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Planetary sustainability collection

Andreas Losch

University of Bern, Faculty of Theology, Länggassstrasse 51, CH-3012 Bern, Switzerland

Editorial

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Author for correspondence: Andreas Losch
E-mail: andreas.losch@theol.unibe.ch

This collection on 'planetary sustainability' is both about a present need and about a future vision. NASA envisaged a threefold scheme under this title:

(1) A world in which all people have access to abundant water, food and energy, as well as protection from severe storms and climate change impacts.
(2) Healthy and sustainable worldwide economic growth from renewable products and resources.
(3) A multi-planetary society, where the resources of the solar system are available to the people of Earth (NASA, 2014).

A pioneering research project at the University of Bern referred to NASA's ideas and started with the analysis of the third point in particular (Losch, 2019a), developing it in the direction of space sustainability. Nevertheless, a more integrative approach including both our space environment and planet Earth is required, as it is important to show the impact of space exploration on Earth's society and economy. That is why the term 'planetary sustainability' should be understood here in the broad sense of this more integrative approach, including planet Earth *and* its space environment, *basically as an understanding of sustainability that takes account of the fact that Earth is a planet*. This is important in at least two ways.

First of all, we have to be aware of the limits that come with living on a planet facing the Anthropocene (Crutzen, 2002; Rockström *et al.*, 2018; Steffen *et al.*, 2015a). Planet Earth today is decisively shaped by human civilization. In 2009, humanity had already transgressed at least three planetary boundaries: human interference with the global nitrogen cycle (through the increase in fertilizer use), the biodiversity boundary and the climate boundary (Rockström *et al.*, 2009). To these must be added today the boundary for land-system change (which has been updated with a new control variable: the amount of forest cover remaining; Steffen *et al.*, 2015b). On the other hand, through the implementation of the Montreal Protocol, "humanity succeeded in reversing the trend with regard to the stratospheric ozone boundary" (Rockström *et al.*, 2009). This shows the significance of these planetary boundaries, which are designed as warning signs, including a buffer before reaching a global threshold or tipping point (Steffen *et al.*, 2015b, p. 2). "Humanity thus needs to become an active steward of all planetary boundaries … in order to avoid risk of disastrous long-term social and environmental disruption." This "suggests the need for novel and adaptive governance approaches at global, regional, and local scales" (Rockström *et al.*, 2009).

The second aspect of our awareness of the planetary shape of Earth points to the fact that our planet has a *space environment*, which is already being exploited very intensively. While 'planetary boundaries' and the Anthropocene are now quite well-received concepts, awareness of what is happening in our space environment is largely limited to space agencies and space enthusiasts. This collection attempts to raise awareness in this regard.

The space environment can be used to help achieve the 17 Sustainable Development Goals (SDGs) of the United Nations (2015). Satellites providing big land data are key in this context, as they can warn against floods, fires or droughts and help in rural and urban development (Di Pippo, 2019). The United Nations Office for Outer Space Affairs (UNOOSA) demonstrates the full impact of space for the fulfilment of the 17 SDGs with its SPACE4SDGS programme (UNOOSA, 2019c). In addition, the idea of a Space2030 agenda, endorsed by the United Nations General Assembly (A/RES/73/91), explores space as a driver for sustainable development, building on space economy, space society, space accessibility and space diplomacy (UNOOSA, 2019b).

Satellites, which will be so helpful in achieving the global SDGs, also demonstrate why we need to work on sustainability in space itself. What started with Sputnik in 1957 has led to more than 8600 objects circulating in outer space today (UNOOSA, 2019a). Almost 5000 satellites are still operating for various purposes. "Just a few uncontrolled space crashes could generate enough debris to set off a runaway cascade of fragments, rendering near-Earth space unusable" (Witze, 2018, p. 25) – along with all of the impacts of this on society and the economy. Already there are more incidents involving space debris caused by the breakup of human-made devices than 'natural' events with micrometeorites (Bonnal & McKnight, 2017, p. 5). Earth's space environment, especially the sought-after orbits, is a limited resource.

Nevertheless, there are massive plans to increase the number of satellites. At the end of May 2019, SpaceX shot the first 60 'Starlink' satellites into space, which are planned as part of a mega-constellation of up to 12,000 satellites providing high-speed Internet to every location on Earth (Mosher, 2019). SpaceX is not the only company planning such constellations. In view of the plans for a multitude of mega-constellations, astronomers worry about another problem: as satellites are built to reflect sunlight in order to keep their instruments cool inside, the night sky could become significantly brighter with their presence, and the increase in radio emissions could pose a problem to radio astronomy (International Astronomical Union, 2019).

The international platform for discussing space affairs is the United Nations Committee on Peaceful Uses of Outer Space (UNCOPUOS). It "adopted a series of non-binding guidelines designed to ensure the long-term sustainability of outer space ('LTS Guidelines'). While the LTS Guidelines represent a consensus approval by the 70 members of the UNCOPUOS, their non-binding 'soft law' status presents challenges for compliance and enforcement" (Martinez, 2019). The legal situation is explained in Martinez's article in this collection. Space law becomes even more complicated regarding the idea of space mining: it is still under discussion as to how the use of extra-terrestrial resources in outer space is covered by the Outer Space Treaty (Hofmann & Bergamasco, 2020).

Space 4.0, as today's situation is commonly labelled, "represents the evolution of the traditionally state-driven space activities into an era of privatization and commercialization of space activities, mirrored by collaboration between governments, the private sector, society and politics" (Bohlmann & Petrovici, 2019). As economics plays a growing role in space, sustainability considerations are ever more important. While the concept is widely regarded as essential, its normative content would benefit from some elaboration and reflection, as discussed in this collection in the article by Vogt and Weber (2019): "Even today, the literature contains basic misunderstandings about this content. So, this article sketches seven such fallacies in the context of global and planetary sustainability." Another more general question relates to economic growth. Blue Origin (and Amazon) CEO Jeff Bezos envisions space as the place to continue economic growth in view of limited resources on Earth (Blue Origin, 2019), similarly to the original NASA idea presented initially. The vision of growth is built into the SDGs, as SDG 8 demands "decent work and economic growth," coupling social well-being with it. One needs to discuss whether this is feasible in view of our planetary boundaries[i] and how the expansion into space can affect these aims.

What is missing within the SDG discourse is an appreciation of our space environment as a somewhat threatened and, most of all, limited domain. This is why the idea has been proposed to establish an 18th 'space environment' SDG, for facilitating discussions on the topic (Galli & Losch, 2019). It "should not only lay out new rules for activities transcending Earth, but also serve as a reminder of the basic human principles that respect and foster life (and all rights connected to it), encourage subsidiarity and strive to attain the best possible amount of human freedom and solidarity," as Catholic social teaching would argue (Wallacher *et al.*, 2019).

What environmental concerns are valid for our space environment, besides the fact that the area close to Earth is a limited resource? One fundamental question relates to the contamination of other celestial bodies with Earthly microbiological life. The Outer Space Treaty is clear about this, stating that "States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter" (United Nations, 1966, Art. IX). Included here is not only *forward*, but also *backward* contamination, issues dealt with in the guidelines set up by the Committee on Space Research (COSPAR). Already the *potential* existence of ancient or even current extra-terrestrial life on celestial bodies such as Mars or Europa certainly adds a lot of complexity to the situation (Persson, 2018). Nevertheless, "The current COSPAR Planetary Protection Policy addresses scientific space exploration only and is primarily concerned with the issue of contamination with micro-organisms. Other impacts of human space exploration that may be detrimental to space exploration itself are not covered" (Galli & Losch, 2019).

These are all building blocks of the concept of planetary sustainability. Finally, such an approach should take into account that although sustainability is about the needs of future generations, humanity on Earth will not continue indefinitely. A potential huge asteroid impact – as happened in the time of the dinosaurs – could change Earth forever. Within this framework, the recent idea of 'planetary defence' – the categorization of asteroid threats and the first missions to attempt to adjust their trajectories – therefore makes sense (ESA, 2020). But in any case, Earth's time is limited. In some 100 million years, the Sun will have grown too hot and too big to allow life on Earth, as is the Sun's fate as a second-generation star. Taking both the asteroid threat and this fact into account, it is quite right to point out that "without our expansion of our instruments and people into space, humanity could conceivably perish" (Pass *et al.*, 2006, p. 5). "To some extent, a truly sustainable concept of sustainability therefore has to be an inter-planetary one, which makes a continuous technological development a necessity" (Losch, 2019a, p. 4). 'Planetary sustainability' as a term aims to keep this in mind. (For a critical review and discussion of the idea, see Beisbart, 2019a, 2019b, 2019c; Losch, 2019b.)

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Note

i. For a first evaluation of the relationship between the SDGs and planetary boundaries, see Randers *et al.* (2019) in this journal.

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