Introduction: The role of nature in the Anthropocene – Defining and reacting to a new geological epoch

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Abstract
In a paradigmatic selection, the Special Issue unites contributions from biology, sustainability research, psychology and philosophy as well as media science and literary studies. It aims to discuss to what extent and on what basis the concept of nature is treated in the Anthropocene discourse with new perspectives, intentions and narratives. Not only the possibly changed conditions for a definition of nature in the Anthropocene are questioned, but also the necessity of an inter- and transdisciplinary opening, which goes along with this questioning and its connection with theoretical and practical issues.

Keywords
acceptance research, biomimetics, ethical challenges, human-technology-nature relationship, interdisciplinarity, nature in the Anthropocene, philosophy, sustainability, technosphere, transdisciplinarity

The demand for inter- and transdisciplinary research on nature in the Anthropocene

In 2002, as is well known, the Dutch atmospheric scientist and Nobel Prize winner Paul J. Crutzen inaugurated a new geological epoch with the following sentences in a one-page article in the journal ‘Nature’: ‘For the past three centuries, the effects of humans on the global environment have escalated. Because of these anthropogenic emissions of carbon dioxide, global climate may depart significantly from natural behaviour for many millennia to come. It seems appropriate to assign the term “Anthropocene” to the present, in many ways human-dominated, geological epoch, supplementing the Holocene – the warm period of the past 10–12 millennia’ (Crutzen, 2002: 23; cf. also

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Crutzen and Stoermer, 2000). Two years earlier, at a conference on Earth system sciences in Mexico, Crutzen had already proclaimed this new epoch replacing the Holocene with great publicity (Davies, 2016: 42; Schwägerl, 2014: 9). Precisely at the turn of the millennium, he thus initiated a debate whose unfolding impact over the past two decades has been as immense as it is thorough. The broad discussion regarding the Anthropocene as a new epoch in the history of the earth has by now reached all areas of science and society. Confirmed by the working group of the ‘International Union of Geological Sciences’ in 2019 (AWG, 2019), the Anthropocene – whether as a concept, a thesis or a discussion – not only breaks down the disciplinary boundaries between natural, human and social sciences. It also transgresses the boundary between science and society in a transdisciplinary way (Horn and Berghthaller, 2018; Inkpen and DesRoches, 2019; Zapf, 2016).

The fact that the Anthropocene discussion is of an interdisciplinary and even transdisciplinary character (Möller et al., 2021) is not without reason, specifically the novelty of the subject area to which the concept of the Anthropocene refers and on the basis of which a new geological epoch is to be established: In the Anthropocene discourse, nature does not simply represent a subject traditionally studied by the natural sciences. Instead, humanity acts as a ‘geological force’, transforming nature into a hybrid (Latour, 1993). Nature as such is not destroyed, but becomes a non-autonomous phenomenon which has been enmeshed with the cultural sphere, thus evaporating traditional coordinate systems. As a result, natural sciences, technology, social sciences, humanities and society as a whole are called upon to reconsider their relationship to nature as the ‘other of their selves’ (Hartung and Kirchhoff, 2014). The classical dichotomies of nature-culture, nature-technology or natural-artificial, which have determined the conceptual system for more than 2000 years, starting with Aristotle (1991: 19), have lost their persuasiveness and definitional unambiguity against the background of the discussion about the Anthropocene. What nature is needs to be rethought and redefined, and not only for purely theoretical-descriptive reasons, but for genuine practical-ethical reasons. In order to know which environmental and nature-ethical action is required in the Anthropocene, it must first of all be clear to which object area this action and its normative claims are directed (Höfele and Hühn, 2021a).

Framework for a concept of nature in the Anthropocene

The debates about the Anthropocene interpret nature or, more precisely, the biosphere of our planet, the Earth, based on certain concepts or narratives (Höfele, 2020a). For example, climate scientist Will Steffen and several other scientists such as Zalasiewicz and Schellnhuber introduced the concept of the ‘Earth system’ as a description of nature into the debate (Steffen et al., 2016). ‘Earth System Science’ is understood as the application of systemic thinking to the biosphere and its climatic conditions in the context of an interdisciplinary approach, which should enable a holistic understanding of the dynamics of our planet. Contrary to what the system concept might initially insinuate, it is not a question of developing a purely synchronic, but primarily a diachronic understanding of the Earth system, which would observe changes in its dynamics and allow predictions about the near future to be formulated. To this end, the science of the Earth system goes back to the findings of the geosciences and in particular the stratigraphy and the chronostratigraphic, which divides rock layers according to the age of their formation. It is assumed that if there is a large difference in the properties of different rock strata, as can in fact be observed in many areas of the Earth, the probability that the state of the Earth system will change is high (Steffen et al., 2016: 327). Chronostratigraphic changes, which have little relevance as isolated events, can thus help to explain and predict both the development of the biosphere and the climate in relation to the Earth system. The integration of climatic findings and those relating to the biosphere can make interdependencies between the different areas visible, which is why we speak of a system.
time, transition scenarios from the Holocene to the Anthropocene can be developed. What is important here is the natural variability and the framework of tolerance that allows a state of the Earth system to still belong to the Holocene despite human influence – or possibly not, which would have the particular result of a long-term increase in surface temperature and sea level as well as radical, irreversible changes in the diversity of the biosphere, including the probability of a new mass extinction.

The chemist James Lovelock and the sociologist Bruno Latour, in particular, have, however, argued with some weighty arguments that, given the fragility of the equilibrium in the biosphere, it may be inappropriate to speak of an Earth system and of transitions between systems. Rather, the Earth is an ‘anti-system’, for the reason that it ‘is made up of agents that are not prematurely unified in a single acting totality’ (Latour, 2017: 87). In the face of this criticism, one must not only ask about the concept of nature as a system, but also about the status of the individual entities united in this system of nature, under which human beings, according to the Anthropocene thesis, should function as a central entity. A description of the Anthropocene using the expression ‘geology of mankind’ (Crutzen, 2002) has thus been vehemently criticised, especially from the point of view of the humanities and, in particular, from a critical perspective towards capitalism.

It is a matter of questioning the use of the species or genus category in the course of the Anthropocene narrative, which is not only theoretically flawed, but also unfit for practice. Andreas Malm and Alf Hornberg criticise the Anthropocene narrative as ideological, insofar as it represents a concept that is accompanied by a paradox: namely, that ‘climate change is denaturalised in one moment – relocated from the sphere of natural causes to that of human activities – only to be renaturalised in the next, when derived from an innate human trait, such as the ability to control fire’ (Malm and Hornberg, 2014: 65). By understanding the Anthropocene as a ‘geology of mankind’, one indicates that one concept of nature has been ‘substituted’ for another, albeit without sufficiently differentiating between them or paying attention to the fact that such hypostatisation of the role of the human species within nature is highly problematic. As can be learned from reading Marx, a species exists only relative to its historical situation and reveals itself only in its real relationships. In such an Anthropocene discourse, it is not taken into account that industrialisation involves an asymmetric exchange of biophysical resources. The human species itself, exaggeratedly speaking, decided at no time to take its own destiny and that of the Earth system into its hands. Thus, depending on the circumstances in which a human being is born, their impact on the atmosphere may vary considerably. However, the claim that climate change is not simply anthropogenic, but sociogenic, has to be recognised as insufficient, since the limitation of the responsible actors to ‘Capitalists in a small corner of the Western world’ (Malm and Hornberg, 2014: 64) conceals the complexity of the interactions, which can be described as tragic.

The tragic is about numerous, incalculable interactions or, more precisely, positive as well as negative and undetermined feedback loops, which the philosopher and scholar of English literature Timothy Morton calls ‘weird’ (Morton, 2016: 5). For him, there is furthermore a ‘dark-ecological loop: a strange loop’ (Morton, 2016: 7) in the figure of a ‘genealogy of mankind’ that marks a new epoch, insofar as the connection between geology and humanity is articulated only in the form of a tragic connection that cannot be further specified. Morton makes this clear, in a fashion at once succinct and exemplary, with the example of car keys: turning them in the ignition, one does not intend to damage the Earth’s climate, not to mention triggering another long-term mass extinction in the history of Earth. Indeed, one understands oneself as part of a civilised humanity, which determines its own destiny and has become a geophysical force of planetary extent, and thus also has formal responsibility, nevertheless one is and feels as a statistically insignificant individual. As such, one has never consciously decided to act in such a broad sense. Man is therefore a ‘tragic criminal’ (Morton, 2016: 9) within the Anthropocene. The tragic draws attention to moments of
unavailability and withdrawal – moments of otherness, which, according to Morton, dissolve even the unified, Euclidean space that supposedly allows a systematic measurement of the Earth’s nature, ignoring that it is composed of places or habitats that interact with each other in a non-definitive and inconsistent way.

In his book entitled *Facing Gaia: Eight Lectures on the New Climatic Regime*, which he originally presented in Edinburgh in 2013 as part of the Gifford Lectures, the sociologist of science Bruno Latour tries to do justice to the missing practical impetus by uncovering its inadequate basis in a homogeneous, uniformly structured system of nature. This is symbolised for him in the figure of the globe as well as in the apparent availability of a universe of planets that are identical to each other, in which the peculiarity of the Earth and its biosphere is not taken into account. Following the scientist James Lovelock, Latour tries to turn his attention back to the limited and unstable biosphere of the Earth. It is about ‘confusing the figures of connection with those of totality’ (Latour, 2017: 130). With Lovelock he describes these ‘figures of connection’, which express themselves in countless interactions without a coordinating unity, in recourse to the mythological figure of Gaia. The fact that he refers back to this mythological figure has something to do with the ambivalence of this goddess, who, as the list of her attributes and descendants shows, ‘is not a figure of harmony’ (Latour, 2017: 82). The Earth described as Gaia or more precisely the ‘small membrane [of the biosphere], hardly more than a few kilometers thick’, represents, according to Latour (2017), ‘not a cybernetic machine controlled by feedback loops but a sequence of historical events’ and ‘confictual connections’ (p. 140f.). To ‘live in the Anthropocene’ means for Latour (2017) to apply the expression ‘sensibility’ ‘to all actors capable of spreading their sensors a little farther and making others feel that the consequences of their own actions are going to fall back on them, come to haunt them’ (p. 141). He summarises this under the slogan ‘being of this Earth’ (Latour, 2017: 139) – being attentive and engaging in the innumerable feedback loops, recognising their unavailability from the limited place where one is.

Even if in a form that lacks sufficient conceptual elaboration, Latour provides some initial hints as to how to describe nature in the Anthropocene. Due to its inextricable interconnectedness and the numerous feedback loops triggered primarily by humans, nature can only be understood from multiple perspectives and not from a single point of view. This necessitates a multidisciplinary approach to nature in the Anthropocene that takes up diverse perspectives. Only in this way can nature and its inescapable interconnectedness with humans and the human-made be adequately grasped. This Special Issue attempts to take only a first step in this direction by combining contributions from natural scientists and humanities scholars on the concept of nature in the Anthropocene.

**Question and focus of the Special Issue on the concept of nature in the Anthropocene**

In a paradigmatic selection, the Special Issue unites contributions from biology, sustainability research, psychology and philosophy, as well as media science and literary studies. It aims to discuss to what extent and on what basis the concept of nature is treated in the Anthropocene discourse with new perspectives, intentions and narratives (Bonneuil and Fressoz, 2015). Not only the possibly changed conditions for a definition of nature in the Anthropocene are questioned, but also the necessity of an inter- and transdisciplinary opening, which goes along with this questioning and its connection with theoretical and practical issues. The question of nature is thereby considered from four different focal points (Dürbeck, 2018):
(a) The global dominion of a humanity which, through its action, irreversibly inscribes itself in nature, thus fundamentally threatening the continued survival of the present biosphere (McKibben, 1989).

(b) The blurring of the boundaries between the human and the natural or between technology and nature, through which the framework of reference for humanity’s conception of itself is fundamentally questioned (Müller, 2014).

(c) The suspension of spatial and temporal limits – not only by accelerating development on a global scale (‘Great Acceleration’, Steffen et al., 2015), thus allowing the future to transform almost immediately into the present, but also by exploiting our planet’s past and exhausting ancient resources.

(d) The new ethical challenge which not only concerns the entirety of human civilisation as well as non-human nature, but also allows entirely new questions about responsibility to emerge (Höfele, 2020b; Von Weizsäcker and Wijkman, 2018).

These four focal points on nature in the Anthropocene always meet more research alliances – from Earth System Science to the definition of the Anthropocene (Steffen et al., 2016), from biomimetics, novelly orienting itself towards nature to construct life-like technical materials systems (Speck and Speck, 2019) to research in sustainability (Ehlers and Krafft, 2006: 19–26) and up to human ecology, culture ecology and ecocriticism, which seek to open a new space for societal reflection in the Anthropocene (Zapf, 2016). As diverse as these perspectives first appear, they as yet all strive towards a new definition of the relationship between the natural and the artificial or nature and culture in view of the Anthropocene. This characterises the relationship of the sciences to each other in a completely new way, while at the same time resulting in a new definition of the essence of humanity and the man-made in view of its environment. This can be demonstrated in an exemplary way within the cluster of excellence ‘Living Adaptive and Energy-autonomous Materials Systems (livMatS)’ where some of the authors of the following articles work (cf. https://www.livmats.uni-freiburg.de/en). From the very beginning, the cluster has been confronted with the challenge of reconsidering the coordinate system of nature, life and the living as well as technology and artificial materials as they have become dubious in light of the Anthropocene. This challenge will be met in the Special Issue in view of four questions:

- To what extent and in which way does the Anthropocene demand a new definition of the classical boundaries between nature, life and technology?
- To what extent does a fundamentally new definition of the concept of nature call for a reconsideration of the human conception of self and world?
- In what way do the multiple inter- and transdisciplinary approaches of the sciences react to the challenges of the Anthropocene? What new understanding of science is depicted from this background?
- In what way could and should ethics and sustainability appropriately encounter the holism of the Anthropocene discourse, which extends to human civilisation as well as non-human nature?

The papers are partly based on discussions at a workshop on ‘livMatS as Part of and Reaction to the Anthropocene’ held August 1–2, 2019, at the Freiburg Center for Interactive Materials and Bioinspired Technologies (FIT) as part of the Cluster of Excellence livMatS. This workshop explored the themes of the Cluster with regards to the Anthropocene and asked to what extent the novel bioinspired technologies developed there should not be understood solely as expressions of the Anthropocene, but at the same time provide answers to the novel environmental ethical questions in the Anthropocene. For the current Special Issue, the discussions held there have been
elaborated once again in a more fundamental and broader framework. Contributions by authors have also been included that do not refer back to discussions in the workshop, but nevertheless follow on from the discussions and topics there and situate them once again in a broader context.

**Content and structure of the Special Issue**

The following six research articles and three review articles ask about the concept of nature in the Anthropocene from different disciplinary perspectives. Of course, these different perspectives from a limited number of disciplines dealing with the Anthropocene cannot claim to be exhaustive. Nevertheless, these perspectives have been chosen paradigmatically for the current Special Issue, with a deliberate emphasis on the humanities approach to the Anthropocene. This is because this area of scholarship is still underexposed in the discourse on the Anthropocene and too little perceived as a necessary complement to the discourse in the natural sciences, especially since it is precisely the humanities that are able to open up a transdisciplinary debate that also includes society beyond science as a group affected and called upon to act.

The first research article by Evi Zemanek on the topic ‘Between fragility and resilience: ambivalent images of nature in popular documentaries with David Attenborough’ explores the concept of nature in nature documentaries, which often present contradictory images of nature: on the one hand, the article presents the resilience of a nature unimpeached by human activity; on the other hand, it shows nature’s vulnerability in the face of anthropogenic influence, thereby calling on humans to act. The author seeks to highlight the incoherencies in popular conceptions of nature with respect to the representation of the two contrasting qualities of vulnerability and resilience. To do so, she looks at documentaries presented by David Attenborough between 1979 and 2020. She traces the gradual increase of an emotionalizing environmentalist rhetoric in these documentaries by means of various motifs. This rhetoric seeks to incorporate the Anthropocene discourse. The author concludes by discussing the potential of documentaries to communicate an ‘ecological imperative for action’ by addressing the vulnerability of nature. To succeed in this endeavor, a delicate balance must be maintained, insofar as an irrevocably destroyed nature makes action seem pointless from the outset, while overemphasis on nature’s resilience does not call for action either.

The second contribution approaches the Anthropocene discourse and its novel concept of nature not primarily from the perspective of the concept of nature, but rather from the perspective of the idea of a technosphere that overlaps and could even replace the natural biosphere. In their contribution entitled ‘The technical non-reproducibility of the Earth system: Scale, Biosphere 2 and T.C. Boyle’s Terranauts’, the literary scholars Philip Hüpkes and Gabriele Dürbeck conceive of the Anthropocene as part of a genealogy that can be traced back to cybernetic notions of the controllability of the planet. In so doing, the authors identify an ambivalent understanding of technology, that can be depicted as an autonomous system on the one hand while also being used as a means of control on the other. To this end, they discuss the Biosphere 2 experiment and its literary reflection in T.C. Boyle’s novel ‘The Terranauts’ (2016) as an example of an attempt to technologically reproduce the Earth system on a smaller scale. The experiment forgets, however, that downsizing the model of the technosphere to a controlled system is accompanied by quite different implications.

Finally, the concept of nature in the Anthropocene cannot be adequately reflected without that of humans, since humans have become ‘a major environmental force’, as Crutzen already noted in 2002 (p. 23). In this respect, Jason Wirth’s philosophical contribution asks the central question, ‘Who is the Anthropos in the Anthropocene?’ Using three neglected intellectual traditions, he
critically explores and reflects on the identity of humans (anthropos) in the Anthropocene. He argues that in the Anthropocene, it is not humanity as such that is in the dock, but rather a particular way of being human, a way of being human experienced by the few that disproportionately benefit from fossil capital. The author seeks to show alternatives to this mode of existence. To this end, he goes back to traditions often forgotten or even suppressed in the present (cf. also Höfele and Hühn, 2021b), namely the philosophy of nature around 1800 as well as spiritual resources in indigenous traditions and in Zen Buddhism on the basis of the Japanese philosopher Nishitani Keiji. The author thereby seeks to envisage a different relationship between nature and humanity that could develop in the Anthropocene.

Taking a comparative approach, Henrieke Stahl also asks about the relationship of the human subject to nature in the Anthropocene era. In her contribution entitled ‘The open subject and translations from nature: Answers to the Anthropocene in contemporary poetry (Gennadij Ajgi, Les Murray, Christian Lehner)’, the author explores the relationship between poetry and natural phenomena through the concepts of ‘aura’ and ‘autopoiesis’ and understands poetry as a ‘translation from nature’. She seeks to demonstrate this through three poems by a Chuvash, an Australian, and a German poet. For the Chuvashian Gennadij Ajgi, the poem translates perceptions of nature which emerge in the context of a meditative act and ultimately lead to a hidden, spiritual dimension becoming visible in nature. For Les Murray, on the other hand, the poet’s task is to imitate the autopoiesis of the natural by himself becoming its medium. Christian Lehner then presents a synthesis of both approaches. All three authors aim not only to present the human relationship to nature, but at the same time to change it through their ‘translation from nature into poetry’. Humanity should open up to nature and understand it as an autonomous subject, equal to human beings, instead of an object that can be instrumentalised.

While the two previous contributions focus on the first part of the word ‘Anthropo-cene’ and shed light on human-nature interaction, the next contribution by Bernadette Bensaude-Vincent, entitled ‘Rethinking time in response to the Anthropocene: From timescales to timescapes’, explores the second part of the word: The suffix ‘cene’ from the Greek ‘kainos’, meaning ‘new’, refers to the novel temporal multidimensionality of the concept of nature in the present age. The author questions the adequacy of the chronological view of time in the Anthropocene. The unified timeline, which believes one can simply string together all events of natural and human history, obscures the view of the diversity of timelines whose interplay constitutes nature and determines the climate. Therefore, the author proposes a radical revision of our concept of time with regard to the current ecological crisis. The current crisis, she argues, should lead us to embrace different ‘time regimes’ that radically diverge from one another. The metaphor of the temporal landscape (‘timescape’) as an alternative to the usual concept of a universal time should help to recognize the different temporalities of humans, natural things and artificial materials. In conclusion, she seeks to demonstrate this on the basis of two Anthropocene phenomena, nuclear technology and plastics.

After this broad picture of the concept of nature in the Anthropocene from the perspective of the humanities, the following contributions take a look at concrete-practical responses to the environmental and ethical challenges in the Anthropocene from the perspective of the natural sciences, sustainability research and psychology. Olga Speck, Max Langer and Max D. Mylo, in their paper titled ‘Plant-inspired damage control – An inspiration for sustainable solutions in the Anthropocene’, demonstrate the contribution that biomimetic products, that is, products that mimic nature, can make to a more sustainable future in the Anthropocene. A major challenge is the economical use of resources to avoid waste. Solutions to this are provided in particular by the damage control mechanisms of plants making them usable for the production of sustainable technologies. Of particular interest here are the self-repair of wounds and the formation of ‘abscission zones’ that lead to controlled degradation of biological systems. Plant-inspired damage control solutions can thus
make a fundamental contribution to the development of sustainable technologies by mimicking the natural in terms of an efficient use of resources and reducing waste.

The following review article by Thomas Speck, Simon Poppinga, Olga Speck and Falk Tauber entitled ‘Bio-inspired life-like motile materials systems: changing the boundaries between living and technical systems in the Anthropocene’ also takes an approach to the concept of nature from the perspective of biomimetics. What was only hinted at in the previous article, however, is again presented more explicitly here, using various examples of plant-inspired products in architecture and soft robotics: namely, the shift, permeability, blurring, and even dissolution of the boundaries between the natural and the artificial in the Anthropocene. The authors ask not only what characteristics are responsible for this increasing lifelikeness and thus blurring of boundaries, but also to what extent this contributes to the greater resilience, robustness and aesthetics of biomimetic products. The article thus shows how the abandonment of the classical demarcations between the artificial and the natural is not only a problem in the Anthropocene, as the concept of the ‘technosphere’ claims, but can also contribute to a technological development characterized by sustainability.

The review article ‘Prospective technology assessment in the Anthropocene – a transition towards a culture of sustainability’ by Martin Möller and Rainer Grießhammer then turns directly to the topic of sustainability. The purpose of this article is to outline current approaches to early sustainability assessment of technologies and to evaluate them with respect to the challenges of the Anthropocene. For this purpose, central definitions of the concept of sustainability are named and important methods of sustainability assessment and technology assessment are presented. Especially in the Anthropocene, where nature and technology are closely intertwined, an agile system for the early assessment of new technologies is indispensable. It is precisely the specific concept of a vulnerable nature that can no longer be separated from the technological and the man-made that requires sustainability research to consider the natural as the non-interchangeable capital of life.

While the research fields of biomimetics and sustainability research are already interdisciplin- ary research networks, the environmental ethical challenges regarding nature in the Anthropocene still require the inclusion of another group, namely society beyond science, who are directly affected by the consequences of the Anthropocene. This claim is addressed in the concluding article by Sabrina Livanec, Michael Stumpf, Lisa Reuter, Julius Fenn and Andrea Kiesel entitled ‘Who’s gonna use this? Acceptance prediction of emerging technologies with cognitive-affective mapping and transdisciplinary considerations in the Anthropocene’. This is because potentially useful technologies in the Anthropocene can only develop their full potential if they are socially accepted and can be integrated in a successful way into the social and natural environment. Participation and transdisciplinarity, however, can only be achieved using adequate methods that foster productive communication between laypersons and the scientific community. To this end, the authors propose the use of Cognitive-Affective Mapping (CAM) to assess the psychological acceptance of novel research approaches and technologies. CAM-based technology acceptance assessment can at least potentially address the concerns of all societal groups and, concomitantly, the concerns of a successful human-technology-nature relationship in the Anthropocene.

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