Current Challenges of Environmental Philosophy

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CHAPTER 5

Are We Risking Too Much the Sustainability of the Anthropocene Technosphere?

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Abstract

One of the most remarkable facts of our time is that our species inhabits a planetary Technosphere of its own making, something entirely new in its (natural and cultural) history. This has allowed our species to acquire unprecedented power over the Earth's course and opened a new chapter in geohistory called the Anthropocene. The acquisition of this power has also made us aware of the consequences of its use and the dangers of its misuse. Thus, a reflection was started on the current functioning of the Technosphere and its evolutionary trajectory, focusing on the risks of its weakening, collapse or disappearance in the short (proceeding decades) to the medium term (coming centuries). This chapter intends to be a contribution to this reflection. In the first part, the vision of the Technosphere of the American geologist Peter Haff is analyzed, not only because he, originally, conceptualized it, but also because he remains the main theorist. In the second part, it is argued that, after their coeval historical emergence, the Technosphere and the Anthropocene remained co-dependent and co-evolutionary realities, and some implications are drawn regarding the symbiotic relationship that has been established between them. The third part examines the serious problem facing the Technosphere in relation to its sustainability, arising from, so-called, Anthropocene risks. The fourth part revisits the idea proposed 20 years ago for the creation of the so-called "Geoscope of Sustainability" as a more sustainable control and governance instrument for the Anthropocene Technosphere.

1 Introduction

Canadian philosopher Sean McGrath claimed, in a recent book, that we are living in the "age of the advent of the Technosphere".[1] It constitutes, according to him "(…) the new home of life in the Anthropocene, the new form that nature

1 Sean McGrath, *Thinking nature: an essay in negative ecology*, Edinburgh: Edinburgh University Press, 2019, p. 10.

 | DOI:10.1163/9789004679955_007

has taken in our age, and if we have no choice but to live in it, we must learn to live in it justly".[2]

However, this man-made sphere, which has become the common home for all living beings, human and non-human, seems to be evolving in a way that raises concerns about its future continuity. Those who are more pessimistic and prone to catastrophism, are convinced that it will soon collapse and bring about the end of the world as we know it (Scenario A). The most optimistic and hopeful consider that there is still time to reform it and ensure a symbiotic relationship with the Earth System, which will help delay the arrival of a more adverse planetary situation for centuries or millennia (Scenario B).

The question, then, is whether the risks we face, with the current way the Technosphere works, are bringing us closer to Scenario A or Scenario B. Will the Technosphere be ruined within a generation or two, or will it last for many generations to come? Will the Technosphere be our salvation or our doom?

The main theorist of the Technosphere has been the US geologist Peter Haff, who not only conceptualized it originally, but has also studied it in detail. For this reason, the first part of this chapter will be devoted to an analysis of his conception of the Technosphere.

The Technosphere is coeval with the Anthropocene. For geoscientists, the Anthropocene concept fundamentally designates a post-Holocene state and non-analogue state of the Earth System, induced mainly by anthropogenic causes, with a tendency to become increasingly unstable, insecure, uncertain and unpredictable.[3] Social scientists and Humanities scholars, on the other hand, understand this as a unique historical-cultural event, marked by the acquisition by the human species of unprecedented power to affect the functioning of the Earth System and corresponding awareness of the responsibility of such interventions. However, although they focus on different aspects of the meaning of the Anthropocene, both recognize that the cause of the

2 Ibid., p. 39.

3 The seminal papers where the Anthropocene was introduced as a geological concept were: Paul Crutzen and Eugene Stoermer, "The 'Anthropocene'," *IGBP Newsletter,* no. 41 (2000): pp. 17–18; Paul Crutzen, "Geology of Mankind," *Nature*, vol. 415 (2002): p. 23. DOI: 10.1038/415023a. In 2009, it evolved into a stratigraphic and geochronological scientific hypothesis that has been researched primarily by the Anthropocene Working Group, led by Polish-British geologist Jan Zalasiewicz. See also João Mendes, "The Anthropocene: scientific meaning and philosophical significance," *Anthropocenica. Revista de Estudos do Antropoceno e Ecocrítica,* vol. 1 (2020) pp. 71–89. DOI: 10.21814/anthropocenica.3097.

continual change in the Earth System, or the instrument that allows our species to intervene, is the Technosphere we have built. In the second part, I will argue that, in addition to their contemporary emergence, the Technosphere and the Anthropocene remain co-dependent and co-evolving realities, and I will draw some implications from the symbiotic relation that exists between them. That is why, although some claim that it would be more correct to use the term Technocene[4] to refer to it, it is preferable to call it the Anthropocene Technosphere.

The two most pressing challenges facing the Anthropocene Technosphere are its increasing autonomy and low level of recycling. The first concerns, in other terms, our growing inability to control and manage the Technosphere and, at the same time, the shrinkage of our room for maneuver, or restriction in our freedom. The second has to do mainly with the Technosphere's relationship with the other natural spheres, which has been increasingly harmful to them, either because of excessive and rapid extraction of its resources, or by the release of excessively negative externalities in them (pollution, waste, etc.). These two challenges are part of a larger challenge: the sustainability of the Technosphere. In part three, I will argue that the sustainability of the Technosphere is largely determined by the "Anthropocene risks" we are taking.

The control of these Anthropocene risks and the sustainability of the Technosphere depend, to a great extent, not without a certain irony, on the creation of innovative technologies. This does not mean to reaffirm the techno-fix thesis.[5] Rather, it means asserting that while technology may be destructive, regressive and certainly incapable of solving all of our problems, it can still help us to reduce these Anthropocene risks and meet the challenge of the sustainability of the Technosphere. In this sense, in the fourth and last part of the chapter, I will revisit the proposal made two decades ago to create the so-called "Geoscope of Sustainability".

4 See, for example, Alf Hornborg, "The political ecology of the Technocene: Uncovering ecologically unequal exchange in the world-system," in *The Anthropocene and the global environmental crisis: Rethinking modernity in a new epoch*, eds. Clive Hamilton, François Gemenne and Christophe Bonneuil, London: Routledge, 2015, pp. 57–69; and Agostino Cera, "The Technocene or Technology as (Neo)environment," *Techné: Research in Philosophy and Technology,* vol. 21, no. 2/3 (2017): pp. 243–281. DOI: 10.5840/techne201710472.

5 In general terms, the thesis states that all problems, even those caused by technologies, can find solutions in better and newer technologies. See, in this regard, for example: Michael Huesemann and Joyce Huesemann, *Techno-Fix: Why Technology Won't Save Us or the Environment,* Gabriola Island: New Society Publishers, 2011.

2 What Is This Thing Called the Technosphere

According to Chris Otter, "[t]he term 'technosphere' first appeared in the writings of systems theorists, geographers and ecologists in the 1960s and 1970s (...)".[6] For example, John Milsum, Canadian engineer, expert in control systems, used the notion in a paper published in the late 1960s to refer to an emergent new sphere, distinct from other spheres of the Earth system, including the sociosphere composed of all human beings.[7] The pioneering Irish ornithologist and environmentalist, Edward Max Nicholson, in turn, conceived a "diagram of the biosphere and technosphere," where the thin terrestrial layer that makes life possible (biosphere) and the socioeconomic and the industrial system, which, in his opinion, characterizes the modern human way of life (technosphere) were represented in interdependence.[8]

However, only half a century later, with the US geologist Peter Haff, the concept was elaborated, mainly in regard of its philosophical relevance. Also according to Otter, it will be "(...) the latest, and arguably most conceptually useful, in a series of monistic concepts that (...) refer to a singular globalized space constructed by humans".[9]

2.1 *Definition*

Peter Haff introduced the concept of "Technosphere" in a paper in 2012, where he defined it as a "(...) widely distributed and interconnected technological systems on whose function modern civilization and society are based".[10]

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6 Chris Otter, "Technosphere," in *Concepts of Urban-Environmental History*, eds. Sebastian Haumann, Martin Knoll and Detlev Mares, Bielefeld: Transcript, 2020, p. 22. The other "monistic concepts" he referred to are: Gilles Deleuze and Félix Guattari "Mécanosphère" in their book *A thousand plateaus: Capitalism and schizophrenia,* trans. Brian Massumi, Minneapolis: University of Minnesota Press, 1987; Pietro Passerini's "Anthropostrome" in his article "The ascent of the anthropostrome: A point of view on the man-made environment," *Environmental Geology of Water Sciences,* vol. 6, no. 4 (1984): pp. 211–221; Kevin Kelly's "Technium" in his book *What technology wants*, London: Penguin 2011; and Peter Baccini and Paul Brunner's "Anthroposphere" in their book *Metabolism of the Anthroposphere: Analysis, Evaluation, Design*, Cambridge, MA: MIT Press, 2012.

7 John Milsum, "The technosphere, the biosphere, the sociosphere. Their systems modeling and optimization," *IEEE Spectrum* vol. 5, no. 6 (1968): pp. 76–82. DOI: 10.1109/MSPEC.1968.5214690.

8 Max Nicholson, *Handbook to the conservation section of the international biological programme*, London: Conservation of Terrestrial Biological Communities, 1968.

9 Ibid., p. 22.

10 Peter Haff, "Technology and human purpose: The problem of solids transport on the Earth's surface," *Earth System Dynamics,* vol. 3, no. 2 (2012): p. 149. DOI: 10.5194/esd-3-149-2012.

In another article published the following year, he reiterated this definition by stating that the Technosphere is:

> (…) the set of large-scale networked technologies that underlie and make possible (…) "artificial" or "non-natural" processes [extraction and processing of raw materials; energy production; electronic communications; transport of goods and merchandise; food industry; political and economic bureaucracies; etc.] without which modern civilization and its present 7×10^9 human constituents could not exist.[11]

The Technosphere, therefore, corresponds to the domain of Technology. Its representation as a sphere serves to suggest, figuratively, that it has acquired a form that accompanies and involves that of the Earth itself.[12] It seems like a set of interconnected technologies weaving a reticular mesh that covers the planet, composing a total system in appearance. In addition to this shape and appearance, each technology that makes up the network serves a specific purpose and, at the same time, contributes to the greater purpose of ensuring the livelihood and functioning of contemporary human civilization.[13]

11 Peter Haff, "Technology as a geological phenomenon: Implications for human well-being," in *A Stratigraphical Basis for the Anthropocene?*, eds. Colin Waters, Jan Zalasiewicz and Mark Williams, London: Geological Society London, 2013, pp. 301–302.

12 The notion of "sphere" does not have to be taken literally as referring to an object with a perfectly smooth and uniform surface. This is a sphere conceived in a purely abstract and ideal way.

13 Lescure followed an identical definition, but with some nuances: "The Technosphere, as defined by the EOS [Earth Organization for Sustainability], is basically our combined infrastructure and machine park, which build up the capability of human civilization to force multiply its efficiency in harvesting resources, while in the same time requiring maintenance. The Technosphere consists of transport systems, such as roads, railways (and in the future monorails and hyperloop systems), canals, ports and airports. It also consists of power plants and energy grids, as well as heating plants and sewage systems. It consists of the agricultural regions and facilities, the transport lanes of food to cities and the supermarkets or food depots where people acquire food. It consists of the mining facilities and other natural resource extraction operations, and the systems bringing these resources to refineries. It consists of the factories, which assemble refined resources into finished products, distributed to the markets and then sold to the consumers. It consists of research centres and universities, which serve to improve the efficiency of the infrastructure and to educate the future managers. And finally, it consists of the billions of people who staff this gargantuan daily operation of our civilisation as workers, engineers, scientists and managers". See Enrique Lescure, "The Technosphere and the Technate," Earth Organization for Sustainability, last modified on May 12, 2017, https://eosprojects.com/the-technosphere-and-the-technate.

Haff seems to conceive, at least tacitly, that, although, the Technosphere is a heterogeneous set of interconnected technologies, it constitutes a relatively singular and homogeneous entity. However, even though the Technosphere can be conceived as such an object, constructed by humans to globally encompass the planet, it still presents itself as fragmented and heterogeneous, a mesh of interconnected technical artifacts that cover the planet. Jennifer Gabrys, for example, criticized the understanding of the Technosphere as a totalizing entity, an all-encompassing system, stating "(…) we need to rupture a notion of a singular technosphere (…) We should be thinking about the technosphere in more distributed ways, in more multiple ways, in more relational ways – inevitably, in more processual ways".[14]

The preference for the name "Technosphere" rather than "Anthroposphere", Haff explained, was because although almost synonymous, the former seems more semantically neutral than the latter and more appropriate for a more objective analysis of the phenomenon.[15]

A third noteworthy aspect is the analogy he established between the so-called classical geological paradigms and this emerging one.[16] As is well known, Eduard Suess introduced in 1875 in *Die Entstehung der Alpen* (The Emergence of the Alps) the geological image that planet Earth can be described as a set of spheres.[17] In that same book, the Austrian geologist also made use, for the first time, of the concept of "Biosphere" defined as a thin layer at the intersection of the Lithosphere, Hydrosphere and Atmosphere (this last was already in circulation since the eighteenth century, the others were coined by Suess). Given Haff's background in Geology, it is not surprising that he wanted to connect with this conceptual tradition inaugurated by Suess.

Finally, according to him, the Technosphere was created by the human species with the main objective of establishing the conditions for modern civilizational life.

2.2 *Properties*

Haff claimed that all four natural geological spheres, possess five fundamental properties – they have a global extension, take over pre-existing structural and metabolic resources, preserve the structure and functionality of pre-existing

14 Jennifer Gabrys, interview with cc.cc, *Continent,* vol. 5, no. 2 (2016): p. 34.
15 Haff, "Technology as a geological phenomenon: Implications for human well-being," p. 302.
16 Ibid.
17 Eduard Suess, *Die Entstehung der Alpen*, Wien: Braumüller, 1875.

spheres, recycle their resources, have autonomy – and that the Technosphere has all of them, at least to some degree.[18]

The first seems rather obvious, because "(…) technology penetrates to nearly every part of the globe through a web of communication and transportation networks"[19] and "(…) is in any practical sense a global phenomenon, spanning the planet and absorbing into itself almost all of the world's human population".[20] Indeed, we might say that the Technosphere emerged from a process that began with the 1st Industrial Revolution at the end of the 18th century, accelerated and intensified after World War II, and became a reality at the turn of the 21th century.

If we think of the modern State as a technology of political organization – one of the largest, most cohesive components of the Technosphere – we realize that it has spread throughout the entire planet and that it is now practically impossible for any human individual to remain outside of it. This is the example given by Haff of the global extent of the Technosphere.

The Technosphere, therefore, seems to have been built in an unplanned way, but from the moment it became a reality, it brought about profound changes in the Human-Technology-Nature relationship.

The second property is also explicit. "The physical components of a geological paradigm", says Haff, "are constructed from parts cadged from the Earth's supply of resources, including from resources used by older paradigms."[21] If so, it is quite clear that the Technosphere extracts and appropriates matter (water, organic material, oxygen, etc.), energy and information (DNA) from the main natural spheres.

Domestic animals, like most physical organisms, and even more human beings, were born directly into the Technosphere and "(…) can be viewed as newly constructed technological parts based on old design information (DNA) captured from the biosphere."[22] Many of them seem to owe their existence to the technological processes that support them and, which appear to be, at the same time, indispensable to their sustenance.

The Technosphere also manifests the third referred property: it preserves the structure and functionality of pre-existing geological paradigms, i.e., it

18 Haff, "Technology as a geological phenomenon: Implications for human well-being," p. 302.

19 Ibid.

20 Ibid., p. 303. Extent (what portion of space it occupies) is not the same as weight (of the artefacts produced by humans, calculated in tons) or impact (measurement of the effects caused by these artefacts on the planet, e.g., on its atmosphere).

21 Ibid., p. 303.

22 Ibid.

appropriates "(...) large quantities of 'natural resources' from the biosphere, hydrosphere and lithosphere, but, at least for the time being, the ancient paradigms continue as globally organized systems."[23]

Indeed, the so-called "natural capital" – "(...) the Earth's thick, fertile soils, mineral resources, bacterial and chemical populations that breakdown or recycle wastes, sources of fresh water, soil mechanisms that filter or detoxify contaminants, a reasonably stable and equable climate, and biological diversity, among many other examples"[24] – is determinant of the subsistence and functioning of the Technosphere and ultimately of human well-being.

This means that the Technosphere faces the permanent challenge of maintaining a harmonious and balanced relationship with the other natural geological spheres, at the risk of endangering its subsistence and that of its components, namely human beings. Unlike other natural spheres, the sphere of Technology has the distinctive property, through its human components, of becoming aware of its own functioning and thus possessing the power of changing it. However, this conservative function is being abandoned, and its sustainability, if not its subsistence, is increasingly at risk.

In close relationship with the latter, the fourth property is also present in the Technosphere: the recycling of resources. Each geological paradigm needs to do so, not only to avoid the depletion of resources but also to prevent the curtailment of its own activity. Furthermore, as Haff also points out, since the Earth is a closed, metabolizing, system (essentially with no mass input or output), it must recycle its own waste, otherwise too much accumulated polluting material will render the system unable to function.

Today, the Technosphere reveals poor recycling capacity for many of the critical resources it uses. If this continues, in the not too distant future, it could lead to a catastrophic reorganization of the Earth and more dramatically to the extinction of our species.

Finally, the Technosphere also has the property of autonomy. Martina Heßler pointed out that the problem of technological autonomy is essentially one concerning the position of human beings in relation to the Technology they have created. According to her, this problem has a complex cultural history going back to ancient Greece. In the last two centuries, however, it has

23 Ibid., p. 304.
24 Ibid.

remained centered on the anthropological, social, political and economic consequences of the creation of machines programmed to work without human intervention.[25]

In the same vein, Haff states that, different from the four natural spheres, which seem to dispense with deliberation and human control to function, we perceive Technology as "(…) not autonomous, but critically dependent on human beings and human actions".[26] Nevertheless, he adds, the fact is that the Technosphere, created by human beings, at a certain moment will have acquired a significant degree of autonomy, to the point of raising the question about whether, and to what extent, the Technosphere still needs its creators to survive.

The gain of autonomy, at the level of the Technosphere as a whole, not at the level of its parts, occurred after the acquisition of a global extension. Haff implies that the autonomy of the Technosphere was not planned. It was designed and built by human beings to serve their interests and expand the limits of their freedom, but it ended up transcending that purpose and reversing the relationship of dependency, that is, becoming a condition of subsistence and survival for its creators, transforming them into its components.

In sum, says Haff, the Technosphere "(…) exhibits a number of properties of earlier geological paradigms. It is autonomous. It is a global phenomenon. It appropriates Earth resources, including energy, mass and information, for its own uses on a large scale",[27] but "(…) unlike earlier Earth paradigms, which recycle most of their waste products, the technosphere does little recycling".[28]

There is an apparently increasing autonomy of the Technosphere whilst, at the same time, a decrease in its control by human beings; but, on the other hand, only humans will be able to prevent the appropriation and depletion of resources and metabolic excess by recycling. This means that the problem of the sustainability of the Technosphere was created by human beings and can only be solved by them.

25 Martina Heßler, "Technik und Autonomie," in *Autonome Systeme und Arbeit. Perspektiven, Herausforderungen und Grenzen der Künstlichen Intelligenz in der Arbeitswelt*, eds. Hartmut Hirsch-Kreinsen and Anemari Karačić, Bielefeld: Transcript, 2019, pp. 247–274.

26 Haff, "Technology as a geological phenomenon: Implications for human well-being," p. 306.

27 Ibid., p 307.

28 Ibid.

2.3 *Dynamics*

After the aforementioned articles from 2012 and 2013, Haff published another in 2014, in which he returned to the concept of the Technosphere, but this time, describing it as a complex system with a planetary dimension.[29]

In this text, he reaffirmed the thesis that the Technosphere is a human creation that has become autonomous from its creators. However, the degree of autonomy achieved by the Technosphere is still insufficient to dispense with human labor as the condition of its subsistence. On the other hand, human beings cannot do without the Technosphere, either, because to dismantle it in part or in total would entail an unbearable existential and moral cost.[30] In a sense, the Technosphere and its human components remain interdependent, their destinies intertwined. This means that the dynamics of the global technospheric system depends, in large part, on its relationship with its special component: human beings.

Haff identifies six rules that determine the evolution of the Technosphere as a complex system of planetary dimension and, *eo ipso*, co-adaption with its human components. These are rules to which most people are subject and cannot escape, a new state of human affairs, "(…) not meant as a metaphor or analogy, but as a physical necessity, a reality".[31] They are rules that decisively determine the sustainability of the Technosphere and the survival of its human (and non-human) inhabitants.

The first is the rule of inaccessibility. It states that we cannot interact directly with most of the large components of the Technosphere or, in other words, that those large components cannot directly influence the behavior of their human parts.[32]

The relevance of this rule is, on the one hand, to make us (more) aware that we are, most of the time, too much focused on what is closer and familiar to us, that is, on local causes and effects – Heidegger would probably say, on what is present-at-hand (*Vorhandenheit*) and the ready-to-hand (*Zuhandenheit*). However, on the other hand, it also reminds us of the fact that we are also components of a larger system not created by any individual human being, and whose functioning we do not fully understand or control, and from which we cannot escape.

29 Peter Haff, "Humans and technology in the Anthropocene: Six rules," *The Anthropocene Review*, vol. 1, no. 2 (2014): pp. 126–136.

30 Haff estimated that, without the Technosphere, the human population would drop to values close to those of the Stone Age, i.e., from the current almost 8,000 million to about 10 million individuals (Cf. Haff, "Technology as a geological phenomenon: Implications for human well-being," p. 302).

31 Haff, "Humans and technology in the Anthropocene: Six rules," p. 129.

32 Ibid., p. 130.

The second is the rule of impotence: most human beings cannot significantly influence the behavior of large technological systems. For example, governments do not easily change policies because of complaints from individuals, groups, or movements. There are, of course, exceptions to the rule. For instance, individuals or groups may sabotage parts of a country's power grid and cause a blackout affecting many services. This rule shows how large technological systems tend to resist not only human interference with their function but also their modification.

The third is the rule of control. We can formulate it this way: when a technological system performs a greater range of behaviors – it is more complex – than any human being, the latter has no control over it. This does not prevent the possibility that some persons may influence its evolution. However, as Haff points out: "The technosphere is not a giant version of a navy ship".[33] A complex system to be controllable has to be designed so that the processes for its operability are in line with the capabilities of its handlers. The problem is that the Technosphere is not a system that has been projected and, therefore, cannot be effectively controlled by us.

In fourth, comes the rule of reciprocity that proclaims that an individual human being can interact directly only with systems at his own scale, for instance with a mobile phone or an automobile, but not with a microchip or the (whole) Technosphere. Ignoring this rule, according to Haff, "(…) encourage[s] the anthropocentric misconception that we created and control large-scale technology".[34]

A fifth one is the, so-called, rule of performance: "(…) at least some of the actions of most system parts must support the function of the system to which they belong".[35] In other words, the rule states that most human beings must perform some tasks in favor of the functioning of the Technosphere.

This rule reveals that human beings are not mere users of the Technosphere, of the goods and services that are produced in it, but fundamental components of it. On the other hand, the Technosphere, as a technological infrastructure on a planetary scale, can no longer be seen as an instrument at the service of the human beings who created it and has become a condition for the possibility of their own existence and coexistence. As Haff crudely states:

> A few individuals may occasionally withdraw from the technosphere voluntarily to become hermits, or fail to work in its support because of mental or physical incapacity, e.g. the sick and the homeless. From the

33 Ibid., p. 132.
34 Ibid., p. 133.
35 Ibid.

> point of view of the technosphere the latter are broken parts, and are in effect discarded from the system unless they can be repaired, i.e. made serviceable again.[36]

The last of the rules is the rule of provision: "It is necessary that the parts of a system experience an environment that makes it possible for them to perform their support function".[37] It implies that the Technosphere is a "host system" that contributes to maintaining a "suitable environment" for its components, or that the Technosphere must provide an environment for the survival and functioning of the human beings.

The rules of performance and provision, in particular, create conditions for positive feedback in relation to human components, providing "(…) gadgets, services and systems that people want (…)"[38] and stimulate expansion of the Technosphere. However, they are the ones who, in the long run, can destabilize it. This will happen, according to Haff, if the technological systems that integrate it remain or become highly metabolic and, at the same time, insufficiently capable of recycling the waste they produce and that the natural systems are not capable of recycling. In other words, that means that if the environmental degradation, the global warming, and the world population continues to rise, the Technosphere may fail to support civilization and the species that created it.

3 Technosphere and Anthropocene: a Coeval, Co-dependent and Co-evolving Relationship

In an interesting passage of an article, elucidating the relationship between the human being and the Technosphere, John Hartley and Carsten Herrmann-Pillath pointed out:

> In current debates about the Anthropocene, the notion of 'technosphere' has attracted much attention and controversy (…) this term is coined after the precedent of the 'biosphere': The claim is made that in the transition to the new geological age, human action results in, is mediated and enabled by and embodied in the technosphere.[39]

36 Ibid.

37 Ibid., p. 134.

38 Ibid.

39 John Hartley and Carsten Herrmann-Pillath, "Towards a Semiotics of the Technosphere," *SSRN* (December 30, 2018): p. 6. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3308002.

If we carefully read what is said in this passage after the colon, we will find that the authors seem to be claiming four different things. First, that human action *results in* the Technosphere, or that this is a product of our species, especially modern humans. Second, that human action *is mediated by* the Technosphere, that is, it needs the help of its instrumental paraphernalia (tools, devices, apparatuses, etc.) to transcend mere intention and reach the real world. Third, that human action *is enabled by* the Technosphere, which means that it cannot produce effects or exert its power without it. Fourth, that human action *is embodied in* the Technosphere, suggesting that everything we do, but also everything we experience, think and imagine, takes place within the Technosphere.

However, more interesting is the claim these authors make that the Technosphere plays a crucial role in the "transition to the new geological age" of the Anthropocene. They are distinct phenomena and concepts, but maintain a kind of umbilical connection, as if they were epochal twins.

As mentioned in the introduction, the Anthropocene can be understood as a power recently acquired (in geochronological terms) by our species capable of affecting the functioning of the Earth System, causing marks on it, which can be visible and hidden, ephemeral, lasting or even indelible. This power began to become evident after World War II, as a result of the process called the "Great Acceleration,"[40] and effective at the turn of the millennium. It was at that moment that we realized that we had built a technological sphere with a planetary dimension, which opened up the possibility of our species becoming a new geological agent and, thereby, opening a new chapter in the Earth's natural history. Therefore, we can say, that the advent of this Technosphere and the transition to the new geo-historical era of the Anthropocene were coeval.

However, if the Technosphere played, to some extent, an instrumental role or was an efficient causal agent in this transition from the Holocene to the Anthropocene, it seems increasingly clear that both the Technosphere and the Anthropocene appear increasingly in co-dependence and coevolution.

It seems almost impossible today to think about the Anthropocene without the Technosphere and vice versa. They are two sides of the same coin. Also, most likely the duration of one will be as short or as long as the other. The eventual collapse of the Technosphere will imply the end of the Anthropocene, because, without it, we will lose the power to affect the Earth System on a global scale. On the other hand, only with the awareness of the Anthropocene as a power, and with the will to preserve it, will we have sufficient reason to

40 Jan Zalasiewicz et al., "When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal," *Quaternary International,* vol. 383 (2015): pp. 196–203. DOI: 10.1016/j.quaint.2014.11.045.

attempt to transform the Technosphere in order to make it sustainable, as a way to maintain it indefinitely.

It is, perhaps, worth remembering that Dutch chemist Paul Crutzen and the American limnologist Eugene Stoermer, argued in their 2000 joint paper that "(…) to develop a world-wide accepted strategy leading to *sustainability* [emphasis added] of ecosystems against human induced stresses will be one of the great future tasks of mankind".[41]

4 Sustainability of the Technosphere and Anthropocene Risks

Jonathan Donges and several colleagues at the Potsdam Institute for Climate Impact Research in Germany made a relevant critique of Haff's vision of the Technosphere's current evolutionary path. In their understanding:

> Assuming that the technosphere develops according to dynamics largely independently of human intentions, Haff's perspective appears incompatible with a humanistic view that underlies the sustainability discourse at large and, more specifically, current frameworks such as UN sustainable development goals and the safe and just operating space for humanity.[42]

On the other hand, British geologist of Polish origin, Jan Zalasiewicz, Chair of the Anthropocene Working Group of the International Commission on Stratigraphy, since its creation in 2009, said in a short text written for the *The UNESCO Courier* in 2018:

> Currently, the technosphere might be regarded as parasitic on the biosphere, altering conditions of planetary habitability. Obvious consequences include greatly increased (and accelerating) rates of extinction of species of plants and animals, and changes to climate and ocean chemistry that are largely deleterious to existing biological communities. These changes can in turn damage both the functioning of the biosphere and human populations. Ideally, therefore, humans should try to help the technosphere develop into a form that is more sustainable in the long term. Nevertheless, humans collectively have no choice but to keep the

41 Crutzen and Stoermer, "The 'Anthropocene'," p. 18.

42 Jonathan Donges et al., "The Technosphere in Earth System Analysis: A Coevolutionary Perspective," *The Anthropocene Review*, vol. 4, no. 1 (2017): p. 23. DOI: 10.1177/2053019616676608.

> technosphere operative – because it is now indispensable to our collective existence.[43]

Combining the statements made in the last three paragraphs, the challenging task we face in our time becomes evident: how to develop a globally accepted strategy for the long-term sustainability of the Anthropocene Technosphere, while mitigating global catastrophic risks in the evolution of the Earth System and the existential risks facing our species that inhabits it?

4.1 *Fine-Tuning the Meaning of Sustainability*

There are many definitions of "sustainability" and "sustainable development", which can be taken as virtually synonymous concepts. Paul Johnston et al. found in the academic literature more than three hundred definitions[44] and Annie Pearce together with Leslie Walrath collected eighty-three.[45]

More recently, Reinald Döbel outlined a history of the notion, confirming this semantic profusion, but pointing to two things.[46] First, that that the term became known worldwide through its definition in the 1987 Brundtland Commission report *Our Common Future*. Here is the canonical passage: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".[47] Second, that the systemic approach become somewhat prevalent in sustainability studies. For example, Michael Ben-Eli, a recognized expert in this field and the founder of the Sustainability Laboratory, described "sustainability" as

> A dynamic equilibrium in the process of interaction between a population and the carrying capacity of its environment such that the

43 Jan Zalasiewicz, "The Unbearable Burden of the Technosphere," *The UNESCO Courier*, no. 2 (2018): pp. 15–17. Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000261900.

44 Paul Johnston et al., "Reclaiming the definition of sustainability," *Environmental Science and Pollution Research – International*, vol. 14, no. 1 (2007), pp. 60–66. DOI: 10.1065/espr2007.01.375.

45 Annie Pearce and Leslie Walrath, *Definitions of Sustainability from the Literature,* accessed on July 20, 2021, Retrieved from: https://ja.scribd.com/document/187314266/Definitions-of-Sustainability-From-the-Literature-Compiled-by-Annie-Pearce-Leslie-Walrath.

46 Reinald Döbel, "Sustainability – A historical and local perspective," in *Communicative Sustainability. Negotiating the Future from the Periphery*, eds. Thomas Bearth, Rose Marie Beck and Reinald Döbel, Berlin, Münster and Zürich: LIT Verlag, 2014, pp. 35–66.

47 World Commission on Environment and Development, "Chapter 2: Towards Sustainable Development," in *Our common future*, Oxford, New York: Oxford University Press, 1987. Retrieved from: https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

> population develops to express its full potential without producing irreversible, adverse effects on the carrying capacity of the environment upon which it depends.[48]

In this regard, Döbel also emphasized that all definitions of sustainability share the ideal that future human beings must enjoy their lives, at least those of current generations, and that human beings, in the present, must be careful not to destroy the conditions necessary to ensure the possibility of the good life of future generations.[49]

Thus, the problem of the sustainability of the Technosphere means that it must be able to persist, if not indefinitely, for, at least, many generations, and it also means that it must coexist in homeostasis with the Earth's major natural ecosystems. This is why David Griggs et al. claimed that the referred Brundtland's 1987 definition of sustainable development should be redefined to "(…) development that meets the needs of the present while safeguarding Earth's life-support system, on which the welfare of current and future generations depends".[50]

If you don't, not only will the basic needs and aspirations of future generations not be secured, but, more crucially, the survival of Earth's System, its biodiversity and our global civilization will be threatened.

However, I want to argue here that the issue of the sustainability of the Technosphere is strongly linked to, or dependent on, the solution of the management and governance problem of the so-called Anthropocene risks.

4.2 *A New Category of Risk for the Age of the Human*

Despite the existence of a vast literature on risks, there is still no established consensus on what, in fact, should be understood by the concept.

What is perhaps the most widely used definition of risk, almost as a convention, considers it to be an objective property of an event or activity that can be measured as the probability of well-defined adverse events. In this view, risk is the probability of, for example, an event, such as the occurrence of an earthquake, multiplied by its possible consequences (for example, number of victims and of the destruction of buildings it can cause).

48 Michael Ben-Eli, "The cybernetics of sustainability: Definition and underlying principles," in *Enough for all forever: A handbook for learning about sustainability*, eds. Joy Murray et al., Champaign, IL: Common Ground Publishing, 2012, p. 297.

49 Döbel, "Sustainability – A historical and local perspective," p. 36.

50 David Griggs et al., "Sustainable development goals for people and planet," *Nature*, vol. 495, no. 7441 (2013): p. 306.

Robert Kates et al. proposed that risk be defined as "(…) an uncertain consequence of an event or activity with respect to something of human value".[51] This alternative definition of risk was later adopted by the International Risk Governance Council, the independent interdisciplinary organization based at the École Polytechnique Fédérale de Lausanne (EPFL) in Lausanne, Switzerland, dedicated to investigating the management and governance of emerging systemic risks that may have adverse consequences for human health and the environment, the economy and society.[52]

Another proposal, by Eugene Rosa, states that risk should be conceived as "(…) a situation or event where something of human value (including humans themselves) is at stake and where the outcome is uncertain".[53] Seeking to simplify and generalize this definition, it seems, the International Organization for Standardization (ISO) proposed in 2009 (revised in 2018) the concept of risk as "the effect of uncertainty on objectives".[54]

Terje Aven criticized these various proposals: risk as the probability of occurrence of a negative or adverse event/activity, as uncertainty about the occurrence of a positive or beneficial event/activity, as uncertainty about the consequences of an adverse event/activity, and as uncertainty about the achievement of the objectives of an event/activity. According to this Norwegian scholar dedicated to theorizing risk, these proposals, as well as others that are similar, suffer from the same problem of treating the concept of risk one-dimensionally. In his opinion, risk should be defined as the expression of the degree of uncertainty, as well as severity, concerning the consequences of an event/activity, therefore it represents a two-dimensional concept.[55] This means determining the risk of an event/activity based on the lack of information and knowledge about its effects or, alternatively, on how much we don't know about them (uncertainty) *plus* the likelihood of causing damage (severity).

51 Robert Kates, Christoph Hohenemser and Jeanne Kasperson, *Perilous Progress: Managing the Hazards of Technology*, Boulder: Westview Press, 1985, p. 21.

52 International Risk Governance Council, *Risk governance – towards an integrative approach,* white paper no. 1, Geneva: IRGC, Geneva, 2005. Retrieved from: https://irgc.org/wp-content/uploads/2018/09/IRGC_WP_No_1_Risk_Governance__reprinted_version_3.pdf.

53 Eugene Rosa, "Metatheoretical foundations for post-normal risk," *Journal of Risk Research,* vol. 1, no. 1 (1998): p. 28. DOI: 10.1080/136698798377303.

54 "ISO Guide 73:2009(en) – Risk management – Vocabulary," ISO, last modified 2009, https://www.iso.org/obp/ui/#iso:std:iso:guide:73:ed-1:v1:en.

55 Terje Aven, "On the new ISO guide on risk management terminology," *Reliability Engineering and System Safety*, vol. 96, no. 7 (2011): p. 720. DOI: 10.1016/j.ress.2010.12.020.

The notion of "Anthropocene risk" is subsidiary to this more general definition of risk. It was Victor Galaz, currently deputy-director of the Stockholm Resilience Centre, who first employed it in a *The Guardian* op-ed piece.[56] However, its formulation in a scientific context only occurred later in an article by Patrick Keys et al. (including Galaz).[57]

What seems to differentiate this new category of risks is that they are complex and systemic. When referring to a system, a risk is complex if the number of variables that compose it makes it difficult, or even impossible to predict with a minimum of consistency or efficiency. Also referred to a system, a risk is systemic if it involves the probability that a part or component of that system negatively affects other parts of, or, the entire system.

This last attribute is of particular help in distinguishing the notion of Anthropocene risk. According to these authors, this kind of risk is related to the degree of uncertainty about the severity of the damages being inflicted to the Earth System by anthropogenic activity, interpenetration of social and ecological systems, and interrelationship of spatial and temporal scales. These three classes of Anthropocene risk are part of the basic taxonomy of this new kind of risk presented by Keys et al. Before reviewing it briefly, it may be helpful to return to a useful distinction made by Billie Turner et al., more than thirty years, between systemic change and cumulative change.[58]

In the context of the Anthropocene, we are obviously considering global changes not naturally caused but man-induced or, if you prefer, changes caused by human action at the level of the Earth System. According to Turner et al. these changes can be systemic and/or cumulative. Both affect the Earth System as a whole, but in different ways. The first takes place more or less directly. Climate change caused by the emission of greenhouse gases into the atmosphere as a result of human activities is perhaps the best known example. Another would be the terrestrial albedo, that is, the proportion of solar radiation that is reflected by the Earth, which has undergone changes caused in the surface of the planet such as land use or by extensive melting of sea ice in the Arctic. The second, cumulative changes, are those that occur locally and regionally, but which end up having a wide and dense distribution around the

56 Victor Galaz, "Anthropocene Risks: Social scientists need to step up to the challenge," *The Guardian*, November 12, 2014, https://www.theguardian.com/science/political-science/2014/nov/12/anthropocene-risks-social-scientists-need-to-step-up-to-the-challenge.

57 Patrick Keys et al., "Anthropocene risk," *Nature Sustainability*, vol. 2 (2019): pp. 667–673. DOI: 10.1038/s41893-019-0327-x.

58 Billie Turner et al., "Two types of global environmental change. Definitional and spatial-scale issues in their human dimensions," *Global Environmental Change*, vol. 1, no. 1 (1990): pp. 14–22. DOI: 10.1016/0959-3780(90)90004-S.

world, that is, they consist of very intense changes in a few regions, but capable of generating a problem on a global scale, including putting natural resources at risk on a global scale. A notorious example is the pollution and depletion of water resources. Another is deforestation.

The notion of Anthropocene risk proposed by Keys et al. encompasses both the systemic and the cumulative. The case studies they describe in their article clearly show this and the existence of a reciprocal and interdependent relationship of influence between the Technosphere and the other geological spheres, namely the Biosphere, where it seems clearer and growing.

The first case has to do with the phenomenon of so-called moisture recycling teleconnections.[59] In the field of atmospheric sciences, the term "teleconnections" is used to refer to climatic anomalies related to each other over great distances. According to Keys et al., millions of farms in the Indian subcontinent depend on groundwater irrigation. However, from the 1990s onwards, they succumbed to the temptation to increase agricultural production, using more pumps to extract water from the ground, alongside a policy that subsidized their fuel. It turns out that, with rising energy prices and the rapid depletion of groundwater, they became alarmed that these agricultural systems were likely to collapse and began looking for technological innovation to make them more sustainable. This had an impact on the local and regional hydrological cycle, mainly influencing evaporation into the atmosphere. Yet, it has also begun to affect moisture flow to other specific parts of the planet. In particular, the authors recall, irrigation in India significantly conditions rainfall in East Africa. This means that the socio-ecological systems that are producing food in India are tele-connected to the dry farming systems in East Africa and therefore can have an impact on them. The situation they are currently facing involves the following dilemma: if communities in India make their agricultural practices more sustainable, it could negatively affect an important part of livestock and agriculture in Africa. There is a clear systemic risk here.

A second case presented in Keys et al. is aquaculture in Southeast Asia.[60] It has an enormous weight in the economy of the region and, according to the authors, represents almost 90% of world aquaculture production. In addition, it is estimated that currently around 50% of all fish consumption in the world comes from aquaculture. This technology for the reproduction and cultivation of aquatic organisms (fish, mollusks, algae, crustaceans, etc.) under controlled conditions is highly dependent on the existence of land cultures, wild fish for food, fresh water and land for their production sites. However, its enormous

59 Keys et al., "Anthropocene risk," p. 669.
60 Ibid., pp. 669–670.

expansion and the strong environmental impacts it has had, has led to devastation of coastal vegetation, mainly mangroves, and the weakening or even disappearance of their livelihoods. This recent decline in aquaculture carries risks not only of causing local disturbances, but also of having impacts on a national, regional or even global level. Aquaculture, to pick just one of the problems it faces, by displacing native aquatic ecosystems, creates less resilient socio-systems in its place and paves the way for species cultivated in them to become incubators of diseases that can spread to other cultivated species and cause antimicrobial resistance, ultimately challenging human health.

The migration of the Sahel biome due to climate change is a third case considered.[61] Climate change, note Keys et al., is affecting the global distribution of biomes, which are roughly ecosystems, habitats or biological communities with a certain level of homogeneity. Temperature variations, in particular, determine what types of plants and distributions of ecological communities can grow in different parts of the world. If the planet warms up, biomes tend to migrate to cooler regions. In the Sahel region,[62] global warming is likely to cause longer periods of drought and warmer temperatures. This situation is likely to have social and political implications at other scales, as people may migrate from this region to ones that are already densely populated, increasing pressure on their socio-ecological systems.

The last case concerns sea level rise and its impact on coastal cities. Keys et al. consider it a paradigm of situations that involve increased Anthropocene risk, although it continues, according to them, without the attention it should have. Due primarily to the thermal expansion of ocean waters in combination with the release of fresh water from the Greenland and Antarctic ice caps, both caused by climate change, a tenth of humanity living in coastal maritime areas is at risk of losing their homes and communities. Furthermore, a similar threat looms over most of the world's current megacities that are at risk of disappearing underwater in the not-too-distant future. Despite the coastal defenses erected by maritime coastal cities, projections suggest that most of their populations will have to migrate inland.

These four cases are good examples of how the functioning of the Earth System, or critical parts of it, is being affected by anthropogenic activity (technologically based and mediated), by the interpenetration of social and

61 Ibid., pp. 670–671.

62 The Sahel forms a transition zone spanning 5,900 km from the Atlantic Ocean in the west to the Red Sea in the East in a belt ranging from several hundred to a thousand kilometers in width, covering an area of about 3 million square kilometers that includes Algeria, Burkina Faso, Chad, Eritrea, Mali, Mauritania, Niger, Nigeria, Senegal, and Sudan.

ecological systems (and socio-technical forces), at different spatial scales (local/regional/global) and temporal scales (short, medium and long term) that influence each other. Furthermore, they illustrate equally well how these three factors work together (and not disjunctively) to generate complex and systemic risks, that is, Anthropocene risks. Finally, they also show how these Anthropocene risks are connected with global catastrophic risks and with existential risks.

An event/activity "(…) that might have the potential to inflict serious damage to human well-being on a global scale" is, according to Nick Bostrom and Milan Ćirković's definition a "global catastrophic risk".[63] Therefore, it seems that, according to these authors, global catastrophic risks differ from Anthropocene risks in that they do not necessarily have anthropogenic causes, but share with them the properties of being relatively complex and systemic.

Bostrom and Ćirković rank the severity of these risks according to their scope (how many people and other morally relevant beings would be affected, at what spatial and temporal scales), intensity (how severely they will harm those affected by them), and probability (what is the likelihood of its occurrence, according to our best judgment given the evidence currently available).[64] Consequently, an event/activity with global catastrophic risk is, at the risk of redundancy, global or transgenerational in scope and endurable or terminal in intensity, and supposedly increasingly likely to occur.

The so-called "existential risk" represents a subset of the global catastrophic risk type. Bostrom and Ćirković argue that an event/activity "(…) that threatens to cause the extinction of Earth-originating intelligent life or to reduce its quality of life (compared to what would otherwise have been possible) permanently and drastically" should be considered an existential risk.[65] What is especially worrying about this type of risk is its irreversibility, which means that we should avoid taking them, as we will not have the opportunity to learn from them.

This is, therefore, one of the greatest challenges of our time: finding effective and efficient ways to make the Anthropocene Technosphere we inhabit remain sustainable and not make us run global catastrophic risks or, worse, a very dangerous existential risk. Tackling it successfully will involve finding a global governance solution for the present and future of the Technosphere that is especially capable of controlling its dynamics, regulating its balanced interaction with other natural geological spheres, particularly the biosphere,

63 Nick Bostrom and Milan Ćirković, eds., *Global Catastrophic Risks*, Oxford: Oxford University Press, 2008, p. 1.
64 Ibid., p. 3.
65 Ibid., p. 4.

recycling the entire production in its socio-ecological systems and avoiding the generation of negative climatic and eco-environmental externalities.

5 Recycling a Forward-Looking Idea: the Sustainability Geoscope

Peter Haff, as we saw above, argued that the Anthropocene Technosphere presents two problems that deserve special attention, as they largely determine how (un)sustainable it will be in the future: its recycling deficit and its growing tendency to increase its autonomy. In relation to the latter, it means, in other terms, the loss of its control by man and the shrinking of the sphere of human freedom. Both problems therefore require the contribution of solutions that involve so-called "green technologies", or more eco-friendly ones, but also those that incorporate circular economic processes as well as the more controversial Smart Earth technologies,[66] Geoengineering,[67] and Earth System Interventions.[68] On the other hand, both problems also require, as I suggested, the global and supranational governance of their functioning, evolution and risk management.

However, in both cases, it will be necessary to have reliable scientific information and knowledge on an unprecedented scale. This will require instrumentation capable not only of monitoring the Earth's vital signs, so to speak, but at the same time the "burden" of the Technosphere on the planet's biogeophysical systems. These instruments for "observing" the Earth in order to control its sustainability will certainly generate huge amounts of data, big data, which will then have to be converted into information (data expunged from noise) and this, then, into knowledge (interpreted and usable information for explanation and prediction purposes). Such instrumentation does not yet exist or does not exist in the desired and necessary global extension or integration.

Notably, a group of German scientists asserted their need two decades ago and proposed, at that time, the creation of what they dubbed "Sustainability Geoscope". The project has never seen the light of day, but, perhaps, we should

66 See, for example, Karen Bakker and Max Ritts, "Smart Earth: A meta-review and implications for environmental governance," *Global Environmental Change*, vol. 52 (2018): pp. 201–211. DOI: 10.1016/j.gloenvcha.2018.07.011.

67 See, for example, Holly Buck, *After Geoengineering: Climate Tragedy, Repair, and Restoration*, London: Verso, 2019.

68 See, for example, Jesse Reynolds, "Earth system interventions as technologies of the Anthropocene," *Environmental Innovation and Societal Transitions*, vol. 40 (2021): pp. 132–146. DOI: 10.1016/j.eist.2021.06.010.

re-evaluate its potential to help solve the problem of the sustainability of the Technosphere. It was presented and discussed at the international workshop held on the 25 and 26 October 2001 in Berlin, promoted by the Nationales Komitee für Global Change Forschung of Germany (German National Committee for Research on Global Change) together with the Potsdam-Institut für Klimafolgenforschung (Potsdam Institute for Climate Impact Research). We can envision it as a step towards creating a meaningful tool to help achieve the global governance goal of a more viable Anthropocene Technosphere.

In the opening part of the report, written after the scientific meeting by the agricultural economist Hermann Lotze-Campen, we can read that it was organized with the objective of "(…) introducing the idea of a Geoscope to the international global change community and preparing the ground for interdisciplinary research efforts for sustainability transitions."[69]

Wolfgang Lucht, a physicist turned geoecologist and sustainability scientist, and Carlo Jaeger, an economist working on global systems, both participants at the meeting, said in an article they wrote together about their vision of the project that human influence today affects almost all components of the global environment, while remaining fundamentally dependent on that environment. The currently emerging state of the planet, where there are no longer distant places to refer to as "fully natural", has been called the Anthropocene. It is characterized by the fact that the human and the natural systems are inseparably intertwined in one earth system, in what may be called an emerging post-natural state.[70]

They said those words in 2001, not long after Crutzen and Stoermer introduced the concept of the Anthropocene. It is surprising how they conceptualize a notion that is just beginning to be used. They define the Anthropocene as the state "where there are no longer distant places to refer to as 'fully natural'" and where "the human and the natural systems are inseparably intertwined in one earth system", or, in other words, of the emergence of a "post-natural state", a euphemism for the Technosphere.

69 Hermann Lotze-Campen, *A Sustainability Geoscope – Observing, Understanding and Managing the Sustainability Transition,* Berlin: International workshop sponsored by the German National Committee on Global Change Research and the Potsdam Institute for Climate Impact Research – PIK, 2001, https://www.pik-potsdam.de/members/hlotze/geoscope_report_international_berlin_oct01.pdf.

70 Wolfgang Lucht and Carlo Jaeger, "The Sustainability Geoscope: a proposal for a global observation instrument for the Anthropocene," in *Contributions to Global Change Research: A Report by the German National Committee on Global Change Research*, eds. D. Heinen, S. Hoch, T. Krafft, C. Moss, P. Scheidt and A. Welschhoff, Bonn: Nationales Komitee für Global-Change-Forschung, 2001, p. 139.

In line with the other participants at the Berlin meeting, they proposed the need to promote the establishment of an observational instrument for the Anthropocene. In their own words, the Sustainability Geoscope would have been an instrument for observing the emerging Anthropocene and the sustainability transition. An instrument they also claimed "(…) suitable for self-reflective change (…)",[71] that is, for an Anthropocene in which we become more aware of the impacts of human action on the planet.

According to them, the Geoscope must provide "(…) data and understanding suited for deciding upon action, and hence bridging the gap between science, politics, and management".[72] It should also be built "(…) step-by-step (…) [as a] global information system requires gradual implementation".[73] Finally, its construction "(…) is to be based upon the principle of iterative invention and reinvention a process of learning by doing", i.e., "[t]he reflexive aspect of this process is an essential constituent of the instrument".[74]

They estimated that the time for its construction would be around 20 years. Its entry into full operation would, therefore, coincide with the moment in which we found ourselves. The construction of such an instrument, however, never began; it never ceased to be a mere idea on paper. This, even so, does not mean that these scientists weren't great visionaries, nor that our need for this instrument has diminished, on the contrary, its construction has become more urgent today. These authors say in the penultimate paragraph of their article:

> The Sustainability Geoscope, we propose, will be an instrument that is suited to and required for meeting the challenges of the 21st century. It has the potential to (…) support us in achieving the sustainability transition that is needed. It is not to be an instrument merely of the natural or of the socioeconomic sciences, but rather it is to keep in view the whole of the human situation.[75]

6 Conclusion

The German economist and philosopher of economics Carsten Herrmann-Pillath has affirmed the importance, perhaps the need to raise "(…) research

71 Ibid., p. 140.
72 Ibid.
73 Ibid.
74 Ibid.
75 Lucht and Jaeger, "The Sustainability Geoscope: a proposal for a global observation instrument for the Anthropocene," p. 143.

into the technosphere to the status of an independent scientific discipline (…)". According to him, this would correspond to a "Copernican turn" in the study of the Anthropocene.[76] In this regard, he even invokes *The Sciences of the Artificial* by the American polymath Herbert Alexander Simon, as the most emblematic and pioneering work of his vision.

Like Peter Haff (see section 2.2 above), he intends, in this way, to neutralize "(…) the implicit anthropocentrism of the notion of 'Anthropocene' (…)."[77] In other words, he seeks to study the Technosphere, the sphere of technology, in itself, "(…) in which man play a role, but not necessarily the central role."[78] This is quite relevant because, if we think by analogy with the study of biology, as Hermann-Pillath suggests, in the context of ecosystems massively shaped by human intervention, "life" is not defined as a phenomenon that has become "human", but that, if this play on words was allowed, has a life of its own.[79]

This Technosphere Science, of course, draws on many disciplines, ranging from engineering to economics, social sciences, or biology.[80]

The analytical exercise carried out in this chapter sought to approximate this approach, focusing on the Technosphere-Anthropocene-Risks entanglement. I argued, on the one hand, that the growing autonomy of the Technosphere in relation to its human creators, that is, its apparent development according to an internal, necessary logic incompatible with human interests and purposes, only became evident in the last quarter of century. This, I have also argued, means that the Anthropocene Technosphere tends to be more uncontrollable and ungovernable and, ultimately, that this situation leads us to face increasing global catastrophic and existential risks.

This growing mismatch that is being observed between the Technosphere, the other geological spheres and Humanity has become a sustainability issue for all three. For hundreds or even thousands of years, we, as a species, have transgressed Nature, its cycles, rhythms, patterns. The Technosphere is the most remarkable result of this long process. However, if we do not quickly find ways to harmonize its functioning with that of other geological spheres and, if we do not readjust to Nature, we will probably succumb. That's the challenge we face now: re-entering the natural adaptive processes we've begun to drift away from.

76 Carsten Herrmann-Pillath, "The Case for a New Discipline: Technosphere Science," *Ecological Economics*, vol. 149 (2018): p. 213. DOI: 10.1016/j.ecolecon.2018.03.024.
77 Ibid.
78 Ibid.
79 Ibid.
80 Ibid.

As I suggested in section 5, a step that can, and probably should, be taken towards this goal of the global governance of the Anthropocene Technosphere, to ensure its viability, involves returning (with a delay of more than two decades) to the idea of building a powerful "Geoscope of Sustainability", a tool that will help to monitor, in real time, or near, the working state of the Earth System, including anthropogenic interference and impact on it.

I can therefore say that we face today the urgent political and moral challenge of making the sustainability of the Anthropocene Technosphere less risky for current and future generations. The critical examination carried out in this chapter sought to be a contribution to initiate a broader and deeper reflection on this matter.

Note on the Text

The content of part 2 of this chapter corresponds to a good extent to the first part of my paper "Does the Sustainability of the Anthropocene Technosphere Imply an Existential Risk for Our Species? Thinking with Peter Haff," *Social Sciences,* vol. 10, no. 8 (2021): pp. 1–14. DOI: 10.3390/socsci10080314.

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