



DIE ERDE

Journal of the
Geographical Society
of Berlin

Anthropocene – humankind as global actor: Insights into historic and current perspectives

Franziska Allerberger¹, Johann Stötter²

¹University of Innsbruck, Department of Geography, Innrain 52f, 6020 Innsbruck, Austria, franziska.allerberger@uibk.ac.at

²University of Innsbruck, Department of Geography, Innrain 52f, 6020 Innsbruck, Austria, hans.stoetter@uibk.ac.at

Manuscript submitted: 17 June 2022 / Accepted for publication: 17 August 2022 / Published online: 30 September 2022

Abstract

By proclaiming a new geological epoch in which humankind has become a dominant global driver and force of Earth system processes, *Crutzen* and *Stoermer* have triggered heated and unexpected debates among the scientific community in 2000. Yet, limiting the Anthropocene to a geological-stratigraphically defined time unit is highly questionable – if not absurd – as already in the 19th century scientists have dealt with the interaction of mind and matter with respect to the actions of humans and their impacts on the environment. Against this background, the article firstly provides an overview of historical concepts addressing humankind as global actor, whereby the differentiation and interplay between mind and matter is explicitly considered. Secondly, several characteristics of the Anthropocene are outlined but without claiming completeness. These considerations lead us to questions regarding the consequences of the Anthropocene as a “diagnosis of present times [Gegenwartsdiagnose]” (*Horn and Bergthaller 2019: 12*) for science itself, which are discussed in more detail in our second contribution in this Special Issue.

Zusammenfassung

Mit der Forderung nach einer neuen geologischen Epoche, in der der Mensch zum dominierenden globalen Treiber für die Prozesse des Erdsystems geworden ist, haben *Crutzen* und *Stoermer* im Jahr 2000 heftige und ungeahnte Debatten in der wissenschaftlichen Gemeinschaft ausgelöst. Die Beschränkung des Anthropozäns auf eine geologisch-stratigraphisch definierte Zeiteinheit ist jedoch höchst fragwürdig, da sich Wissenschaftler:innen bereits im 19. Jahrhundert mit der Wechselwirkung von Geist und Materie in Bezug auf das Handeln des Menschen und dessen umgestaltende Auswirkungen auf die Umwelt beschäftigt haben. Vor diesem Hintergrund gibt der Artikel zunächst einen Überblick über historische Konzepte, die den Menschen als globalen Akteur thematisieren, wobei die Unterscheidung bzw. das Zusammenspiel von Geist und Materie explizit berücksichtigt wird. Zweitens werden einige Charakteristika des Anthropozäns skizziert, ohne jedoch Anspruch auf Vollständigkeit zu erheben. Diese Überlegungen führen uns zu Fragen hinsichtlich der Konsequenzen, die mit dem Anthropozän als „Gegenwartsdiagnose“ (*Horn and Bergthaller 2019: 12*) für die Wissenschaft selbst einhergehen, die eingehender in unserem zweiten Beitrag in diesem Special Issue diskutiert werden.

Keywords Anthropocene, global actor, humankind, mind-matter

Franziska Allerberger, Johann Stötter 2022: Anthropocene – humankind as global actor: Insights into historic and current perspectives. – DIE ERDE 153 (3): 138-149



DOI:10.12854/erde-2022-631

1. Introduction

‘A picture is worth a thousand words’ – and therefore we invite all readers to pause and to have a look at the photographs made by *Edward Burtynsky*: <https://www.edwardburtynsky.com/projects/photographs/anthropocene>. It becomes apparent that *Edward Burtynsky* as an artist is explicitly dealing with human actions and their consequences. In particular, together with colleagues he tries to capture the multiplicity of human imprints on system Earth becoming increasingly visible in the 21st century (see e.g. ‘The Anthropocene Project’: <https://theanthropocene.org/>). However, thinking of humankind as a relevant global actor is not first and foremost a phenomenon of nowadays scientific and societal discussions regarding the so-called ‘Anthropocene’. Against this background, in this contribution we provide a comprehensive literature review on historic concepts dealing with humankind as global actor (chapter 2). This is followed and complemented by an outline of the more recent debate on the Anthropocene, whereby we do not try to provide a definition, but rather summarise these findings in a few essential characteristics without claiming to be exhaustive (chapter 3). We conclude by pointing out which consequences science itself should draw from the challenges coming along with the Anthropocene. This ‘normative imperative’ in sense of a call for action is discussed more in detail in our second contribution in this issue (*Allerberger and Stötter 2022*).

2. A short history of concepts on humankind as global actor

When *Crutzen and Stoermer (2000)* published the first ideas on the ‘Anthropocene’ and thus, quasi-officially, introduced it into the scientific discourse, a new term was coined, but not necessarily a new idea and through *Crutzen (2002)*, discussions and interpretations were directed towards geology. However, a review of the scientific discourses that ultimately gave rise to the concept of the ‘Anthropocene’ reveals two directions that focus on the importance of humans with respect to the (re)shaping of planet Earth. In the sense of the dualism thought of *Descartes (1641)*, on the one hand the changes in their material dimension (‘res extensa’) are in the focus of consideration, while on the other hand the human mind (‘res cogitans’) and its contributions to the processes of change are the starting point of the discussions.

The first insights that humans have developed into a formative shaper of the Earth system date back at least to the second half of the 18th century and were discussed more intensively from the middle of the 19th century (see *Table 1*), so that *Goudie and Viles (2016: 1)* describe the word ‘Anthropocene’ as “a new term for an old concept”. Without introducing a term of his own, *Buffon (1778: 322)* already points to the dominance of human activity by characterising the seventh and last of his geological epochs as follows: “When the power of Man overcame that of Nature. [Lorsque la puissance de l’Homme a secondé celle de la Nature.]¹”. In this sense, *Marsh (1864)* shows in detail how humans have transformed the surface of planet Earth by inappropriate management of natural resources, i.e. forests, soils and water, and further discusses the influence of human action on climate. *Marsh (1864: 8)* argues that “man has reacted upon organized and inorganic nature, and thereby modified, if not determined, the material structure of his earthly home. The measure of that reaction manifestly constitutes a very important element in the appreciation of the relations between mind and matter, as well as in the discussion of many purely physical problems.” The ideas that humans have become one, if not the essential, shaping factor for the surface of system Earth through their actions is later taken up and further discussed by e.g. *Woeikof (1901)* or *Shaler (1912)* – a substantive debate that continues to this day (see e.g. *Fischer 1916; Thomas 1956; Nir 1983; Szabó et al. 2010; Goudie and Viles 2016*).

However, a first conceptual approach to the word ‘Anthropocene’ was already made by *Jenkyn (1854a: 313)*, who introduced the term “Anthropozoic” for rocks of Post-Pleistocene age. Elsewhere (*Jenkyn 1854b: 140*) he refers to these rocks as “rocks which were deposited [...] in the human epoch”, thus giving a name to this geological epoch already contextualised by *Lyell (1833: 52)* for all “contemporaneous” formations. This interpretation is continued by *Dana (1863: xiv)*, who speaks of an “Age of Man” and puts it on a level with an “Era of Mind”, in which mind is seen as the dominant element and the “supremacy of the spiritual” is acknowledged (*Dana 1863: 574*).

Haughton (1865: 138) continues the discussion by introducing the term “Anthropozoic Epoch”, before *Stoppani (1873)*, to whom this terminology is often attributed, calls the “èra antropozoica [...] [definita da] un nuovo elemento: è una nuova forza tellurica, che, per la sua potenza e universalità, non sviene in faccia

Anthropocene – humankind as global actor: Insights into historic and current perspectives

Table 1 Brief overview of the temporal development of the term ‘Anthropocene’ and related concepts (the allocation to the categories of matter and mind/spirit is subjective and corresponds to the perception of the authors). Source: own elaboration

Author	Year	Terminology	Focus	
			Matter (natural spheres)	Mind/Spirit
<i>Buffon</i>	1778	“When the power of Man overcame that of Nature”	x	
<i>Lyell</i>	1833	Human Epoch	x	
<i>Jenkyn</i>	1854	Anthropozoic Human Epoch	x	
<i>Dana</i>	1863	Era of Mind Age of Man	x	x
<i>Marsh</i>	1864	“Man and Nature”	x	(x)
<i>Haughton</i>	1865	Anthropozoic Epoch	x	
<i>Stoppani</i>	1873	Anthropozoic Era	x	
<i>LeConte</i>	1877	Psychozoic Era Era of Mind Reign of Man		x
<i>Schuchert</i>	1918	Age of Reason		x
<i>Pavlov</i>	1922	Anthropogène	x	
<i>Teilhard de Chardin</i> <i>Le Roy</i> <i>Vernadsky</i>	1920s	Noosphere	(x)	x
<i>Markl</i>	1982	Anthropozoikum	x	
<i>Stoermer</i>	1980s	Anthropocene	x	
<i>Crutzen and Stoermer</i>	2000	Anthropocene	x	(x)
<i>Steffen et al.</i>	2004	Great Acceleration	x	x
<i>Anthropocene Working Group</i>	2019	Anthropocene chrono-stratigraphic unit	x	

alle maggiori forze del globo [new telluric force which in power and universality may be compared to the greater forces of earth]”. More recently, *Markl* (1982) has associated the term ‘Anthropozoic’ with current species extinctions triggered by anthropogenic activities.

Pavlov (1922: 76) argues in a similar direction by defining the term “Anthropogène” as “period of humankind [période du genre humain]”. Soviet geologists followed up on this idea, which eventually resulted in the proposal to replace the term “Quaternary” by “the term ‘anthropogene’ (anthropogenic system and period)” (*Gromov et al.* 1960: 11). It is *LeConte* (1877: 269), who characterizes the human mind as shaping a geologic time unit, in which he introduces the term

“Psychozoic era” or “era of mind” into the scientific discussion. For him the “reign of man” *LeConte* (1877: 561) begins with the Neolithic. *Schuchert* (1918: 45; actually in a lecture in 1916) takes up the idea and speaks of an “Age of reason” in which man “attained highest civilization”.

These thoughts are taken up in the 1920s with the concept of the ‘Noosphere’ whereby it is not clear who first raised and used the term. *Grinevald* (1998: 155) writes about this in bullet points: “1924: [...] Many discussions with Pierre Teilhard de Chardin (1881-1955) and Edouard Le Roy (1870-1954). The trio invented the concept of ‘the noosphere’”. According to *Hamilton and Grinevald* (2015), it can be assumed that *Teilhard de Chardin* first wrote down the term in an

unpublished document in 1925. Following the concept of spheres developed by *Suess* (1875), a sphere of the human mind is introduced to complement the spheres of nature with the 'Noosphere', a consideration first published by *Le Roy* (1927). On the one side, the 'Noosphere' follows the mineral (Geosphere; first stage) and the organic (Biosphere; second stage) and is therefore understood as last great stage of the history of planet Earth, and explicitly "outside and above the biosphere" (*Teilhard de Chardin* 1964: 163). On the other side, *Vernadsky* (1926) suggested that the combination of biosphere and human mind constitutes the noosphere, in which humanity has become a geological force. This closes the circle, as it were, that led to the discussion of the geological dimension initiated by *Crutzen* (2002) at the beginning of the 21st century.

Following a suggestion of *Zalasiewicz et al.* (2008) that it might be appropriate to see the Anthropocene as a new geological epoch, the Stratigraphy Commission of the Geological Society of London decided that the proposal had merit and should be examined further. As a consequence, in the same year, the Anthropocene Working Group (AWG) was ratified as a formal component of the Subcommittee on Quaternary Stratigraphy within the International Commission on Stratigraphy (*British Geological Survey, BGS* 2021). Soon, discussions started about the start-date of the new epoch (see e.g. *Lewis and Maslin* 2015).

After many years of evaluating evidence, the Anthropocene Working Group agreed on recommending the 'Anthropocene' as a new geological epoch, which differs in terms of function and structure from the Holocene (*Waters et al.* 2016) and recommended a start-date based on a mid-20th century boundary (*Zalasiewicz et al.* 2017). Finally, the *Anthropocene Working Group* (2019: 4) has completed a binding vote: a) that the Anthropocene is "treated as a formal chronostratigraphic unit defined by a GSSP [Global Stratigraphic Section and Point]", and b) "the primary guide for the base of the Anthropocene" is "one of the stratigraphic signals around the mid-twentieth century of the Common Era".

In this sense, the stratigraphic definition of the Anthropocene follows the idea that "the profound transformation of Earth's environment that is now apparent, a transformation owing not to the great forces of nature or to extra-terrestrial sources but to the numbers and activities of people – the phenomenon of global change. Begun centuries ago, this transfor-

mation has undergone a profound acceleration during the second half of the twentieth century" (*Steffen et al.* 2004: iii). These accelerating processes of the Earth system had first been highlighted by *McNeill* (2001). Thus, the Anthropocene is understood as the period of the Great Acceleration (see *Steffen et al.* 2015a), respectively that the Great Acceleration serves as quantitative proof for the Anthropocene Series/Epoch (*Head et al.* 2021).

3. The 'Anthropocene' – a fuzzy attempt at a definition²

From a natural scientific point of view, it is scientific consensus that the International Commission on Stratigraphy, in its role and self-image as a time keeper for the history of Planet Earth, should address the definition of the new geological epoch 'Anthropocene'. The fact that they are attempting this by means of a GSSP yet to be defined (see *Anthropocene Working Group* 2020) is in keeping with their understanding of systems and time. However, due to the dimension of this new time unit that goes far beyond the character of a chronostratigraphic unit defined by geological-geomorphological processes, which is already recognisable from the brief description of the historical approaches and the development history of the 'Anthropocene' concept, this is clearly too little.

At the same time, this refers to the fact that there is no such thing as 'the' Anthropocene. Rather, a variety of different approaches and understandings can be discerned in the more recent discussions as e.g. shown by *Zalasiewicz et al.* (2021) who discuss different understandings and conceptualisations of the Anthropocene in various disciplines. Also worth mentioning at this point are, for example, the research of *Bonneuil* (2015) and *Dürbeck* (2018), who identify four respectively five narratives on the Anthropocene. The spectrum of narratives ranges from rather apocalyptic-catastrophic 'glimpses' of possible futures to more optimistic perspectives with inherent hope for a sustainable society fit for future. This illustrates the extent to which 'the' Anthropocene is socially constructed and in negotiation (see e.g. *Laux* 2018). This 'construction process' is not only limited to the scientific level, but also takes place in other parts of society. For example, the German Museum in Munich installed an exhibition entitled 'Welcome to the Anthropocene' (*Möllers et al.* 2015).

The pessimistic narratives mentioned should be seen in close connection with scientific findings, for example from natural sciences. In this sense, the recently published Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2022: 1; emphasis in the original) shows that “[b]eyond 2040 and depending on the level of global warming, climate change will lead to numerous risks to natural and human systems (*high confidence*). For 127 identified key risks, assessed mid and long-term impacts are up to multiple times higher than currently observed (*high confidence*)”. Human-induced climate change is thus not only an “existential risk” (Rockström et al. 2021: 1), but an increasingly complex and difficult challenge to tackle (IPCC 2022). However, these climate change risks cannot be considered in isolation. In terms of a holistic view, they must always be seen in the context of other global/planetary challenges as they are identified, for example, by Amanatidou et al. (2012), *Future Earth* (2014) and by the German Advisory Council on Global Change (WBGU 1996).

Firstly, these challenges of the 21st century illustrate that they are not only ecological problems that confront humankind, but rather reflect the interconnectedness of the social and the ecological domains. In view of the Anthropocene, authors like Jahn et al. (2015), Brand (2016), Brand and Wissen (2017, 2018) as well as Wissen (2021) call for a change of perspective or a broadening of perspectives respectively, whereby production and lifestyles as well as gender roles and thus also questions regarding prevailing power relations are taken into account. This is also important insofar as ‘the humankind’ as a uniform collective is not responsible for the socio-ecological crises. Thus, the prosperity of the countries of the Global North is in many ways based on the exploitation of the countries of the Global South. The “imperial mode of living”, to speak with Brand and Wissen (2018: 287), can thus be named as the cause of ecological and social carrying capacity being exceeded (Steffen et al. 2015b; Raworth 2017). Similarly, Lessenich (2016: 17) speaks of an “externalisation society [Externalisierungsgesellschaft]” and states: “Whoever talks about our prosperity in this country should not be silent about the associated, interwoven, even causally connected hardships of other people elsewhere. But that is exactly what is happening all the time. [Wer von unserem Wohlstand hierzulande redet, dürfte von den damit verbundenen, verwobenen, ja ursächlich zusammenhängenden Nöten anderer Menschen andernorts nicht schweigen. Genau das aber ist es, was ununterbrochen geschieht.]”

Secondly, this results in the urgent need to act now, which has been proclaimed for many decades, and to take correspondingly ambitious action, but which has so far failed to materialise (Blühdorn et al. 2020c). On the one hand, this urgency resonates with a feeling of being overwhelmed and powerless with regard to possible apocalyptic Anthropocene futures. This sense of ‘eco-anxiety and grief’ is an emerging field of scientific inquiry and associated with questions of mental health (e.g. Cunsolo et al. 2020; Coffey et al. 2021, Comtesse et al. 2021). On the other hand, Görg (2016) points out that Earth system scientists in particular want to draw attention to hitherto inadequate measures with their analyses and accordingly aim at promote a motivation to act with their messages on the state of the Earth system. Thus, the Anthropocene is associated with a „contrariness of time scales [Gegensätzlichkeit der Zeitskalen]” (Görg 2016: 12): “On the one hand, urgent action is invoked [...]. On the other hand, the consequences of human activity in earth-historical times are thematised. [...] [it] is thought [...] in time scales that are neither captured by politics nor by the social imagination at all. [Einerseits wird ein dringliches Handeln beschworen [...]. Andererseits werden die Folgen des menschlichen Wirkens in erdgeschichtlichen Zeiten thematisiert. [...] [es] wird [...] in Zeitskalen gedacht, die weder von der Politik noch von der gesellschaftlichen Imagination überhaupt erfasst werden]”. Thus, in addition to complexities, uncertainties, non-linearities and non-knowledgeability are inherent characteristics of the problems outlined (Ratter 2012; Görg 2016; Lenton et al. 2019; Galaz 2019) – and thus equally part of negotiation and decision-making processes (Gabriel 2013).

This results in challenges for positively and thus optimistically framed Anthropocene narratives that should not be underestimated. It seems more than clear that a ‘business-as-usual’ approach is no longer viable and that a transformation towards a sustainable, future-oriented society is required instead (e.g. WBGU 2011; Patterson et al. 2015; *Club of Rome* 2020). However, firstly, Blühdorn et al. (2020c) have elaborated that despite all the sustainability rhetoric of recent years and decades, practices are still prevalent that maintain and are built upon “our freedom, our values and our lifestyle [unsere[r] Freiheit, unsere[n] Werte[n] und unsere[n] Lebensstil[.]” (Blühdorn 2020a: 20; emphasis in the original) and thus manifest a “*Society of Non-Sustainability [Gesellschaft der Nicht-Nachhaltigkeit]*” (Blühdorn 2020b: 9; emphasis in the original). Secondly, the demand for a socio-ecological

transformation or “transformations towards sustainability” (Patterson et al. 2015) does not per se provide clear answers to the questions of what, how, when, by whom and for whom transformation should take place – these points are rather part of negotiation processes (O’Brien 2012). The difficulty of ‘navigating’ through Anthropocene challenges is further increased by the fact that the normative target horizon of sustainability is equally ambiguous and, in this sense, not a concept of harmony, as Vogt (2019: 30) demonstrates using the UN Sustainable Development Goals as an example: “[...] With their unresolved tension between developmental and ecological goals, they lack conceptual coherence. [...] They seem like the return of utopia in the post-utopian age. [Mit ihrer unaufgelösten Spannung zwischen entwicklungspolitischen und ökologischen Zielen fehlt es ihnen an konzeptioneller Kohärenz. [...] Sie wirken wie die Rückkehr der Utopie im postutopischen Zeitalter.]“

In summary, we can understand the Anthropocene with Horn and Bergthaller (2019: 12) as a “diagnosis of present times [Gegenwartsdiagnose].” As the presentation of the challenges illustrates, this is just as much – or even more – a crisis diagnosis, which moves between hope and hopelessness; between opportunities and disasters; between “change and preservation [Wandel und Bewahrung]” (Schneider and Vogt 2018: 105). In it, and thus also in the concept of the Anthropocene, an elusive ‘sense of time’ is condensed, which can also be described as a “metamorphosis of the world [Metamorphose der Welt]“ in the sense of Beck (2017: 15-16): “The eternal certainties of modern societies break away, and something entirely new appears on the scene. In order to grasp the transformation of the world, we have to examine this newness, look at what is breaking out of the old, and try to discern the structures and norms of the future in the confusion of the present. [Die ewigen Gewissheiten moderner Gesellschaften brechen weg, und etwas ganz und gar Neues tritt auf den Plan. Um die Verwandlung der Welt zu erfassen, müssen wir dieses Neue untersuchen, uns ansehen, was aus dem Alten hervorbricht, und die Strukturen und Normen der Zukunft im Durcheinander der Gegenwart auszumachen versuchen.]“

4. Characteristics of the Anthropocene

The Anthropocene apparently lacks a clear definition and is rather a ‘fuzzy concept’. However, in the following section several ‘key’ characteristics of the Anthro-

pocene are derived from the previous explanations:

- era of multiple crisis (Brand and Wissen 2017), resulting from the complex, interwoven Global Grand Challenges which are i) associated with multiple uncertainties (see e.g. Kallerud et al. 2013; *Future Earth* 2014) and ii) strongly connected with processes like industrialisation (e.g. Osterhammel 2010; Headrick 2020), digitalisation (e.g. WBGU 2019) as well as globalisation (e.g. Messner 2010);
- Great Acceleration of many processes in the second half of the 21st century (see e.g. Steffen et al. 2004, 2015a; McNeill and Engelke 2014; Head et al. 2021);
- persistent discourse on the carrying capacity of planet Earth in ever new narratives (see e.g. Malthus 1798; Meadows et al. 1972; Hardin 1986; Wackernagel and Rees 1996; Rockström et al. 2009; Steffen et al. 2015b; Raworth 2017);
- progressive exploitation and overshoot of the global environmental commons (see e.g. Rockström et al. 2009; Steffen et al. 2015b; Raworth 2017; Wackernagel and Beyers 2019; German et al. 2021), and thus:
- possible crossing of planetary boundaries and tipping points towards non-reversible, new system states (see e.g. Lenton et al. 2008, 2019; Rockström et al. 2009, 2021; Steffen et al. 2015b, 2018; Wang-Erlandsson et al. 2022).

In more general terms, the characteristics can be described as follows:

- local and regional acting of each individual which contributes to global drivers, whereby humans have become the most influential factor of natural process cycles of the earth system (see e.g. Goudie and Viles 2016; German et al. 2021);
- spatial and temporal decoupling of causes and effects (see Stötter et al. 2014).

Keeping in mind these characteristics, it becomes evident that the Anthropocene challenges our capacity to think and plan ahead:

- future thinking in general (e.g. Atance 2008, 2015; Hölscher 2016, 2018; Oettingen et al. 2018) as well as the need to think on timescales that are far beyond human imagination and thinking in particular (e.g. Görg 2016) are not only challenged by our linear and present-centred mindset (e.g. Textor 1995; Dator 2009), but also because of missing knowledge how to deal with certain possible futures (e.g. Gabriel 2013; for a detailed analysis regarding the demar-

cation between “space of experience [Erfahrungsräum]” and “horizon of expectations [Erwartungshorizont]” relevant in this context see *Koselleck* 2020: 349-374);

- future thinking becomes a demanding task for ethical reasons as well (e.g. *Birnbacher* and *Brudermüller* 2001; *Gransche* 2016). Hence, complexity, uncertainty and not-knowing do not serve as an excuse for not trying to deal with possible futures (e.g. *Gransche* 2016);
- narratives about possible futures in the Anthropocene oscillate between hope and hopelessness or opportunities and disaster scenarios respectively (e.g. *Bonneuil* 2015; *Dürbeck* 2018).

It must be said that the mentioned characteristics are by no means to be understood as all-encompassing and exclusive but as potential entry points to think about the Anthropocene – or more precisely: they challenge our thinking about the Anthropocene and therefore our stance towards and understanding of past, present and future(s). Besides, the mentioned aspects can be seen complementary to the ‘thought styles’ outlined by *Hafner* (2022, this issue).

5. Conclusion

As has been shown above, the discussions regarding humans as global actor already have its roots in the 18th century, covering a wide range of different terminologies as well as underlying assumptions with respect to the relationship between mind and matter. The Anthropocene as current dominant ‘terminus technicus’ is not easy to grasp, there is no single or shared understanding (for other terms used related to the Anthropocene see *Hafner* 2022, this issue). Rather, a diversity of disciplinary perspectives can be found, pointing to the fact that the Anthropocene comprises many facets going beyond a mere geological-stratigraphic ‘definition’. For instance, this is also mirrored by the contributions made in course of the scientific conference ‘Cultures in the Anthropocene. An interdisciplinary Challenge’ organised by two Research Centres of the University of Innsbruck, which took place as an online event from June 30th to July 3rd, 2021 (see <https://www.uibk.ac.at/congress/kulturen-im-anthropozoen/#english>). Despite this multiplicity of understandings and scientific investigations, one aspect is falling short: What has been largely disregarded is the crucial question regarding the consequences of the Anthropocene on science itself

as the Anthropocene mostly and only serves as epistemic object of interest. However, we have to acknowledge that there is an increasing differentiation and specialisation of scientific disciplines (e.g. *Mittelstrass* 2018). This development is assumed to be problematic. On the one hand, the disciplinary development of modern sciences comes along with an increased discursive separation of non-consensual thinking of humans and nature (e.g. *Chakrabarty* 2021). On the other hand, the global challenges of the Anthropocene (see chapter 3) can only be addressed in a comprehensive manner through inter- and transdisciplinary cooperation due to their inherent complexity (e.g. *Jahn* et al. 2015; *Paasche* and *Österblom* 2019). In other words: addressing the question regarding the role of science and its institutions is of utmost importance as there is a widely accepted consensus among the scientific community that the Anthropocene confronts us with tremendous, global challenges – regardless of the underlying definition or understanding of the concept itself. To tackle and overcome these challenges, science and its institutions can (and must) play an important role (e.g. *Fazey* et al. 2018, 2020; *Jahn* et al. 2015). Though, in order to comply with this societal responsibility, science and its institutions themselves must overcome major challenges profoundly questioning manifested structures, modes of operations as well values and attitudes. In other words, the Anthropocene calls for a self-transformation of the scientific system. In our second contribution in this issue (*Allerberger* and *Stötter* 2022), we aim at pointing out first steps and potential entry points for such a self-transformation in the sense of a ‘normative imperative for science in general and universities in particular’.

Notes

¹ The square brackets used throughout this manuscript after a literal quotation contain the text in the original language translated by the authors.

² This chapter is partly based on *Allerberger* (2021).

References

- Allerberger, F.* 2021: Raus aus dem Elfenbeinturm! Studierende als Partner:innen und Gestalter:innen für eine (Selbst-) Transformation von Wissenschaft und Gesellschaft auf dem Weg zu einer nachhaltigen Zukunft: Master Thesis. – Unpublished, Innsbruck
- Allerberger, F.* and *J. Stötter* 2022: The Anthropocene beyond stratigraphy – towards a normative imperative for

- science and universities. – *DIE ERDE* **153** (3): 198-215, doi:10.12854/erde-2022-632
- Amanatidou, E., S. Giesecke, K. Jarmai, T. Loikkanen and P. Warnke* 2012: VERA Deliverable 1.2 Typology of RTDI directed towards Grand Societal Challenges. – Online available at: https://eravisions.archiv.zsi.at/attach/D1_2_VERA_Stocktaking_and_Typology_WP1_final_version.pdf, accessed 7/8/2021
- Anthropocene Working Group* 2019: Newsletter of the Anthropocene Working Group. – Online available at: <http://quaternary.stratigraphy.org/wp-content/uploads/2020/09/Anthropocene-Working-Group-Newsletter-Vol-9-final.pdf>, accessed 18/5/2022
- Anthropocene Working Group* 2020: Newsletter of the Anthropocene Working Group. – Online available at: <http://quaternary.stratigraphy.org/wp-content/uploads/2021/03/AWG-Newsletter-2020-Vol-10.pdf>, accessed online 18/5/2022
- Atance, C.M.* 2008: Future Thinking in Young Children. – *Current Directions in Psychological Science* **17** (4): 295-298, doi:10.1111/j.1467-8721.2008.00593.x
- Atance, C.M.* 2015: Young Children's Thinking About the Future. – *Child Development Perspectives* **9** (3): 178-182, doi:10.1111/cdep.12128
- Beck, U.* 2017: *Die Metamorphose der Welt*. – Berlin
- Birnbacher, D. and G. Brudermüller* 2001: *Zukunftsverantwortung und Generationensolidarität*. – Schriften des Instituts für Angewandte Ethik e.V. Vol. 3. – Würzburg
- Blühdorn, I.* 2020a: Haben wir es gewollt? Vorüberlegungen. – In: *Blühdorn, I., F. Butzlaff, M. Deflorian, D. Hausknost and M. Mock* (eds.): *Nachhaltige Nicht-Nachhaltigkeit. Warum die ökologische Transformation der Gesellschaft nicht stattfindet*. – X-Texte zu Kultur und Gesellschaft. – Bielefeld: 13-27
- Blühdorn, I.* 2020b: Am Anfang ... – In: *Blühdorn, I., F. Butzlaff, M. Deflorian, D. Hausknost and M. Mock* (eds.): *Nachhaltige Nicht-Nachhaltigkeit. Warum die ökologische Transformation der Gesellschaft nicht stattfindet*. – X-Texte zu Kultur und Gesellschaft. – Bielefeld: 9-11
- Blühdorn, I., F. Butzlaff, M. Deflorian, D. Hausknost and M. Mock* 2020c: *Nachhaltige Nicht-Nachhaltigkeit. Warum die ökologische Transformation der Gesellschaft nicht stattfindet*. – X-Texte zu Kultur und Gesellschaft. – Bielefeld
- Bonneuil, C.* 2015: The Geological Turn. Narratives of the Anthropocene. – In: *Hamilton, C., C. Bonneuil and F. Gemenne* (eds.): *The anthropocene and the global environmental crisis. Rethinking modernity in a new epoch*. – London/New York: 15-31
- Brand, U.* 2016: "Transformation" as a New Critical Orthodoxy: The Strategic Use of the Term "Transformation" Does Not Prevent Multiple Crises. – *GAIA - Ecological Perspectives for Science and Society* **25** (1): 23-27, doi:10.14512/gaia.25.1.7
- Brand, U. and M. Wissen* 2017: *Imperiale Lebensweise. Zur Ausbeutung von Mensch und Natur in Zeiten des globalen Kapitalismus*. – München
- Brand, U. and M. Wissen* 2018: What Kind of Great Transformation? The Imperial Mode of Living as a Major Obstacle to Sustainability Politics. – *GAIA - Ecological Perspectives for Science and Society* **27** (3): 287-292, doi:10.14512/gaia.27.3.8
- British Geological Survey (BGS)* 2021: The Anthropocene. – Online available at: <https://www.bgs.ac.uk/geology-projects/anthropocene/>, accessed 18/5/2022
- Buffon, G.-L.L.* 1778: *Les époques de la nature*. – Paris
- Chakrabarty, D.* 2021: *The climate of history in a planetary age*. – Chicago/London
- Club of Rome* 2020: *Planetary Emergency 2.0. Securing a New Deal for People, Nature and Climate*. – Online available at: http://clubofrome.org/wp-content/uploads/2020/09/COR-PEP_Sep2020_A4_16pp-v2.pdf, accessed 7/8/2021
- Coffey, Y., N. Bhullar, J. Durkin, M.S. Islam and K. Usher* 2021: Understanding Eco-anxiety: A Systematic Scoping Review of Current Literature and Identified Knowledge Gaps. – *The Journal of Climate Change and Health* **3** (7): 100047, doi:10.1016/j.joclim.2021.100047
- Comtesse, H., V. Ertl, S.M.C. Hengst, R. Rosner and G.E. Smid* 2021: Ecological Grief as a Response to Environmental Change: A Mental Health Risk or Functional Response? – *International journal of environmental research and public health* **18** (2): 734, doi:10.3390/ijerph18020734
- Crutzen, P.J.* 2002: Geology of mankind. – *Nature* **415** (6867): 23, doi:10.1038/415023a
- Crutzen, P.J. and E.F. Stoermer* 2000: The 'anthropocene'. – *The Global Change Newsletter* **41**: 17-18. – Online available at: <http://www.igbp.net/download/18.316f18321323470177580001401/1376383088452/NL41.pdf>, accessed: 23/08/2022
- Cunsolo, A., S.L. Harper, K. Minor, K. Hayes, K.G. Williams and C. Howard* 2020: Ecological grief and anxiety: the start of a healthy response to climate change? – *The Lancet Planetary Health* **4** (7): e261-e263, doi:10.1016/S2542-5196(20)30144-3
- Dana, J.D.* 1863: *Manual of Geology: Treating of the Principles of the Science with special reference to American Geological History*. – Philadelphia
- Dator, J.* 2009: Alternative Futures at the Manoa School. – *Journal of Future Studies* **14** (2): 1-18. – Online available at: <http://www.futures.hawaii.edu/publications/futures-studies/AltFuturesManoa2009.pdf>, accessed 23/08/2022
- Descartes, R.* 1641: *Meditationes de prima philosophia*. – Paris

- Dürbeck, G. 2018: Narrative des Anthropozän – Systematisierung eines interdisziplinären Diskurses. – *Kulturwissenschaftliche Zeitschrift* **3** (1): 1-20, doi:10.2478/kwg-2018-0001
- Fazey, I., N. Schöpke, G. Caniglia, J. Patterson, J. Hultman, B. van Mierlo, F. Säwe, A. Wiek, J. Wittmayer, P. Aldunce et al. 2018: Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. – *Energy Research & Social Science* **40** (5): 54-70, doi:10.1016/j.erss.2017.11.026
- Fazey, I., N. Schöpke, G. Caniglia, A. Hodgson, I. Kendrick, C. Lyon, G. Page, J. Patterson, C. Riedy, T. Strasser et al. 2020: Transforming knowledge systems for life on Earth: Visions of future systems and how to get there. – *Energy Research & Social Science* **70** (6): 101724, doi:10.1016/j.erss.2020.101724
- Fischer, E. 1916: Der Mensch als geologischer Faktor. – *Zeitschrift der Deutschen Geologischen Gesellschaft (Abhandlungen und Monatsberichte)* **67**: 106-148
- Future Earth 2014: Future Earth Strategic Research Agenda 2014. – Paris. – Online available at: <https://council.science/wp-content/uploads/2020/06/Future-Earth-Strategic-Research-Agenda-2014.pdf>, accessed 7/8/2021
- Gabriel, J. 2013: Der wissenschaftliche Umgang mit Zukunft. Eine Ideologiekritik am Beispiel von Zukunftsstudien über China: Dissertation Universität Trier, 2012. – Wiesbaden
- Galaz, V. 2019: Global Challenges, Governance, and Complexity. Applications and Frontiers. – Cheltenham, UK/Northampton, MA, USA
- German, V., G. Gratzler, F. Fehr and J. Stötter 2021: Globale Umwelt-Commons. – In: Allianz Nachhaltige Universitäten in Österreich (ed.): Von den Optionen zur Transformation. – Innsbruck: 47-62
- Görg, C. 2016: Zwischen Tagesgeschäft und Erdgeschichte: Die unterschiedlichen Zeitskalen in der Debatte um das Anthropozän. – *GAIA - Ecological Perspectives for Science and Society* **25** (1): 9-13, doi:10.14512/gaia.25.1.4
- Goudie, A. and H.A. Viles 2016: Geomorphology in the Anthropocene. – Cambridge
- Gransche, B. 2016: Ethik der Veränderung – verantwortliches Handeln und Veränderungsbeschleunigung. – In: Maring, M. (ed.): Zur Zukunft der Bereichsethiken – Herausforderungen durch die Ökonomisierung der Welt. – Karlsruhe: 55-71
- Grinevald, J. 1998: Appendix I: A Biographical Chronology. – In: Vernadsky, V.I. (ed.): Biosphere. – New York: 151-159
- Gromov, V.I., I. Krasnov, K.V. Nikiforova and E.V. Shantser 1960: Printsipy stratigraficheskogo podrazdeleniya chetvertichnoi (antropogenovoi) sistemy i ee nizhnaya granitsa. Principles of a stratigraphic subdivision of the Quaternary (Anthropogenic) system and its lower boundary. – *Chronologiya i climaty chetvertichnogo perioda*, Moscow.
- Hafner, R. 2022: The Anthropocene: Thought styles, controversies and their expansions. A review. – *DIE ERDE* **153** (3): 149-161, doi: 10.12854/erde-2022-619
- Hamilton, C. and J. Grinevald 2015: Was the Anthropocene anticipated? – *The Anthropocene Review* **2** (1): 59-72, doi:10.1177/2053019614567155
- Hardin, G.W. 1986: Cultural carrying-capacity - a biological approach to human problems. – *Bioscience* **36**: 599-606, doi:10.1093/bioscience/36.9.599
- Haughton, S. 1865: Manual of Geology. – London
- Head, M.J., W. Steffen, D. Fagerlind, C.N. Waters, C. Poirier, J. Syvitski, J.A. Zalasiewicz, A.D. Barnosky, A. Cearreta, C. Jeandel et al. 2021: The Great Acceleration is real and provides a quantitative basis for the proposed Anthropocene Series/Epoch. – Episodes. *Journal of International Geoscience*, doi:10.18814/epiiugs/2021/021031
- Headrick, D.R. 2020: Humans versus Nature. – Oxford
- Hölscher, L. 2016: Die Entdeckung der Zukunft. – Göttingen
- Hölscher, L. 2018: Future Thinking: A Historical Perspective. – In: Oettingen, G., A.T. Sevincer and P.M. Gollwitzer (eds.): The Psychology of Thinking about the Future. – New York: 15-30
- Horn, E. and H. Bergthaller 2019: Anthropozän zur Einführung. – Hamburg
- IPCC 2022: Headline Statements from the Summary for Policymakers. Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change: 28 February 2022 (subject to final copyediting). – Cambridge. – Online available at: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_HeadlineStatements.pdf, accessed 18/5/2022
- Jahn, T., D. Hummel and E. Schramm 2015: Nachhaltige Wissenschaft im Anthropozän. – *GAIA - Ecological Perspectives for Science and Society* **24** (2): 92-95, doi:10.14512/gaia.24.2.6
- Jenkyn, T.W. 1854a: Lessons in Geology, No. L. Chapter V. On the classification of rocks, section IV. On the tertiaries. – *Popular Educator* **4**: 313-316
- Jenkyn, T.W. 1854b: Lessons in Geology, No. XLVI, Chapter IV. On the effects of organic agents on the Earth's crust. – *Popular Educator* **4**: 139-141
- Kallerud, E., E. Amanatidou, P. Upham, M. Nieminen, A. Klitkou, D. Sutherland Olsen, M.L. Toivanen, J. Oksanen and L. Scordato 2013: Dimensions of Research and Innovation Policies to Address Grand and Global Challenges. – Oslo
- Koselleck, R. 2020: Vergangene Zukunft. Zur Semantik geschichtlicher Zeiten. – Frankfurt am Main
- Laux, H. 2018: Das Anthropozän. Zur Konstruktion eines

- neuen Erdzeitalters. – In: *Laux, H. and A. Henkel* (eds.): Die Erde, der Mensch und das Soziale. Zur Transformation gesellschaftlicher Naturverhältnisse im Anthropozän. – Bielefeld: 15-26
- Le Roy, E.* 1927: L'Exigence Idéaliste et le Fait de l'Evolution. – Paris
- LeConte, J.* 1877: Elements of Geology. – New York
- Lenton, T.M., H. Held, E. Kriegler, J.W. Hall, W. Lucht, S. Rahmstorf and H.J. Schellnhuber* 2008: Tipping elements in the Earth's climate system. – Proceedings of the National Academy of Sciences of the United States of America **105** (6): 1786-1793, doi:10.1073/pnas.0705414105
- Lenton, T.M., J. Rockström, O. Gaffney, S. Rahmstorf, K. Richardson, W. Steffen and H.J. Schellnhuber* 2019: Climate tipping points - too risky to bet against. – Nature **575** (7784): 592-595, doi:10.1038/d41586-019-03595-0
- Lessenich, S.* 2016: Neben uns die Sintflut. Die Externalisierungsgesellschaft und ihr Preis. – München
- Lewis, S.L. and M. A. Maslin* 2015: Anthropocene: Earth System, geological, philosophical and political paradigm shifts. – The Anthropocene Review **2** (2): 108-116, doi:10.1177/2053019615588791
- Lyell, C.* 1833: Principles of geology, being an attempt to explain the former changes of the Earth's surface, by reference to causes now in operation. – London
- Malthus, T.R.* 1798: An Essay on the Principle of Population as It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers. – London
- Markl, H.* 1982: Untergang oder Übergang – Natur als Kulturaufgabe. – In: *von Ditfurth, H.* (ed.): Mannheimer Forum – ein Panorama der Naturwissenschaften. – Studienreihe Boehringer **82/83**. – Mannheim: 61-98
- Marsh, G.P.* 1864: Man and Nature. Physical Geography as Modified by Human Action. – New York
- McNeill, J.R.* 2001: Something new under the sun: an environmental history of the twentieth-century world. – New York
- McNeill, J.R. and P. Engelke* 2014: The great acceleration. An environmental history of the anthropocene since 1945. – Cambridge, Massachusetts/London, England
- Meadows, D.H., D.L. Meadows, Randers, J. and W.W. Behrens III* 1972: The limits to growth. A report for the Club of Rome's project on the predicament of mankind. – New York
- Messner, D.* 2010: Globale Strukturanpassung: Weltwirtschaft und Weltpolitik in den Grenzen des Erdsystems. – In: *Welzer, H., H.-G. Soeffner and D. Giesecke* (eds.): KlimaKulturen. Soziale Wirklichkeiten im Klimawandel. – Frankfurt am Main: 65-80
- Mittelstrass, J.* 2018: The Order of Knowledge: From Disciplinarity to Transdisciplinarity and Back. – European Review **26** (S2): S68-S75, doi:10.1017/S1062798718000273
- Möllers, N., C. Schwägerl and H. Trischler* (eds.) 2015: Willkommen im Anthropozän. Unsere Verantwortung für die Zukunft der Erde; Sonderausstellung des Deutschen Museums und des Rachel Carson Center for Environment and Society. – München
- Nir, D.* 1983: Man, a Geomorphological Agent: An Introduction to Anthropogenic Geomorphology. – Jerusalem
- O'Brien, K.* 2012: Global environmental change II. – Progress in Human Geography **36** (5): 667-676, doi:10.1177/0309132511425767
- Oettingen, G., A.T. Sevincer and P.M. Gollwitzer* (eds.) 2018: The Psychology of Thinking about the Future. – New York
- Osterhammel, J.* 2010: Die Verwandlung der Welt. Eine Geschichte des 19. Jahrhunderts. – München
- Paasche, Ø. and H. Österblom* 2019: Unsustainable Science. – One Earth **1** (1): 39-42, doi:10.1016/j.oneear.2019.08.011
- Patterson, J., K. Schulz, J. Vervoort, C. Adler, M. Hurlbert, S. van der Hel, A. Schmidt, A.S. Barau, P. Obani, M. Sethi et al.* 2015: 'Transformations towards sustainability' Emerging approaches, critical reflections, and a research agenda. – Lund/Amsterdam
- Pavlov, A.P.* 1922: Epoques glaciaires et interglaciaires de l'Europe et leur rapport a l'histoire de l'homme fossile. – Bulletin de la Société impériale des naturalistes de Moscou **31**: 23-76
- Ratter, B.M.W.* 2012: Complexity and Emergence: Key Concepts in Non-Linear Dynamic Systems. – In: *Glaser, M., G. Krause, B.M.W. Ratter and M. Welp* (eds.): Human-nature interactions in the anthropocene. Potentials of socio-ecological systems analysis. – New York: 90-104
- Raworth, K.* 2017: Why it's time for Doughnut Economics. – IPPR Progressive Review **24** (3): 216-222, doi:10.1111/newe.12058
- Rockström, J., W. Steffen, K. Noone, A. Persson, F.S. Chapin, E.F. Lambin, T.M. Lenton, M. Scheffer, C. Folke, H.J. Schellnhuber et al.* 2009: Planetary Boundaries: Exploring the Safe Operating Space for Humanity. – Ecology and Society **14** (2): Art. 32, doi:10.1038/461472a
- Rockström, J., J. Gupta, T.M. Lenton, D. Qin, S.J. Lade, J.F. Abrams, L. Jacobson, J.C. Rocha, C. Zimm, X. Bai et al.* 2021: Identifying a Safe and Just Corridor for People and the Planet. – Earth's Future **9** (4): e2020EF001866, doi:10.1029/2020EF001866
- Schneider, M. and M. Vogt* 2018: Selbsterhaltung, Kontrolle, Lernen. – In: *Karidi, M., M. Schneider and R. Gutwald* (eds.): Resilienz. Interdisziplinäre Perspektiven zu Wandel und Transformation. – Wiesbaden: 103-123
- Schuchert, C.* 1918: The Earth's Changing Surface and Climate During Geological Time. – In: *Barrell, J., C. Schuchert, L.L. Woodruff, R.S. Lull and E. Huntington* (eds.): The Evolution of the Earth and its Inhabitants. – New Haven: 45-81

- Shaler, N.S. 1912: Man and the Earth. – New York
- Steffen, W., A. Sanderson, P. Tyson, J. Jäger, P. Matson, B. Moore III, F. Oldfield, K. Richardson, H.-J. Schellnhuber, B.L. Turner II and R. Wasson 2004: Global Change and the Earth System. A Planet under Pressure. – Berlin et al.
- Steffen, W., W. Broadgate, L. Deutsch, O. Gaffney and C. Ludwig 2015a: The trajectory of the Anthropocene: The Great Acceleration. – *The Anthropocene Review* **2** (1): 81-98, doi:10.1177%2F2053019614564785
- Steffen, W., K. Richardson, J. Rockström, S.E. Cornell, I. Fetzer, E.M. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit et al. 2015b: Planetary boundaries: guiding human development on a changing planet. – *Science* **347** (6223): 1259855, doi:10.1126/science.1259855
- Steffen, W., J. Rockström, K. Richardson, T.M. Lenton, C. Folke, D. Liverman, C.P. Summerhayes, A.D. Barnosky, S.E. Cornell, M. Crucifix et al. 2018: Trajectories of the Earth System in the Anthropocene. – *Proceedings of the National Academy of Sciences of the United States of America* **115** (33): 8252-8259, doi:10.1073/pnas.1810141115
- Stoppani, A. 1873: Corso di geologia. Vol. 2: Geologia Stratigrafica. – Milano
- Stötter, J., H. Formayer, F. Prettenhaler, M. Coy, M. Monreal and U. Tappeiner 2014: Kapitel 1: Zur Kopplung zwischen Treiber- und Reaktionssystemen sowie zur Bewertung von Folgen des Klimawandels. – In: Stötter, J. (ed.): Band 2: Klimawandel in Österreich: Auswirkungen auf Umwelt und Gesellschaft. Kapitel 1: Zur Kopplung zwischen Treiber- und Reaktionssystemen sowie zur Bewertung von Folgen des Klimawandels. – Wien: 383-409
- Suess, E. 1875: Die Entstehung der Alpen. – Wien
- Szabó, J., L. Dávid and D. Lóczy 2010: Anthropogenic Geomorphology. – Dordrecht
- Teilhard de Chardin, P. 1964: The Future of Man. – London
- Textor, R.B. 1995: The ethnographic futures research method: An application to Thailand. – *Futures* **27** (4): 461-471, doi:10.1016/0016-3287(95)00011-K
- Thomas, W.L. 1956: Man's Role in Changing the Face of the Earth. – Chicago
- Vernadsky, V.I. 1926: Biosfera. – Moscow
- Vogt, M. 2019: Ethik des Wissens. Freiheit und Verantwortung der Wissenschaft in Zeiten des Klimawandels. – München
- Wackernagel, M. and B. Beyers 2019: Ecological Footprint. Managing our biocapacity budget. – Gabriola Island, British Columbia
- Wackernagel, M. and W.E. Rees 1996: Our Ecological Footprint: Reducing Human Impact on the Earth. – Philadelphia
- Wang-Erlandsson, L., A. Tobian, R.J. van der Ent, I. Fetzer, S. te Wierik, M. Porkka, A. Staal, F. Jaramillo, H. Dahlmann, C. Singh et al. 2022: A planetary boundary for green water. – *Nature Reviews Earth & Environment* **461**: 472, doi:10.1038/s43017-022-00287-8
- Waters, C.N., J. Zalasiewicz, C. Summerhayes, A.D. Barnosky, C. Poirier, A. Gąsuzka, A. Cearreta, M. Edgeworth, E.C. Ellis, M. Ellis et al. 2016: The Anthropocene is functionally and stratigraphically distinct from the Holocene. – *Science* **351** (6269): aad2622, doi:10.1126/science.aad2622
- WBGU 1996: World in Transition: The Research Challenge. Annual Report 1996. – Berlin et al.
- WBGU 2011: Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation: Hauptgutachten. – Wissenschaftlicher Beirat Globale Umweltveränderungen. – Berlin
- WBGU 2019: Towards Our Common Digital Future. Flagship Report. – Berlin
- Wissen, M. 2021: An den Grenzen des Kapitalismus. Krise und Transformation aus politisch-ökologischer und intersektionaler Perspektive. – *EthikJournal* **7** (1): 1-23
- Woeikof, A. 1901: De l'influence de l'homme sur la terre. – *Annales de Géographie* **10**: 97-114
- Zalasiewicz, J., M. Williams, A. Smith, T.L. Barry, A.L. Coe, P.R. Bown, P. Brechley, D. Cantrill, A. Gale, P. Gibbard et al. 2008: Are we now living in the Anthropocene. – *GSA Today* **18** (2): 4. – Online available at: <https://www.geosociety.org/gsatoday/archive/18/2/pdf/i1052-5173-18-2-4.pdf>, accessed 23/08/2022
- Zalasiewicz, J., C.N. Waters, C.P. Summerhayes, A.P. Wolfe, A.D. Barnosky, A. Cearreta, P. Crutzen, E. Ellis, I.J. Fairchild, A. Gąsuzka et al. 2017: The Working Group on the Anthropocene: Summary of evidence and interim recommendations. – *Anthropocene* **19** (1): 55-60, doi:10.1016/j.an-cene.2017.09.001
- Zalasiewicz, J., C.N. Waters, E.C. Ellis, M.J. Head, D. Vidas, W. Steffen, J.A. Thomas, E. Horn, C.P. Summerhayes, R. Leinfelder et al. 2021: The Anthropocene: Comparing Its Meaning in Geology (Chronostratigraphy) with Conceptual Approaches Arising in Other Disciplines. – *Earth's Future* **9** (3): 17, doi:10.1029/2020EF001896