Vol. 153, No. 3 · Opinion article

DIE ERDE
Journal of the Geographical Society of Berlin

The Anthropocene beyond stratigraphy – towards a normative imperative for science and universities

Franziska Allerberger, Johann Stötter

University of Innsbruck, Department of Geography, Innrain 52f, A-6020 Innsbruck, Austria, franziska.allerberger@uibk.ac.at, hans.stoetter@uibk.ac.at

Manuscript submitted: 17 June 2022 / Accepted for publication: 03 August 2022 / Published online: 30 September 2022

Abstract

The Anthropocene, regardless of which interpretation of content and time one follows, is characterised by the fact that humans have become one, if not the global driver and creator. The increasingly intensive interventions in the Earth system result in global challenges that increasingly call the future of all humankind into question. A way out of this crisis situation only seems possible by means of a comprehensive socio-ecological transformation. In the context of this dualism between challenges and solution options, science is expected and demanded to take on a central role in overcoming the existential crisis. In order to fulfil this social responsibility, the science system must transform itself and overcome inherent lock-ins that have so far prevented significant impacts beyond the academic world. In the sense of a 'normative imperative for science in general and universities in particular' (also see Allerberger and Stötter 2022, this issue), we aim to provide starting points for such a self-transformation in relation to four different fields of action of universities. These include transdisciplinary and transformative research, among others, to fulfil the Third Mission, overcoming excellence fetishism, teaching that empowers students to deal with challenges in a solution-oriented way, and a completely different attitude towards the governance of universities, including changes in the dimensions of culture, structure, communication and cooperation.

Zusammenfassung

Das Anthropozän ist, unabhängig davon welcher inhaltlichen und zeitlichen Interpretation man folgt, durch die Tatsache geprägt, dass der Mensch zu einem, wenn nicht dem globalen Treiber und Gestalter geworden ist. Aus den immer intensiveren Eingriffen in das System Erde resultieren globale Herausforderungen, die in zunehmendem Maße die Zukunft der gesamten Menschheit in Frage stellen. Die Überwindung dieser krisenhaften Situation erscheint nur mittels einer umfangreichen sozial-ökologischen Transformation möglich. Im Kontext dieses Dualismus zwischen Herausforderungen und Lösungsoptionen wird von der Wissenschaft erwartet und gefordert, eine zentrale Rolle bei der Überwindung der existentiellen Krise zu übernehmen. Um dieser gesellschaftlichen Verantwortung nachkommen zu können, muss sich das Wissenschaftssystem selbst transformieren und inhärente *lock-ins* überwinden, die bisher wesentliche Wirkungen über die akademische Welt hinaus verhindern. Im Sinne eines ‚normativen Imperativs für die Wissenschaft im Allgemeinen und die Universitäten im Besonderen' (siehe *Allerberger* und *Stötter* 2022, in diesem Heft) zielen wir darauf ab, Ansatzpunkte für eine solche Selbsttransformation in Bezug auf vier verschiedene Handlungsfelder der Universitäten zu liefern. Dazu gehören die transdisziplinäre und transformative Forschung u. a. zur Erfüllung des Auftrags der Third Mission,

Franziska Allerberger, Johann 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

die Überwindung des Exzellenzfetischismus, eine Lehre, die die Studierenden befähigt, lösungsorientiert mit den Herausforderungen umzugehen, sowie eine völlig andere Haltung gegenüber der Governance von Hochschulen einschließlich Veränderungen in den Dimensionen Kultur, Struktur, Kommunikation und Kooperation.

Keywords Anthropocene, normative imperative, self-transformation, science, university fields of action

1. Introduction and preliminary remarks

There is no doubt that the time we are currently living in can be called the Anthropocene. In many ways, humans have become creators and drivers of global dimension (see discussion in *Allerberger* and *Stötter* 2022, this issue). Regardless of which scenarios we follow, a look into the future shows that this dominant role of humans will not change much in the long term.

What will have to change, however, is the direction of human drivers, the way in which humans affect the Earth system. Regardless of when one places the beginning of the Anthropocene (see e.g. *Lewis* and *Maslin* 2015; *Zalasiewicz* et al. 2021), if one can, at all, speak of *the* beginning, in the course of the Anthropocene so far, the manifold interventions of human activities have ultimately accumulated to ever greater and accelerating challenges (see e.g. *Steffen* et al. 2004, 2015a; *McNeill* and *Engelke* 2014; *Head* et al. 2021). In the sense of a "diagnosis of present times [Gegenwartsdiagnose]" (*Horn* and *Bergthaller* 2019: 12), which can, by no means exaggerated, also be seen as a diagnosis of crisis, the strands of development triggered by human activity, largely unintentionally, have led to the fact that existential services and boundaries of the Earth system have partly been reached today, and have partly already been exceeded. In areas where we are still within the so called planetary boundaries, however, we continue to head unchecked towards exceeding them (see e.g. *Meadows* et al. 1972; *Wackernagel* and *Rees* 1996; *Rockström* et al. 2009, 2021; *Steffen* et al. 2015b; *Raworth* 2017; *Wackernagel* and *Beyers* 2019).

In this contribution, the multifaceted understandings and discussions regarding the Anthropocene (see e.g. *Allerberger* and *Stötter* 2022 as well as *Hafner* 2022, both in this issue) are taken as point of departure to reflect upon the role of science in this context. Thereby, the analysis and reflections of this article provide a foundation for a normative imperative for science in general and its institutions in particular, namely, to seriously contribute the process of self-transformation in order to make it a success. Because we do not only want to act as demanders, we conclude by giving an example of how we ourselves try to contribute to a self-transformation of science and its institutions within the scope of the inter-university project 'UniNEtZ – Universities and Sustainable Development Goals'.

We are aware of the fact that discourses regarding necessary changes of the dominant scientific system are not new (see Section 2.2). However, this article is an attempt to shed new light on this crucial issue. Please note as well, that content and argumentation of this article must be seen against the background of our first article in this issue (*Allerberger* and *Stötter* 2022).

2. Questioning the current role of science and universities in the 21st century

2.1 General demands

Now that the consequences of human action on the problem side and (in)action on the solution side are becoming increasingly visible and, as a consequence, the future of the Earth system as a whole is no longer certain, especially with regard to its functionality as a basis for a future worth living (see e.g. *Meadows* et al. 1972; *U.S. Government Printing Office* 1980; *Horn* 2014; *Oreskes* and *Conway* 2014; *IPBES* 2019; *IPCC* 2022), the calls for profound, society-wide, socio-ecological transformation are becoming louder and louder (see e.g. *WBGU* 2011; *Göpel* 2016, 2020; *Harari* 2019; *Jackson* 2021). Against the background of the fact that science is a part of society, the demand for transformation made primarily by representatives of the scientific community must also refer to science itself as well as its institutions and actors.

In this context, *Lagasnerie* (2018: 15) raises the following key questions: "Do our actions contribute to the production of a more just and reasonable world, does it promote the unfolding of a progressive practice? Or do we, through our actions, de facto participate in the reproduction of the system, collaborate

with it, even aggravate the situation?" ["Trägt unser Handeln zur Herstellung einer gerechteren und vernünftigeren Welt bei, fördert es die Entfaltung einer fortschrittlichen Praxis? Oder haben wir durch unser Handeln de facto Anteil an der Reproduktion des Systems, arbeiten wir mit ihm zusammen, verschlimmern wir die Situation sogar?"][1]. Asking these questions is more than justified insofar as *Jahn* et al. (2015), for example, invite us to analyse the extent to which science has contributed over the decades and centuries to the fact, that human action is now effective on earth-historical scales. At the same time, the work of *Blühdorn* et al. (2020) shows that science – and especially those disciplines which dedicate themselves to transformational narratives under the guiding principle of sustainability – has a share in the perpetuation of non-sustainable lifestyles. In view of this diagnosis, it seems all the more important "to determine what kind of truth, knowledge and research should be pursued when advocating for a world more worth living, what framework it needs, how it should be written, disseminated and thought about" ["zu bestimmen, welche Art von Wahrheit, von Wissen und von Forschung angestrebt werden soll, wenn man für eine lebenswertere Welt eintritt, welchen Rahmen sie benötigt, wie sie zu schreiben, verbreiten und denken wäre"] (*Lagasnerie* 2018: 15).

The discussion of this appeal by *Lagasnerie* (2018) will be the focus of the following sections. Since we as authors of this publication are also part of both the science and the university system and the thoughts expressed here therefore also relate to our own academic endeavour, thinking and acting, we take a position with this opinion paper.

Since science and universities in this sense cannot remain completely untouched by the developments of the Anthropocene and persist in the sense of '*business as usual*' in familiar ways of working and thinking that have grown over the last decades and centuries, the following questions arise:

- What consequences can be derived from the dynamics of a world in transformation with all its challenges as well as the resulting "diagnosis of present times [Gegenwartsdiagnose]" (*Horn* and *Bergthaller* 2019: 12) and diagnosis of crisis of the Anthropocene for the self-understanding of science in general and consequently also for its institutions such as universities in particular?
- What position and function can, should – and must – science take in the 21st century in a society of "sustainable non-sustainability" ["nachhaltige Nicht-Nachhaltigkeit"] (*Blühdorn* 2020: 13) and what can and should science do to overcome this challenging state?

In the following, we try to show examples of potential steps or entry points that should be taken towards a fundamentally changed self-understanding of scientific practice. These considerations and demands are based on the conviction that the dominant science system and its institutions must transform themselves if they, as part of society, want to meet the challenges of the Anthropocene in a correspondingly serious manner. From a normative point of view, supported by the guiding principle of an imperative of a sustainability transformation, it is not a matter of wanting to, but of having to. We will try to justify and substantiate this imperative argumentation more in detail in the following statements. In doing so, we will address not only science and higher education as evolved institutions with consolidated structures and established practices of thought and action, but also the resulting specific relationship between science and society. Our considerations will be concreted based on central fields of action of universities (i.e. third mission, research, teaching, governance). To avoid misunderstandings, please note that we mainly refer to the current, dominant scientific system and, strictly speaking, to academia (i.e. in our analysis, we do not include NGOs or independent institutions conducting research as well).

2.2 Development of modern science and its relationship to society – a short insight

Let us first take a look at universities and science as evolved and well-established institutions. In doing so, it becomes evident that 'modern', dominant science as we know it today has emerged in the course of the last centuries. This process of establishing modern science is closely associated to the founding of the first universities in Paris, Bologna and Oxford; as early as 1500, there were around 60 (*Füssel* 2017a). This "communities of teachers and learners" ["Gemeinschaft der Lehrenden und Lernenden"] (*Füssel* 2017a: 193) secured far-reaching privileges for themselves from the very beginning (*Füssel* 2017a). Alongside the church, universities are among the longest lasting and well-entrenched institutions (*Olsen* 2007; *Paleari* et al. 2015;

Füssel 2017a). Besides, they are also ranked among the "most influential places of knowlegde in Europe" ["einflussreichsten Orten des Wissens in Europa"] (*Füssel* 2017a: 193). They were not only co-creators of a new, 'modern' society at the time of the Enlightenment and later during industrialisation (*Paleari* et al. 2015; *Füssel* 2017a, 2017b), but also repeatedly underwent internal processes of change themselves (*Paleari* et al. 2015; *Füssel* 2017a). Two processes that started in the Middle Ages and then in the 18th and 19th century respectively continue to shape scientific practice and universities up to the present. These include, on the one hand, the differentiation between philosophy and science that began with the Enlightenment in the 18th century, which was a prerequisite for the differentiation into natural sciences, social sciences and humanities that took place in the 19th century. The ever-advancing differentiation into various disciplines resulted in increasing specialisation as well as the demarcation and fragmentation of knowledge (*Mittelstrass* 2018; *Fazey* et al. 2020).

This development of differentiation was also accompanied by a change in scientific theoretical considerations about what science is and how it is conducted or, normatively speaking, how science should be and how it should be conducted (*Schurz* 2014). In the context of discourses on the nature of science, the 20th century discussion on value judgments (*Albert* and *Topitsch* 1971) and the positivism controversy (*Adorno* et al. 1969) should also be seen, which is significant with regard to the considerations on the normative character of the Third Mission (see Section 3.1). *Weber's* (1904, 1917) postulate of the freedom of the sciences to make value judgements, based on the principles of empiricism, set the starting point here. This demand, made primarily in the direction of the social sciences, triggered massive counter-movements. *Horkheimer's* Critical Theory (term: *Horkheimer* 1937; origins: *Horkheimer* 1932a,b), which represents a counter-model to what he called the 'traditional theory' of science, should be emphasised here (*Horkheimer* 1937). On the other hand, the publication system should be mentioned here (*Banks* 2018), as the basis of scientific discourse, which in the meantime also follows an exponentially advancing differentiation and specialisation dynamic.

Both are in different ways expressions of a far-reaching 'crisis' of the scientific system. The consequence of this is not least that the social impact and thus also the social relevance of scientific activity all too often falls by the wayside (e.g. *Binswanger* 2014; *Fazey* et al. 2018; *Fazey* et al. 2020). With regard to the specific relationship between science and society, this results in an ambivalence. On the one hand, an increasingly pronounced scientification can be observed (*Weingart* 1983). This goes hand in hand with the fact that "science becomes a hegemonic power of distinction, it draws the boundary line in scientific knowledge and thus at the same time devalues everyday practices of distinction and the lifeworld knowledge that supports them" ["Wissenschaft [...] zu einer hegemonialen Unterscheidungsmacht [wird], sie zieht die Grenzlinie im wissenschaftlichen Wissen und entwertet damit zugleich die alltäglichen Unterscheidungspraktiken und das sie stützende lebensweltliche Wissen"] (*Becker* et al. 2006: 180). However, this proclamation of an interpretative sovereignty of scientific knowledge over other forms and stocks of knowledge (*Fazey* et al. 2020) is accompanied on the other hand by a lack of or inadequate orientation towards action in order to contribute to solving socio-ecological challenges (*Fazey* et al. 2018; *Fazey* et al. 2020). More generally speaking, the current 'status quo' of the dominant scientific system mirrors societal developments. For instance, *Troiani* and *Dutson* (2021: 5-6) are pointing out that "[t]he neoliberal university has taken hold in many developed countries and shifted the imperatives of Higher Education from a liberal, openly accessible, lesser time pressured and broadly based education to more vocational forms of Higher Education that focus on the commercialization and marketization of teaching and research for industry and business." We have to keep in mind this development in order to understand the underlying criticism of the dominant scientific system and current practices of academic science.

3. A call for action: Specific demands for self-transformation

3.1 Field of action 1: Third Mission

These findings strike science and research at its very core: its "social obligation" ["gesellschaftliche Verpflichtung"] (*Schneidewind* 2016: 15; see also *Paleari* et al. 2015) which in recent discussions is often described with the term Third Mission. For instance, the Third Mission was uptaken into the Austrian National Development Plan for Public Universities (GUEP) 2022-2027 (*BMBWF* 2019). It is also reflected by the Sustainability-Manifesto of the Austrian Universities association (uniko, Österreichische Universitätenkon-

ferenz) in which universities understand themselves as "tought leaders which make a significant contribution to sustainable development through their extensive scientific expertise" ["Vordenkerinnen, die durch ihre umfangreiche wissenschaftliche Expertise einen wesentlichen Beitrag zu einer nachhaltigen Entwicklung leisten"] (*uniko* 2020: 1). The question regarding the *responsibility* of science and its institutions is an inherent aspect of the Third Mission. In this regard, *Vogt* (2019: 15; emphasis in the original) states: "**The relationship between science and society** is currently being reconsidered. There are calls to rethink knowledge and responsibility as well as freedom and autonomy together as a whole." ["**Das Verhältnis zwischen Wissenschaft und Gesellschaft** wird derzeit neu vermessen. Es wird gefordert, Wissen und Verantwortung sowie Freiheit und Autonomie neu zusammenzudenken."]. However, against the background of the outlined well-established and 'entrenched' structure of science and its institution, the following also becomes apparent: The assumption of responsibility in the sense of a seriously taken Third Mission is not an easy and unpleasant task. Among other things, this can be explained by the normative attitude inherent in the approach towards science and research we call for here and that questions and rejects a positivistic understanding of science (*Vogt* 2019). In other words: "value-free research is neither possible nor desirable" (*Vogt* and *Weber* 2020: 17). Thus, science cannot shirk 'the political'; it has long since assumed an essential significance in the context of political debates and negotiation processes (*Lagasnerie* 2018; *Sager* and *Wagner* 2019; *Vogt* 2019). Therefore, it should also be obvious: Third Mission as a field of action is not just an add-on that higher education institutions must address additionally. Rather, it should be a matter of fact that serves as core guiding principal for the attitude as well as the actions of all university members in conjunction with the normative target horizon of a sustainability-driven socio-ecological transformation. For this reason, the Third Mission is of particular relevance for all other fields of action.

3.2 Field of action 2: Research

Regarding the field of action 'research', let us first take a look at the disciplinary differentiation already mentioned, which is also the basis for the organisational structure into faculties (*Gibbons* 1998). However, it is not only about the differentiation into different departments per se, but also about the division into natural sciences as well as social sciences and humanities, which already manifested itself at the end of the 19th century (*Füssel* 2017a). Meanwhile, "numerous *cultures of knowledge* (*Knorr Cetina* 2002) have established themselves, forming large and separate clusters between which there is a divide that is difficult to bridge: the physical-chemical and biological sciences on the one hand, and the social sciences and humanities on the other" ["haben sich zahlreiche *Wissenskulturen* (*Knorr Cetina* 2002) etabliert, die große und voneinander getrennte Cluster bilden, zwischen denen eine nur schwer zu überbrückbare Kluft besteht: die physikalisch-chemischen und die biologischen Wissenschaften auf der einen Seite, die sozial- und geisteswissenschaftlichen auf der anderen"] (*Becker* and *Jahn* 2006: 110, emphasis in the original). *Gibbons* (1998) already sees this organisation of scientific disciplines as no longer in keeping with the times. In particular, the arrangement in silos stands in sharp contrast to the complex challenges of the Anthropocene that are afflicted with uncertainties (see *Allerberger* and *Stötter* 2022, this issue). For example, addressing the Sustainable Development Goals (SDGs; *UN* 2015) requires interdisciplinarity as a first step (*Paasche* and *Österblom* 2019; *Schemmel* 2020), i.e. integrative cooperation between different disciplines from the natural sciences, social sciences and humanities, and consequently also systemic thinking (*Jahn* et al. 2015; *Vogt* and *Weber* 2020; *Fazey* et al. 2020). Just as the dichotomy of nature and culture has long been abolished in the age of the Anthropocene (see *Allerberger* and *Stötter* 2022, this issue), science must also overcome this separation (*Paasche* and *Österblom* 2019; *Schemmel* 2020).

The approaches to overcome this dichotomy have a long and varied history with very different approaches. On the one hand, the 'thinking together' of humans and nature, and thus of natural and social sciences, is based on considerations of the theory of science (e.g. 'hybrid networks' in the sense of the Actor Network Theory by *Latour* 2005; 'dualism between mind and matter' according to *Zierhofer* 2002; but also 'three worlds' by *Popper* 1973). On the other hand, there is the pragmatic insight from global problem analyses (e.g. *Kates* et al. 2001; *Ehlers* 2005, 2008; *Gallopín* 2006; *Becker* and *Jahn* 2006; *WBGU* 2007), which new scientific approaches bridging the dichotomy, such as 'Coupled Human-Environment Systems' (CHES) (*Berkes* et al. 2003) or 'Social Ecological Systems' (SES) (*Turner* 2010). The ecologisation processes of social science disciplines (e.g. *Weichhart* 1995; *Singh*

et al. 2013), from which e.g. human ecological (see e.g. *Barrows* 1923; *Young* 1974; *Nentwig* 2005) and social ecological (e.g. *Becker* and *Jahn* 2000, 2006; *Fischer-Kowalski* et al., 1997; *Fischer-Kowalski* and *Weisz* 1999) concepts have emerged, should also be seen in this context. Despite these diverse approaches and concepts, the dichotomy between natural and social sciences still exists and this arguably most important interdisciplinary interface has still not become an everyday scientific practice.

3.2.1 Transdisciplinary and transformative research

However, in the Anthropocene, an interdisciplinary way of working is no longer sufficient either. Rather, a transdisciplinary or transformative research practice is required (e.g. *Lang* et al. 2012; *Future Earth* 2014; *Jahn* et al. 2015; *Patterson* et al. 2015; *Schneidewind* et al. 2016; *Fazey* et al. 2018). But what exactly is meant by this? Transdisciplinarity and similar concepts/approaches are used to describe very different varieties of a new form of science, which are to be understood as a critique of the existing system and consequently call for a fundamental rethinking with regard to the design of scientific practice (e.g. *Pohl* and *Hirsch Hadorn* 2007; *WBGU* 2011; *Klein* 2014; *Vilsmaier* and *Lang* 2014; *Osborne* 2015; *Schneidewind* et al. 2016; *Fazey* et al. 2018). In the debates related to transdisciplinarity, various approaches can be distinguished, some of which overlap, but some of which are contradictory (for an overview see e.g. *Pohl* and *Hirsch Hadorn* 2007; *Klein* 2014; *Osborne* 2015). As *Wehrden* et al. (2019) show, a demarcation from interdisciplinarity is also by no means unambiguous. In a narrower sense, transdisciplinarity is about a research practice in which context-specific knowledge production (or: problem identification and problem solving) takes place in a collaborative setting between scientific actors from different disciplines (interdisciplinarity) and non-scientific actors (e.g. *Klein* et al. 2001; *Lang* et al. 2012; *Jahn* et al. 2015; *Wanner* et al. 2018). This form of scientific practice is gaining importance especially in the context of sustainability science (e.g. *Lang* et al. 2012), which explicitly focuses on questions of dynamic, cross-scale nature-society interactions and their inherent systemic complexity (*Kates* et al. 2001). *Häberli* et al. (2001: 5) state the following in this regard: "The keyword for the 21st century is sustainability. Transdisciplinarity is one of the major tools for reaching it" and *Jahn* et al. (2015: 94) add: "In the Anthropocene, transdisciplinary cooperation [...] [becomes] the norm in the production of scientific knowledge." ["Die transdisziplinäre Kooperation [...] [wird] im Anthropozän zum Regelfall bei der Erzeugung wissenschaftlichen Wissens."]. Considerations for such a new self-understanding of scientific practice are by no means phenomena of the 21st century, but can already be found, among others, in *Gibbons* et al. (1994) and *Gibbons* (1999, 'mode-2 knowledge production'; 'socially robust knowledge') or in *Funtowicz* and *Ravetz* (1993, 'post-normal science'). Even more than transdisciplinarity, transformative science emphasises the direct claim to design of scientific activity: "We can therefore speak of *transformative science,* which is defined as: a specific type of science that does not only observe and describe societal transformation processes, but rather initiates and catalyses them. Transformative science aims to improve our understanding of transformation processes and to simultaneously increase societal capacity to reflect on them" (*Schneidewind* et al. 2016: 6; emphasis in the original). Or in other words: Researching not only *about* sustainability, but *for* sustainability is the guiding principle.

3.2.2 Excellence

This normative credo may sound simple and, in view of the global challenges of the Anthropocene, more than plausible. However, a transdisciplinary or transformative research practice is opposed by the strong inner-scientific obligation to focus on excellence. Thus, science also follows a growth paradigm-oriented acceleration imperative (*Binswanger* 2014; *Paasche* and *Österblom* 2019; *Fazey* et al. 2020). The ancient Olympic motto "faster, higher, stronger"[2] is reflected in science in a strong output orientation: more and more publications, ranked as highly as possible and subsequently cited as much as possible in the most prestigious journals in the shortest possible time, seems to be the ultimate goal (*Binswanger* 2014; *Edwards* and *Roy* 2017; *Banks* 2018; *Kun* 2018; *Paasche* and *Österblom* 2019; *Seppelt* et al. 2019). While scientists were already measuring the world in *Alexander von Humboldt's* time (cf. *Kehlmann* 2005), the focus now seems to be on 'measuring science' for its own sake, without any real questioning of its usefulness. Quantitative measurements, various indices, bibliometric evaluation systems and rankings set the framework for what is called scientific achievement and excellence (*Stölting* 2002; *Krainer* and *Winiwarter* 2016; *Schneidewind* 2016; *Seppelt* et al. 2019).

Excellence applies and is everywhere (see e.g. *Binswanger* 2014), it "is the gold standard of the university world" (*Moore* et al. 2017: 2) and thus sets the pace for research and also administration. The criticism already briefly outlined can be condensed in the words of *Stilgoe* (2014: n.p.) as follows: "'Excellence' tells us nothing about how important the science is and everything about who decides." We will go into more detail about why this is the case by looking at some of the reasons that seem to us to be particularly relevant for our further considerations – without claiming to be complete.

First, *Ferretti* et al. (2018: 732; emphasis in the original) describe excellence as an "*essentially contested concept*" (see *Gallie* 1956). The authors thus attribute the characteristics of excellence to be "complex, open and value-laden" (*Ferretti* et al. 2018: 732) and make it clear that it is not an objectively measurable 'quantitative variable', but rather the result of negotiation processes and thus dependent on individuals. Secondly, the supposed objectively measurable and recordable excellence is about a 'well-founded' quantification of scientific output. However, it is not only the method of quantitative recording that is to be questioned (*Binswanger* 2014). The consequences of this understanding of excellence are also, or even more so, subject to harsh criticism. In the sense of a self-reinforcing feedback loop (*Meadows* 2008), scientists are stuck in an endless loop of publishing and thus simultaneously force the production of often socially irrelevant results (see above). If that were not enough, quantification and related incentive mechanisms reduce scientific output to such an extent that what is actually relevant – the content – no longer seems to have any significance (*Binswanger* 2014: 59, 65): "The increasing irrelevance of content is the result of artificially staged competition for publication in professional journals. [...] scientists produce more and more nonsense, which adds nothing to real scientific progress." In this context, *Ferretti* et al. (2018: 739) state thirdly in their interview study on the European Commission's Research and Excellence in Science & Technology indicator (RES&T): "[T]he bottleneck for quantification is existing data. In other words, data availability influences what is possible to quantify [...]." Fourthly, in addition to the points mentioned above, the prevailing self-control mechanism – peer review – calls into question the current evaluation schemes for 'scientific excellence'. This is not objective, but highly subjective, undermining scientific thinking outside the mainstream defined by a (small) scientific elite (*Binswanger* 2014). In view of this, the credo of the 'freedom of science' seems more than paradoxical: research is increasingly conducted on what can be published with the greatest possible probability (*Binswanger* 2014). In other words: "So ultimately, the realisation remains that, due to structural necessities, assimilation, well-dosed subordination and, above all, purposeful action are the essential keys to scientific success" ["So bleibt letztlich die Erkenntnis, dass aufgrund struktureller Notwendigkeiten, Assimilation, wohldosierte Subordination und allem voran zweckbestimmtes Handeln die wesentlichen Schlüssel zum wissenschaftlichen Erfolg seien"] (*Dickel* and *Gudat* 2021: 93).

Against the backdrop of transdisciplinary or transformative research as well as the obvious failure of inner-scientific 'excellence criteria', it seems to be the order of the day to develop other evaluation criteria. Not least because dishonest behaviour such as embellishing results or publishing in dubious journals etc. are the result of the pressure to perform in this kind of scientific self-image (*Edwards* and *Roy* 2017; *Sager* and *Wagner* 2019; *Paasche* and *Österblom* 2019). Precarious employment conditions for academic staff do the rest in this context (*Sager* and *Wagner* 2019).

It is beyond of the scope of this paper to make a sophisticated and well thought out proposal. What we will do instead is to highlight at least some entry points for potential pathways that can (or should) be followed. According to what we have described before, the crucial challenge is to develop approaches going beyond measuring mere academic output. Instead, they should allow an assessment of potential impacts beyond academia. In the scientific discourse, this aspect is discussed under the heading of societal or social impact factor. As far as we are concerned, the concept of a societal impact factor still lacks a shared definition and understanding, hence such alternative approaches are in its early stages. Besides, trying to assess societal impact of research comes along with other key and tricky challenges (*Kaufmann-Hoyez* et al. 2016; *Krainer* and *Winiwarter* 2016), among them problems of:

Causality: It is difficult or even impossible to coherently relate a certain effect (= societal impact) to a certain cause (= research activity). And even if a cause-effect relationship can be identified, there still will be uncertainty about the strength of this causal link.

Temporal connectivity: The problem of causality is strongly linked to temporal aspects of impact assessment. For instance, intended effects might unfold month or even years after a research activity. Hence, it is by no means clear when such an assessment should be conducted as there is uncertainty at what point in time (un)intended impacts occur.

Resources: In addition, *Kainer* and *Winiwarter* (2016) point to the fact that the assessment process should be easy to handle and should not cause much additional documentary effort as this could hinder the research process itself.

Nonetheless, as the literature reviews conducted for instance by *Bornmann* (2013), *Smit* and *Hessels* (2021) and *Viana-Lora* and *Nel-lo Andreu* (2021) are indicating, different kinds of assessment methods are already discussed in the scientific community. The authors identified a broad range of approaches, including methods like Public Value Mapping, Flows of Knowledge (*Smit* and *Hessels* 2021), as well as Alternative Metrics, Productive Interactions, Case Studies (*Viana-Lora* and *Nel-lo Andreu* 2021) and Interviews (*Viana-Lora* and *Nel-lo Andreu* 2021; for an example see *Kaufmann-Hoyez* et al. 2016). All these methods can serve as potential entry points for further development – however, it is a necessity that all of them are critically assessed, and we are convinced that 'new' evaluation criteria must not contribute to the continuance of the current status quo, neither directly nor indirectly. Against the background of what we have discussed before regarding excellence in science, mere quantification seems to be the wrong direction. We therefore suggest to explicitly take qualitative approaches into consideration. For instance, first attempts have been proposed by *Bergmann* et al. (2005; quality criteria for transdisciplinary research/guide for formative evaluation of research projects), *Carew* and *Wickson* (2010; TD Wheel), *Mitchell* et al. (2015; Outcome Spaces Framework, for an updated version see *Duncan* et al. 2020), *Schneider* et al. (2019; Theory of Change) as well as *Krainer* and *Winiwarter* (2016; assessment scheme with respect to different 'actor arenas'). Most importantly, these qualitative approaches allow a more comprehensive assessment of the quality of a research process and allow to a greater extent to explicitly take normative assumptions or beliefs into account.
Even though these examples seem promising we must admit that 'measuring' societal impact is by no means an easy task and perhaps there will be no 'silver bullet solution' at all. Furthermore, we should be aware of the fact that defining and assessing impact beyond academia is not only about re-defining excellence, but rather, re-thinking excellence requires to take a totally different stance towards science and research – it will have a sharp influence on our daily business and the scientific elite might lose influence and power. The question of power is also relevant with respect to the development process of assessment methods since the outcome strongly depends on the people involved (*Ferretti* et al. 2018). Besides, the meta-analysis for instance of transdisciplinary research projects (see e.g. *Lux* et al. 2019; *Newig* et al. 2019; *Schneider* et al. 2019) might be useful for the development quality criteria as well as new evaluation criteria. Despite the challenges ahead, one point seems to be clear: Since the term 'excellence' comes along with a specific understanding of how we have got used to think about research and its institutions, we should explicitly think about introducing and coining a new term for a new attitude regarding science and research in general as well as evaluation of research processes in particular.

3.3 Field of action 3: Teaching

There is consensus at both, international and national level (e.g. Global Action Programme; UNESCO 2013, 'The Future we want'; Agenda 2030; Österreichische Strategie zur Bildung für Nachhaltige Entwicklung; Grundsatzerlass zur Umweltbildung für Nachhaltige Entwicklung; Grundsatzerlass für politische Bildung) as well as in numerous scientific publications (see e.g. *Olsson* et al. 2016; *Keller* 2017) that Education for Sustainable Development (ESD) has one, if not the key role in overcoming the major challenges of the 21st century. *UNESCO* (2012: 2) puts it this way: "Education for Sustainable Development allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future." The Berlin Declaration (*UNESCO* 2022: 3) even goes a step further by demanding to "ensure that ESD is a foundational element of our education systems at all levels, with environmental and climate action as a core curriculum component, while maintaining a holistic perspective on ESD that recognizes the interrelatedness of all dimensions of sustainable development."

In the Austrian National Development Plan for Public Universities (*BMBWF* 2019: 28-29, emphasis in the original) this is specified as follows: "As institutions aiming at education and literacy for future leaders and decision-makers, universities have an obligation,

in view of the challenges posed by the *Grand Challenges* and the *Sustainable Development Goals* (SDGs) (climate change, food security, energy supply, resource scarcity, biodiversity, demographic change, social security, migration, etc.), to equip their students with the relevant problem-solving skills. The integration of the principle of sustainability into the educational and research content and the process of knowledge transfer is therefore an important awareness-raising concern." ["Als Bildungs- und Ausbildungsstätten künftiger Führungskräfte und Entscheidungsträgerinnen und Entscheidungsträger haben die Universitäten angesichts der Herausforderungen durch die *Grand Challenges* und der *Sustainable Development Goals* (SDGs) (Klimawandel, Ernährungssicherheit, Energieversorgung, Ressourcenverknappung, Biodiversität, demografischer Wandel, soziale Sicherheit, Migration u.a.) die Verpflichtung, ihre Studierenden mit den entsprechenden Lösungskompetenzen zu befähigen. Die Integration des Prinzips der Nachhaltigkeit in die Bildungs- und Forschungsinhalte und den Prozess der Wissensvermittlung ist daher ein wichtiges bewusstseinsbildendes Anliegen."] There is a consensus that learners of today are the change agents of tomorrow (see e.g. *Weiss* and *Barth* 2019; *UNESCO* 2020).

These considerations express the central demands for a new Studium Generale, which aims to ensure that all graduates of a university degree programme are equipped with 'literacy for the Anthropocene' or 'literacy for the 21st century'. In accordance with the future viability for the 21st century that is being striven for, the term Studium 21 is proposed for this.

It is therefore the social responsibility of higher education institutions to ensure that no one graduates from higher education without, on the one hand, having an awareness of the specific Grand Challenges resulting from the Anthropocene and, on the other hand, having acquired basic problem-solving skills to overcome them. *Vogt* (2018: 14 emphasis in the original) even sees it as "the most important form of responsibility of higher education institutions [...] to help **students** strengthen their reflective potential and to develop contemporary action knowledge together with them" ["die wichtigste Form der Verantwortung von Hochschulen [...], den **Studierenden** zu helfen, ihr Reflexionspotenzial zu stärken und mit ihnen gemeinsam zeitgemäßes Handlungswissen zu erarbeiten"]. For society, according to *Vogt* (2018: 14), this means the creation of an "indispensable 'resource' for modern knowledge societies" ["unverzichtbare[n] 'Ressource' moderner Wissensgesellschaften"].

On the one hand, this involves the acquisition of basic systemic knowledge about the Grand Challenges of the Anthropocene (see e.g. *BMBWF* 2019) as well as principles and conceptual considerations for solving and overcoming them (see e.g. Agenda 2030; Paris Agreement). On the other hand, it is about the acquisition of competences, which are demanded by *Leicht* et al. (2018: 10) as decisive for thinking and acting in terms of sustainable development:

- systems thinking competency
- anticipatory competency
- normative competency
- strategic competency
- collaboration competency
- critical thinking competency
- self-awareness competency
- integrated problem-solving competence

In order for Studium 21 to successfully lead to the desired 'literacy for the Anthropocene', it is not only necessary to acquire knowledge and competences, but also to think about the question of how this knowledge is acquired, the methodology and didactics. On the one hand, complex new challenges and adequate solution concepts require value-based approaches, as *Friis Bach* (2016: iii) puts it: "Now more than ever, education has a critical role to play, not only in providing learners with knowledge and skill to address these challenges, but also in promoting the values that will instil respect and responsibility towards others and the planet itself." On the other hand, new, innovative formats of teaching and learning are needed (see e.g. *Warburton* 2003; *Olsson* et al. 2016; *Keller* 2017; *Nasibulina* 2017; *Keller* et al. 2019). According to *Keller* (2017), conceptual considerations such as moderate constructivism (see e.g. *Bodner* 1986; *Oberrauch* et al. 2015; *Howlett* et al. 2016; *Riede* et al. 2016) or conceptual change (see e.g. *Posner* et al. 1982; *Krüger* 2007; *Oberrauch* and *Keller* 2015) play an essential role here.

All this is only possible if university teachers, in their role as multipliers, have the "knowledge, skills, values and attitudes needed for the transition to sustainability" (*UNESCO* 2020: 2). This requires a programme for building capacities of educators (see priority action 3, *UNESCO* 2020 or the BuNE-Certificate – Certificate Education and Sustainable Development for University Lecturers, in German: Zertifikat Bildung und Nachhaltige Entwicklung für Hochschullehrende; Alliance of Sustainable Universities in Austria 2022).

3.4 Field of action 4: Governance

In order to successfully implement the transformation of science and universities or the partial aspects called for here as examples, a transformation of governance is required first and foremost. We follow the understanding of governance at higher education institutions by *Bormann* et al. (2020: 22): "When we talk about governance, we mean both organisational structures and the administrative apparatus and the management of complex processes."

The question of how governance at higher education institutions should be designed so that they are 'best equipped' to meet existing, increasing and new demands is not new (see e.g. *Brüsemeister* and *Heinrich* 2011; *Poppenhagen* 2016). Mostly, it is about increasing performance and goals in the context of excellence, profile building, internationality in an increasingly global competition. In response to such constantly changing framing conditions and demands, higher education institutions have repeatedly undergone processes of transformation. In the context of our demands for self-transformation, however, such discussions and resulting proposals lead in the wrong direction. Rather, what is needed here are considerations such as those called for by *Bormann* et al. (2020), *Initiative for Sustainability and Ethics at Universities* (2017) or *Lütke-Spatz* et al. (2022). In this sense, self-transformation is seen as a profound, quite radical process of renewal, shaped by normative framing, which can possibly have a disruptive character (for more detailed analysis of the understanding of (self-) transformation see e.g. *O'Brien* 2012; *Nalau* and *Handmer* 2015; *Patterson* et al. 2015; *Nölting* et al. 2016). In our understanding, a self-transformation does not only refer to institutional or structural aspects. It also includes the individual level, i.e. a self-transformation requires that members of higher education institutions or of the scientific system more generally speaking reflect upon their underlying values, assumptions, and habits – and (try to) change them where necessary. For instance, this importance of the individual level for transformation is reflected by initiatives like "The Inner Development Goals" (*Inner Development Goals* 2022). From a more theoretical point of view, the interplay of both, the structural and individual level, must be taken into consideration as research conducted for instance by sociologist Nobert Elias is pointing out (see e.g. *Treibel* 2008; *Elias* 2016).

In all these considerations, new ground is definitely being broken. Since it is absolutely unclear from today's perspective how the dynamics of the Anthropocene will continue, the call for a transformation of governance at higher education institutions can only be kept very general. As highlighted in the conclusion (see below), the project UniNEtZ II (Universitäten und Nachhaltige Entwicklungsziele, in English: Universities and Sustainable Development Goals, second project phase 2022-2024) will attempt to concretise the self-transformation of higher education institutions and to take first implementation steps as well as to implement actions accordingly over the next three years (*Allerberger* et al. 2021; *Stötter* et al. 2021). Some aspects that are essential in our understanding, referred to as dimensions following *Lütke-Spatz* et al. (2022), will be briefly discussed here:

Structural dimension
Since the self-transformation is to be seen as a whole institution process, all fields of action of the higher education institutions are affected in the same way. Therefore, there is a need for both field of action-specific and, in terms of overall coordination, cross-field of action structures (such as a responsible vice rectorate, a sustainability advisory board, ...). It is essential that all status groups or curiae (students, administration, researchers and teachers) and all university bodies are equally involved in all discussion and decision-making processes.

Dimension of cooperation
Since the critical processes of the Anthropocene are not limited by political or systemic boundaries, they pose challenges for all of humanity and thus for the entire scientific community and all higher education institutions alike. For this reason, the scientific examination of the Global Grand Challenges as well as the development of solution strategies and their implementation must not be made the content of mutual competition, but requires joint, cooperative and coordinated action by the various groups of actors or curia within a university as well as between universities and in cross-university networks (see e.g. *The Bavarian Network for Sustainability in Higher Education* 2022; *Alliance of Sustainable Universities in Austria* 2022).

Dimension of communication
The successful transformation of the science and university system stands and falls with communication and negotiation processes. When communicating internally, it is important to involve as many actors as possible, to encourage them to actively participate and to give them the necessary freedom to do so. In

this sense, participation in the transformation of science, research and society should not be understood as an 'add-on' that is lost in daily business. Rather, freedom should give both students and staff the opportunity to take these issues seriously and thus to see them as a core part of their work. Design processes must take place in a form of dialogue in which all participants communicate with each other on equal terms and make decisions together. Equally important, however, is external communication, which, in the sense of the Third Mission, forms a regular task of a transformed and transformatively oriented science (see Sections 3.1 and 3.2.1).

Dimension of higher education culture

Higher education institution culture is understood as the intellectual diffusion of the science system and higher education institutions based on a common, institution-wide understanding of values, which is shaped and supported by all members of the higher education institution and lived out through social practices. The prerequisite for the development and then the living of a corresponding culture is, on the one hand, the critical-reflexive discussion and analysis of the existing system, and on the other hand, the participatory development of a common understanding of sustainability to which the university members feel committed and which they see as an "ethical principle that informs regulation and operations" (*Bavarian Network for Sustainability in Higher Education* 2019: 2) for their behaviour and actions.

4. Conclusion

In summary, it can be stated – speaking in terms of systems theory (see *Meadows* 2008) – that the currently prevailing science system functions as an 'apparatus' oriented towards self-preservation. Evaluation and reputation mechanisms, and thus, also incentive mechanisms, follow an internally defined logic that has a self-reinforcing effect (*Edwards* and *Roy* 2017; *Fazey* et al. 2020). However, this apparently smoothly functioning logic and the associated attitude of scientific activity often has no relevance to non-scientific, real-world challenges (*Fazey* et al. 2018, 2020).

For the self-transformation of science and its institutions proclaimed here, there is neither a way to run things by the rule book nor an already successfully well-travelled path that we can follow. No, rather, we must, in the truest sense of the word, dare great things and, figuratively speaking, embark on a journey into the unknown and explore new territory. Going down this path of self-transformation is not an end in itself. In view of the challenges of the Anthropocene outlined above, it is rather the order of the day, whereas 'business as usual' is absolutely not an alternative. On this path, we will be accompanied not only by "trial and error" (*Fazey* et al. 2018: 65), but also by a "normative compass" (*WBGU* 2016: 146), which is linked to values such as responsibility towards planet Earth as an inseparable human-environment system (see e.g. *Pope Francis* 2015; *Vogt* 2021). This involves both an inwardly directed, self-reflective examination of one's own thoughts and actions in the sense of mindfulness, as well as outwardly directed intentions that should be based on the spirit of altruism. In the following, we attempt to formulate part of this normative compass in the sense of a normative imperative, i.e. **as an urgent call for action that all those who belong to the scientific community in whatever roles and positions contribute to the self-transformation of the current, dominant science system and its well-established institutions**. Therefore, the aspects described associated to the different fields of action of universities not only serve as potential entry points for action, but also – and most importantly – as a basis for the normative imperative we proclaim.

As a first step, this imperative calls for all of us as members of the science and university community to reflect critically on our own ways of thinking and acting. We understand this against the background of normative ethics, which focuses on the question of good and right action. In the sense of social ethics, it is not about the good for each individual, but about the good for the community as a whole or a specific group (e.g. affected persons) (*Fenner* 2010). This perspective thus explicitly takes up the considerations regarding the Third Mission (see Section 3.1). At the same time, the statement of the imperative remains somewhat vague. Therefore, further specification is subject to additional work whereby different roles and responsibilities have to be defined. In any case it should be obvious that acting according to the normative imperative requires leaving the own comfort zone.

Therefore, instead of giving the impression of only making demands on others, we will conclude by briefly showing how we ourselves are trying to act in the sense of a self-transformation of science and, subsequently, are aiming at a socio-ecological transformation of society as a whole. We are doing so in cooperation with a large group of researchers, artists as

well as students in Austria in course of the project 'UniNEtZ – Universities and Sustainable Development Goals' (*UniNEtZ* 2022) in which we play different roles (*Johann Stötter*: member of the Steering Committee; *Franziska Allerberger*: member of the coordination team, together: co-responsibility for priority theme 5: transformation of universities and society).

As an inter-university project of 17 universities, two scientific federal institutions and the student association forum n, UniNEtZ has set itself two long-term goals for its launch in 2019. On the one hand, directed outwards, it is about contributing to the sustainable development of society as a whole; on the other hand, directed inwards, it is about anchoring sustainable development in the universities and thus transforming them (*Stötter* et al. 2019; *Allerberger* et al. 2021). In the second project phase 2022-2024 (UniNEtZ II), the focus is now on implementing these goals (*Stötter* et al. 2021). Five priority areas, that are largely oriented towards the imperatives set here, are guiding UniNEtZ in doing so, i.e. i) transdisciplinary dialogue with society, ii) scientific accompaniment and monitoring of societal transformation, iii) transformation in the field of research, iv) transformation in the field of teaching and v) transformation in the field of governance. A first and important step to trigger and implement a self-transformation of universities or academia in Austria respectively was the preparation of the so called *UniNEtZ – Policy Statement "Transformation of universities to pioneers of societal sustainability"*[3]. The Declaration is the result of an intense and participatory process in the last couple of weeks and months. It highlights the necessity as well as urgency of a self-transformation of Higher Education Institutions and will serve as "compass" for the UniNEtZ-Community in order to work towards a socio-ecological transformation in Austria.

Notes

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

[2] Since 2021, the official Olympic motto is "faster, higher, stronger – together" (see *International Olympic Committee* 2021: n.p.).

[3] Available for download here: https://www.uninetz.at/media/Grundsatzerkl%C3%A4rung_FINAL-1.pdf, for more background information see: https://www.uninetz.at/ueber-uns

References

Adorno, T.W., R. Dahrendorf, H. Pilot, H. Albert, J. Habermas and *K.R. Popper* 1969: Der Positivismusstreit in der deutschen Soziologie. – Frankfurt am Main

Albert, H. and E. Topitsch 1971: Werturteilsstreit. Third edition. – Darmstadt

Allerberger, F. and *Stötter, J.* 2022*:* Anthropocene – humankind as global actor: Insights into historic and current perspectives. – DIE ERDE **153** (3): 138-148, doi:10.12854/erde-2022-631

Allerberger, F., A. Schneeberger, J. Stötter, H. Kromp-Kolb, F. Fehr, S. Liedauer, H. Dallinger, T. Beck, B. Kernegger, I. Glatz and *R. Lang* 2021: Das Projekt UniNEtZ: Universitäten und die 17 Ziele für nachhaltige Entwicklung. – In: *Allianz Nachhaltige Universitäten in Österreich* (ed.): UniNEtZ-Optionenbericht. Von den Optionen zur Transformation. – Innsbruck

Alliance of Sustainable Universities in Austria 2022: Zertifikat für Hochschullehrende. – Online available at: https://nachhaltigeuniversitaeten.at/zertifikat/, accessed 5/18/2022

Banks, D. 2018: Thoughts on Publishing the Research Article over the Centuries. – Publications **6** (1): 1-11, doi:10.3390/publications6010010

Barrows, H.H. 1923: Geography as human ecology. – Annals of the Association of American Geographers **13** (1): 1-14, doi.org/10.2307/2560816

Bavarian Network for Sustainability in Higher Education 2019: Memorandum of Understanding on the cooperation of higher education institutions within the framework of the 'Bavarian Network for Sustainability in Higher Education'. – München. – Online available at: https://sae58cb7e2208a3d2.jimcontent.com/download/version/1614867080/module/9182528776/name/190912_MoU_final_englisch_LLS.pdf, accessed 5/18/2022

Becker, E. and *T. Jahn* 2000: Sozial-ökologische Transformationen. Theoretische und methodische Probleme transdisziplinärer Nachhaltigkeitsforschung. – In: *Brand, K.-W.* (ed.): Nachhaltige Entwicklung und Transdisziplinarität. Besonderheiten, Probleme und Erfordernisse der Nachhaltigkeitsforschung. – Angewandte Umweltforschung Vol. 16. – Berlin: 67-84

Becker, E. and *T. Jahn* 2006: Horizonte und Nachbarschaften. – In: *Becker, E.* and *T. Jahn* (eds.): Soziale Ökologie. Grundzüge einer Wissenschaft von den gesellschaftlichen Naturverhältnissen. – Sozialwissenschaften 2001-2008. – Frankfurt am Main: 110-139

Becker, E., T. Jahn and *D. Hummel* 2006: Gesellschaftliche Naturverhältnisse. – In: *Becker, E.* and *T. Jahn* (eds.): Soziale Ökologie. Grundzüge einer Wissenschaft von den gesellschaftlichen Naturverhältnissen. – Sozialwissen-

schaften 2001-2008. – Frankfurt am Main: 174-197

Bergmann, M., B. Brohmann, E. Hoffmann, C.M. Loibl, R. Rehaag, E. Schramm and *J.-P. Voß* 2005: Quality Criteria of Transdisciplinary Research. A Guide for the Formative Evaluation of Research Projects. – Frankfurt am Main

Berkes, F., J. Colding and *C. Folke* (eds.) 2003: Navigating social-ecological systems. Building resilience for complexity and change. – Cambridge

Binswanger, M. 2014: Excellence by Nonsense: The Competition for Publications in Modern Science. – In: *Bartling, S.* and *S. Friesike* (eds.): Opening Science. – Cham: 49-72

Blühdorn, I. 2020: 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., F. Butzlaff, M. Deflorian, D. Hausknost and *M. Mock* (eds.) 2020: Nachhaltige Nicht-Nachhaltigkeit. Warum die ökologische Transformation der Gesellschaft nicht stattfindet. – X-Texte zu Kultur und Gesellschaft. – Bielefeld

BMBWF 2019: Der Gesamtösterreichische Universitätsentwicklungsplan 2022-2027. – Wien. – Online available at: https://www.bmbwf.gv.at/dam/jcr:b7701597-4219-42f3-9499-264dec94506e/GUEP%202022-2027_Aktualisiert_um_Statistik_final_bf.pdf, accessed 8/8/2021

Bodner, G.M. 1986: Constructivism: A theory of knowledge. – Journal of Chemical Education **63** (10): 873, doi:10.1021/ed063p873

Bormann, I., M. Rieckmann, M. Bauer, B. Kummer, S. Niedlich, M. Doneliene and *L. Jaeger* 2020: Nachhaltigkeitsgovernance an Hochschulen. BMBF-Projekt „Nachhaltigkeit an Hochschulen: entwickeln – vernetzen – berichten (HOCHN). – Berlin/Vechta

Bornmann, L. 2013: What is societal impact of research and how can it be assessed? A literature survey. – Journal of the American Society for Information Science and Technology **64** (2): 217-233, doi:10.1002/asi.22803

Brüsemeister, T. and *M. Heinrich* (eds.) 2011: Autonomie und Verantwortung. Governance in Schule und Hochschule. – Münster

Carew, A.L. and *F. Wickson* 2010: The TD Wheel: A heuristic to shape, support and evaluate transdisciplinary research. – Futures **42** (10): 1146-1155, doi:10.1016/j.futures.2010.04.025

Dickel, M. and *G. Gudat* 2021: Offenes Denken. – In: *Dickel, M.* and *H.J. Böhmer* (eds.): Die Verantwortung der Geographie. Sozial- und Kulturgeographie. – Bielefeld: 91-112

Duncan, R., M. Robson-Williams and *D. Fam* 2020: Assessing research impact potential: using the transdisciplinary Outcome Spaces Framework with New Zealand's National Science Challenges. – Kōtuitui: New Zealand Journal of Social Sciences Online **15** (1): 217-235, doi:10.1080/1177083X.2020.1713825

Edwards, M.A. and *S. Roy* 2017: Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hypercompetition. – Environmental Engineering Science **34** (1): 51-61, doi:10.1089/ees.2016.0223

Ehlers, E. 2005: Mensch-Umwelt-Beziehungen als geographisches Paradigma. – In: *Schenk, W.* (ed.): Allgemeine Anthropogeographie. – Gotha/Stuttgart: 769-784

Ehlers, E. 2008: Das Anthropozän. Die Erde im Zeitalter des Menschen. – Darmstadt.

Elias, N. 2016: Figuration. – In: *Kopp, J.* and *A. Steinbach* (eds.): Grundbegriffe der Soziologie. Lehrbuch. – Wiesbaden: 83-86

Fazey, I., N. Schäpke, 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. Schäpke, 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

Fenner, D. 2010: Einführung in die angewandte Ethik. – Tübingen

Ferretti, F., Â.G. Pereira, D. Vértesy and *S. Hardeman* 2018: Research excellence indicators: time to reimagine the 'making of'? – Science and Public Policy **45** (5): 731-741, doi:10.1093/scipol/scy007

Fischer-Kowalski, M., H. Haberl, W. Hüttler, H. Payer, H. Schandl, V. Winiwarter and *H. Weisz* (eds.) 1997: Gesellschaftlicher Stoffwechsel und Kolonisierung von Natur. Ein Versuch in Sozialer Ökologie. – Amsterdam

Fischer-Kowalski, M. and *H. Weisz* 1999: Advances in Human Ecology. – Stamford

Friis Bach, C. 2016: Foreword. – In: *United Nations* (ed.): Ten Years of the UNECE Strategy for Education for Development. Evaluation report on the implementation of the UNECE Strategy for Education for Sustainable Development from 2005 to 2015. – New York/Geneva

Funtowicz, S.O. and *J.R. Ravetz* 1993: Science for the post-normal age. – Futures **25** (7): 739-755, doi:10.1016/0016-3287(93)90022-L

Füssel, M. 2017a: Universität. – In: *Sommer, M., S. Müller-Wille* and *C. Reinhardt* (eds.): Handbuch Wissenschaftsgeschichte. – Stuttgart: 193-201

Füssel, M. 2017b: Aufklärung. – In: *Sommer, M., S. Müller-*

Wille and *C. Reinhardt* (eds.): Handbuch Wissenschaftsgeschichte. – Stuttgart: 278-286

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

Gallie, W.B. 1956: 'Essentially Contested Concepts'. – Proceedings of the Aristotelian Society **56**: 167-198

Gallopín, G.C. 2006: Linkages between vulnerability, resilience, and adaptive capacity. – Global Environmental Change **16** (3): 293-303, doi:10.1016/j.gloenvcha.2006.02.004

Gibbons, M. 1998: Higher Education Relevance in the 21st Century. – Washington, DC. – Online available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/437341468782126524/higher-education-relevance-in-the-21st-century, accessed 7/8/2021

Gibbons, M. 1999: Science's new contract with society. – Nature **402**: C81-C84, doi:10.1038/35011576

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and *M. Trow* 1994: The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies. – London et al.

Göpel, M. 2016: The great mindshift. How a new economic paradigm and sustainability transformations go hand in hand. – Cham

Göpel, M. 2020: Unsere Welt neu denken. Eine Einladung. – Ullstein Buchverlage GmbH. – 9. Auflage. – Berlin

Häberli, R., W. Grossenbacher-Mansuy and *J.T. Klein* 2001: Summary. – In: *Klein, J.T., R. Häberli, R.W. Scholz, W. Grossenbacher-Mansuy, A. Bill* and *M. Welti* (eds.): Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society. – Basel: 3-5

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

Harari, Y.N. 2019: 21 lessons for the 21st century. – 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 (online publication), doi:10.18814/epiiugs/2021/021031

Horkheimer, M. 1932a: Bemerkungen über Wissenschaft und Krise. – Zeitschrift für Sozialforschung **1** (1/2): 1-4

Horkheimer, M. 1932b: Geschichte und Psychologie. – Zeitschrift für Sozialforschung **1** (1): 125-144, doi:10.5840/zfs193211/294

Horkheimer, M. 1937: Traditionelle und kritische Theorie. – Zeitschrift für Sozialforschung **6** (2): 245-294, doi:10.5840/zfs19376265

Horn, E. 2014: Zukunft als Katastrophe. – Frankfurt am Main

Horn, E. and *H. Bergthaller* 2019: Anthropozän zur Einführung. – Hamburg

Howlett, C., J.-A. Ferreira and *J. Blomfield* 2016: Teaching sustainable development in higher education. – International Journal of Sustainability in Higher Education **17** (3): 305-321, doi:10.1108/IJSHE-07-2014-0102

Initiative for Sustainability and Ethics at Universities 2017: Positions- und Forderungspapier Nachhaltigkeit und Ethik an Hochschulen. – Online available at: https://netzwerk-n.org/wp-content/uploads/2022/06/Positionspapier-ausfuehrliche-Version-1.pdf , accessed 5/18/2022

Inner Development Goals 2002: Inner Development Goals. Transformational Skills for Sustainable Development. – Online available at: https://www.innerdevelopmentgoals.org, accessed 5/18/2022

International Olympic Committee 2021: The Olympic Motto. – Online available at: https://olympics.com/ioc/olympic-motto, accessed 5/18/2022

IPBES 2019: Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn. – Online available at: https://zenodo.org/record/6417333#.Yvt07y-22Rs, accessed 5/18/2022

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 copy-editing). Cambridge. – Online available at: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_HeadlineStatements.pdf, accessed 5/18/2022

Jackson, T. 2021: Wie wollen wir leben? Wege aus dem Wachstumswahn. – München

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

Kates, R.W., W.C. Clark, R. Corell, J.M. Hall, C.C. Jaeger, I. Lowe, J.J. McCarthy, H.J. Schellnhuber, B. Bolin, N.M. Dickson, S. Faucheux, G.C. Gallopin, A. Grübler, B. Huntley, J. Jäger, N.S. Jodha, R.E. Kasperson, A. Mabogunje, P. Matson, H. Mooney, B. Moore III, T. O'Riordan and *U. Svedin* 2001: Sustainability Science. – Science **292**: 641-642, doi:10.1126/science.1059386

Kaufmann-Hayoz, R., R. Defila, A. Di Giulio and *M. Winkelmann* 2016: Was man sich erhoffen darf. Zur gesellschaftlichen Wirkung transdisziplinärer Forschung. – In: *Defila, R.* and *A. Di Giulio* (eds.): Transdisziplinär forschen – zwischen Ideal und gelebter Praxis. Hotspots, Geschichten,

Wirkungen. – Frankfurt am Main: 289-327

Kehlmann, D. 2005: Die Vermessung der Welt. Roman. – Reinbek

Keller, L. 2017: "Sustainable Development? - Let us change concepts!". Theoretical and Practical Contributions to the Transformation of Society, Science, Knowledge, and Education from a Geographer's Perspective. – Innsbruck

Keller, L., J. Stötter, A. Oberrauch, A. Kuthe, A. Körfgen and *K. Hüfner* 2019: Changing Climate Change Education: Exploring moderate constructivist and transdisciplinary approaches through the research-education co-operation k.i.d.Z.21. – GAIA – Ecological Perspectives for Science and Society **28** (1): 35-43, doi:10.14512/gaia.28.1.10

Klein, J.T. 2014: Discourses of transdisciplinarity: Looking Back to the Future. – Futures **63**: 68-74, doi:10.1016/j.futures.2014.08.008

Klein, J.T., R. Häberli, R.W. Scholz, W. Grossenbacher-Mansuy, A. Bill and *M. Welti* (eds.) 2001: Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society. – Basel

Knorr Cetina, K. 2002: Wissenskulturen. Ein Vergleich naturwissenschaftlicher Wissensformen. – Frankfurt am Main

Krainer, L. and *V. Winiwarter* 2016: Die Universität als Akteurin der transformativen Wissenschaft: Konsequenzen für die Messung der Qualität transdisziplinärer Forschung. – GAIA – Ecological Perspectives for Science and Society **25** (2): 110-116, doi:10.14512/gaia.25.2.11

Krüger, D. 2007: Die Conceptual Change-Theorie. – In: *Krüger, D.* and *H. Vogt* (eds.): Theorien in der biologiedidaktischen Forschung. – Berlin/Heidelberg: 81-92

Kun, Á. 2018: Publish and Who Should Perish: You or Science? – Publications **6** (2): 18, doi:10.3390/publications6020018

Lagasnerie, G.d. 2018: Denken in einer schlechten Welt. Second edition. – Berlin

Lang, D.J., A. Wiek, M. Bergmann, M. Stauffacher, P. Martens, P. Moll, M. Swilling and *C.J. Thomas* 2012: Transdisciplinary research in sustainability science: practice, principles, and challenges. – Sustainability Science **7** (S1): 25-43, doi:10.1007/s11625-011-0149-x

Latour, B. 2005: Reassembling the Social: An Introduction to Actor-Network-Theory. – Oxford

Leicht, A., J. Heiss and *W.J. Byun* 2018: Introduction. – In: *Leicht, A., J. Heiss* and *W.J. Byun* (eds.): Issues and trends in Education for Sustainable Development. Education on the Move. – Paris: 7-16

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

Lütke-Spatz, L., J. Stötter and *E. Veulliet* 2022: Blaupause Nachhaltigkeitsstrategie der bayerischen Hochschulen. – München

Lux, A., M. Schäfer, M. Bergmann, T. Jahn, O. Marg, E. Nagy, A.-C. Ransiek and *L. Theiler* 2019: Societal effects of transdisciplinary sustainability research – How can they be strengthened during the research process? – Environmental Science & Policy **101** (4): 183-191, doi:1016/j.envsci.2019.08.012

McNeill, J.R. and *P. Engelke* 2014: The great acceleration. An environmental history of the Anthropocene since 1945. – Cambridge et al.

Meadows, D.H., D.L. Meadows, J. Randers and *W.W. Behrens III* 1972: The limits to growth. A report for the Club of Rome's project on the predicament of mankind. A Potomac Associates book. – New York

Meadows, D.H. 2008: Thinking in systems. A primer. Eleventh printing. – White River Junction

Mitchell, C., D. Cordell and *D. Fam* 2015: Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research. – Futures **65**: 86-96, doi:10.1016/j.futures.2014.10.007

Mittelstrass, J. 2018: The Order of Knowledge: From Disciplinarity to Transdisciplinarity and Back. – European Review **26** (S2): S68-S75, doi:10.1017/S1062798718000273

Moore, S., C. Neylon, M. Paul Eve, D. Paul O'Donnell and *D. Pattinson* 2017: "Excellence R Us": university research and the fetishisation of excellence. – Palgrave Communications **3** (1): 803, doi:10.1057/palcomms.2016.105

Nalau, J. and *J. Handmer* 2015: When is transformation a viable policy alternative? – Environmental Science & Policy **54** (8): 349-356, doi:10.1016/j.envsci.2015.07.022

Nasibulina, A. 2017: Education for Sustainable Development. – In: *Kantola, J.I., T. Barath, S. Nazir* and *T. Andre* (eds.): Advances in Human Factors, Business Management, Training and Education. – Proceedings of the AHFE 2016 International Conference on Human Factors, Business Management and Society, July 27-31, 2016, Walt Disney World, Florida. – Cham: 947-954

Nentwig, W. 2005: Humanökologie. Fakten – Argumente – Ausblicke. Second edition. – Berlin/Heidelberg

Newig, J., S. Jahn, D.J. Lang, J. Kahle and *M. Bergmann* 2019: Linking modes of research to their scientific and societal outcomes. Evidence from 81 sustainability-oriented research projects. – Environmental Science & Policy **101** (7): 147-155, doi:10.1016/j.envsci.2019.08.008

Nölting, B., J. Pape and *B. Kunze* 2016: Nachhaltigkeitstransformation als Herausforderung für Hochschulen – Die Hochschule für nachhaltige Entwicklung Eberswalde auf dem Weg zu transdisziplinärer Lehre und Forschung. – In: *Leal Filho, W.* (ed.): Forschung für Nachhaltigkeit an deutschen Hochschulen. Theorie und Praxis der Nachhaltigkeit. – Wiesbaden: 131-147

Oberrauch, A. and *L. Keller* 2015: Methodenkombination in

der Conceptual Change-Forschung. Komplexität in multiperspektivischen Forschungsdesigns gerecht werden. – In: *Budke, A.* and *M. Kuckuck* (eds.): Geographiedidaktische Forschungsmethoden. – Praxis neue Kulturgeographie Band 10. – Berlin/Münster: 86-109

Oberrauch, A., L. Keller, M. Riede, S. Mark, A. Kuthe, A. Körfgen and *J. Stötter* 2015: „k.i.d.Z.21 – kompetent in die Zukunft". Grundlagen und Konzept einer Forschungs-Bildungs-Kooperation zur Bewältigung der Herausforderungen des Klimawandels im 21. Jahrhundert. – GW-Unterricht **139**: 19-31

O'Brien, K. 2012: Global environmental change II. – Progress in Human Geography **36** (5): 667-676

Olsen, J.P. 2007: The Institutional Dynamics of the European University. – In: *Maassen, P., J. Muller, A. Amaral, A. Arimoto, N. Cloete, D. Dill, J. Enders, P. Gumport, M. Henkel, G. Jones* and *J.P. Olsen* (eds.): University Dynamics and European Integration. – Higher Education Dynamics. – Dordrecht: 25-54

Olsson, D., N. Gericke and *S.-N. Chang Rundgren* 2016: The effect of implementation of education for sustainable development in Swedish compulsory schools – assessing pupils' sustainability consciousness. – Environmental Education Research **22** (2): 176-202, doi:1080/13504622.2015.1005057

Oreskes, N. and *E.M. Conway* 2014: The collapse of Western civilization. A view from the future. – London

Osborne, P. 2015: Problematizing Disciplinarity, Transdisciplinary Problematics. – Theory, Culture & Society **32** (5-6): 3-35, doi:10.1177%2F0263276415592245

Paasche, Ø. and *H. Österblom* 2019: Unsustainable Science. – One Earth **1** (1): 39-42, doi:10.1016/j.oneear.2019.08.011

Paleari, S., D. Donina and *M. Meoli* 2015: The role of the university in twenty-first century European society. – The Journal of Technology Transfer **40** (3): 369-379, doi:10.1007/s10961-014-9348-9

Patterson, J., K. Schulz, J. Vervoort, C. Adler, M. Hurlbert, S. van der Hel, A. Schmidt, Aliyu Barau, Pedi Obani, M. Sethi, N. Hissen, M. Tebboth, K. Anderton, S. Börner and *O. Widerberg* 2015: 'Transformations towards sustainability' Emerging approaches, critical reflections, and a research agenda. – Lund/Amsterdam

Pohl, C. and *G. Hirsch Hadorn* 2007: Principles for designing transdisciplinary research. – Rat der Schweizerischen Wissenschaftlichen Akademien. – München

Pope Francis 2015: Encyclical letter Laudato si' of the Holy Father Francis. On care for our common home. – London

Poppenhagen, N. 2016: Einstellung von Studierenden: Feste Anstellung statt Start-up? – Konrad-Adenauer-Stiftung, Informationen und Recherchen. – Online available at: https://www.kas.de/documents/252038/253252/7_dokument_dok_pdf_47972_1.pdf/7f0297ec-7686-aa04-ee38-82a7e017c9cc?version=1.0&t=1539649559518, accessed 5/18/2022

Popper, K.R. 1973: Objektive Erkenntnis. Ein evolutionärer Entwurf. – Hamburg

Posner, G.J., K.A. Strike, P.W. Hewson and *W.A. Gertzog* 1982: Accommodation of a scientific conception: Toward a theory of conceptual change. – Science Education **66** (2): 211-227, doi:10.1002/sce.3730660207

Raworth, K. 2017: Why it's time for Doughnut Economics. – IPPR Progressive Review **24** (3): 216-222, doi:10.1111/newe.12058

Riede, M., A. Kuthe, L. Keller and *A. Greissing* 2016: Development, application, and impact assessment of a moderate-constructivist intervention to prepare teenagers for challenges of climate change and energy transition. – Umweltpsychologie **20** (1): 39-61

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

Sager, K. and *G.G. Wagner* 2019: Wissenschaft unter Druck: Vertrauensverlust oder Zeichen gewachsener gesellschaftlicher Relevanz? – In: *Hinsch, W.* and *D. Eggers* (eds.): Öffentliche Vernunft? – Berlin/Boston: 21-34

Schemmel, M. 2020: Global history of science as a knowledge resource for the Anthropocene. – Global Sustainability **3:** 269, doi:10.1017/sus.2020.16

Schneider, F., M. Giger, N. Harari, S. Moser, C. Oberlack, I. Providoli, L. Schmid, T. Tribaldos and *A. Zimmermann* 2019: Transdisciplinary co-production of knowledge and sustainability transformations: Three generic mechanisms of impact generation. – Environmental Science & Policy **102**: 26-35, doi:10.1016/j.envsci.2019.08.017

Schneidewind, U. 2016: Die „Third Mission" zur „First Mission" machen? – die hochschule **25** (1): 14-22

Schneidewind, U., M. Singer-Brodowski, K. Augenstein and *F. Stelzer* 2016: Pledge for a transformative science. A conceptual framework. – Wuppertal

Schurz, G. 2014: Einführung in die Wissenschaftstheorie. Fourth edition. – Darmstadt

Seppelt, R., M. Beckmann, T. Václavík and *M. Volk* 2018: The Art of Scientific Performance. – Trends in ecology & evolution **33** (11): 805-809, doi:10.1016/j.tree.2018.08.003

Singh, S.J., H. Haberl, M. Chertow, M. Mirtl and *M. Schmid* (eds.) 2013: Long Term Socio-Ecological Research. Studies in Society: Nature Interactions Across Spatial and Tempo-

ral Scales. – Dordrecht

Smit, J.P. and *L.K. Hessels* 2021: The production of scientific and societal value in research evaluation: a review of societal impact assessment methods. – Research Evaluation **30** (3): 323-335, doi:10.1093/reseval/rvab002

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.L., A. Sanderson, P.D. Tyson, J. Jäger and *P.A. Matson* (eds.) 2004: Global change and the earth system. A planet under pressure. – Global change The IGBP series. – Berlin/Heidelberg

Stilgoe, J. 2014: 'Against Excellence'. – Online available at: https://www.theguardian.com/science/political-science/2014/dec/19/against-excellence, accessed 5/18/2022

Stölting, E. 2002: Wissenschaft als Sport. Ein soziologischer Blick auf widersprüchliche Mechanismen des Wissenschaftsbetriebes. – Die Hochschule: Journal für Wissenschaft und Bildung **11** (2): 58-78

Stötter, J., H. Kromp-Kolb, A. Körfgen, F. Allerberger, T. Lindenthal, I. Glatz, R. Lang, F. Fehr and *L. Bohunovsky* 2019: Österreichische Universitäten übernehmen Verantwortung: Das Projekt

Stötter, J., H. Kromp-Kolb, R. Lang, A. Schneeberger, I. Glatz, F. Allerberger and *F. Fehr* 2021: Von UniNEtZ zu UniNEtZ II – eine Reflexion zu Erreichtem und ein Ausblick zu Angestrebtem. – GAIA – Ecological Perspectives for Science and Society **30** (4): 278-280, doi:14512/gaia.30.4.12

The Bavarian Network for Sustainability in Higher Education 2022: The Bavarian Network for Sustainability in Higher Education. – Online available at: https://www.nachhaltigehochschule.de/english/, accessed 5/18/2022

Treibel, A. 2008: Die Soziologie von Norbert Elias. Eine Einführung in ihre Geschichte, Systematik und Perspektiven. – Wiesbaden

Troiani, I. and *C. Dutson* 2021: The Neoliberal University as a Space to Learn/Think/Work in Higher Education. – Architecture and Culture **9** (1): 5-23

Turner II, B.L. 2010: Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? – Global Environmental Change **20** (4): 570-576, doi:10.1016/j.gloenvcha.2010.07.003

UN 2015: Transforming Our World. The Agenda 2030 for Sustainable Development: A/RES/70/1 – n.p.

UNESCO 2012: Education for sustainable development: building a better, fairer world for the 21st century. – Paris. – Online available at: https://unesdoc.unesco.org/ark:/48223/pf0000216673, accessed 5/18/2022

UNESCO 2020: Education for sustainable development: a roadmap. – Paris

UNESCO 2022: Berlin Declaration on Education for Sustainable Development. – Paris. – Online available at: https://en.unesco.org/sites/default/files/esdfor2030-berlin-declaration-en.pdf, accessed 5/18/2022

uniko 2020: uniko-Manifest für Nachhaltigkeit. Positionspapier. – Wien. – Online available at: https://uniko.ac.at/modules/download.php?key=21707_DE_O&f=1&jt=7906&cs=02F6, accessed 8/8/2021

UniNEtZ 2022: About. – Online available at: https://www.uninetz.at/en/about-us, accessed 8/8/2021

U.S. Government Printing Office 1980: The Global/2000 Report to the President: Entering the Twenty-First Century. – Washington

Viana-Lora, A. and *M.G. Nel-lo-Andreu* 2021: Approaching the Social Impact of Research Through a Literature Review. – International Journal of Qualitative Methods **20** (2): 160940692110521, doi:10.1177%2F16094069211052189

Vilsmaier, U. and *D.J. Lang* 2014: Transdisziplinäre Forschung. – In: *Heinrichs, H.* and *G. Michelsen* (eds.): Nachhaltigkeitswissenschaften. – Berlin/Heidelberg: 87-113

Vogt, M. 2018: Grenzen der Harmonie. Zur Spannung zwischen Freiheit und Verantwortung in der Wissenschaft. – München. – Online available at: https://www.hochn.uni-hamburg.de/-downloads/180717-vortrag-vogt-freiheit-und-verantwortung.pd, accessed /8/2021

Vogt, M. 2019: Ethik des Wissens. Freiheit und Verantwortung der Wissenschaft in Zeiten des Klimawandels. – München

Vogt, M. 2021: Christliche Umweltethik. Grundlagen und zentrale Herausforderungen. – Freiburg

Vogt, M. and *C. Weber* 2020: The Role of Universities in a Sustainable Society. Why Value-Free Research is Neither Possible nor Desirable. – Sustainability **12** (7): 1-21, doi:3390/su12072811

Wackernagel, M. and *B. Beyers* 2019: Ecological Footprint. Managing our biocapacity budget. First edition. – Gabriola Island

Wackernagel, M. and *W.E. Rees* 1996: Our Ecological Footprint: Reducing Human Impact on the Earth. – Philadelphia

Wanner, M., A. Hilger, J. Westerkowski, M. Rose, F. Stelzer and *N. Schäpke* 2018: Towards a Cyclical Concept of Real-World Laboratories. – disP – The Planning Review **54** (2): 94-114, doi:10.1080/02513625.2018.1487651

Warburton, K. 2003: Deep learning and education for sustainability. – International Journal of Sustainability in Higher

Education **4** (1): 44-56, doi:10.1108/14676370310455332

WBGU 2007: Welt im Wandel. Sicherheitsrisiko Klimawandel. – Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen. – Berlin/Heidelberg

WBGU 2011: Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation: Hauptgutachten. – Wissenschaftlicher Beirat Globale Umweltveränderungen. – Berlin

WBGU 2016: Der Umzug der Menschheit: Die transformative Kraft der Städte. – Berlin

Weber, M. 1904: Die »Objektivität« sozialwissenschaftlicher und sozialpolitischer Erkenntnis. – Archiv für Sozialwissenschaft und Sozialpolitik **19** (1): 22-87

Weber, M. 1917: Der Sinn der »Wertfreiheit« der soziologischen und ökonomischen Wissenschaften. – Logos Internationale Zeitschrift für Philosophie der Kultur **VII** (1): 40-88

Wehrden, H. von, *M.H. Guimarães, O. Bina, M. Varanda, D.J. Lang, B. John, F. Gralla, D. Alexander, D. Raines, A. White* and *R.J. Lawrence* 2019: Interdisciplinary and transdisciplinary research: finding the common ground of multifaceted concepts. – Sustainability Science **14** (3): 875-888, doi:10.1007/s11635-018-0594-x

Weichart, P. 1995: Humanökologie und Geographie. – Österreich in Geschichte und Literatur mit Geographie **39**: 39-55

Weingart, P. 1983: Verwissenschaftlichung der Gesellschaft – Politisierung der Wissenschaft. – Zeitschrift für Soziologie **12** (3): 225-241, doi:10.1515/zfsoz-1983-0303

Weiss, M. and *M. Barth* 2019: Global research landscape of sustainability curricula implementation in higher education. – International Journal of Sustainability in Higher Education **20** (4): 570-589, doi:10.1108/IJSHE-10-2018-0190

Young, G.L. 1974: Human Ecology as an Interdisciplinary Concept: A Critical Inquiry. – Advances in Ecological Research 8: 1-105, doi:10.1016/S0065-2504(08)60277-9

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

Zierhofer, W. 2002: Gesellschaft. Transformation eines Problems. – Oldenburg