified and transformed landscapes, these changes are at scales that are far smaller than those constituting the Anthropocene. However, Albert's point, rather seems to be that certain, characteristically human, types of intervention in the landscape, once enormously magnified and spread across multiple dimensions, *would*, in fact, eventually generate our new Epoch. (That would be the reason why she speaks of "a baseline" rather than the starting point of the Anthropocene).

[8] The background supposition here is that the Anthropocene is generated by what at first sight would seem to be adaptive local engagements, which, however, in the long run and cumulatively, may turn out to be increasingly mal-adaptive, especially if their consequences become globalized.

[9] As commented by one of the reviewers of this article, there may, nonetheless, be significant limits to human adaptation if we would like Earth systems to remain stable enough for the continuation of contemporary human societies, and that surpassing those limits in part is a matter of scales. That is, as Steffen et al. (2015) argue, if our intention is to keep Earth systems in a "Holocene-like state" then certain "planetary boundaries" have to be respected.

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