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Has Climate Change Ended Nature?

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In his 1989 book *The End of Nature*, Bill McKibben claims that, because of large-scale climate change produced by human technologies, no place on Earth can be considered natural anymore. In 2000, at a conference in Cuernavaca, Mexico, Paul J. Crutzen proclaimed that we live in the Anthropocene, a new phase in the history of the planet in which humankind has imposed itself as a decisive influence on the global ecology, interfering with its fundamental systems. Is nature truly over? And, if so, are we left with nothing more to do than mourning its end? In this chapter, I reconstruct how humans have allegedly ended nature (Section 1); hence I analyse two different possible readings of the 'end of nature' claim, namely the ontological and the epistemological readings, showing that the first one is either false or unfounded, while the second one is possibly true (Section 2). Finally, I show how the analysis previously conducted can help in better focusing the (ontological) target of our conservation actions and the (epistemological) tools at our disposal (Section 3).

1. How Humans Are Supposed to Have Ended Nature

The view that human activities may have an impact on climate is not a novelty. The German naturalist and explorer Alexander von Humboldt (1769–1859) was probably the first person to theorise the existence of a link between human activities and climate, pointing out three ways in which the firsts affect the second: deforestation, reckless irrigation and the 'great masses of steam and gas' produced by industrial centres (Wulf 2015, 326). The American scientist Eunice Foote (1818–1888) was, by comparison, the first person who tested experimentally the hypothesis that atmospheric gases affect Earth's temperature, or what we call today 'the greenhouse effect'. In

her 1856 article, 'Circumstances affecting the heat of the sun's rays', Foote related changes in the types and quantities of atmospheric gases – including carbon dioxide (CO_2) – to earth's temperature, concluding that 'an atmosphere of that gas [CO_2] would give our earth a high temperature' (Foote 1856, 383).

The phenomena underlined by Humboldt were destined to escalate together with the greenhouse effect tested by Foot. The main reasons for this were the massive increase of human population, on the one hand, and energy consumption and related anthropogenic emissions of greenhouse gases on the other hand.

Starting with population growth, around 1800 there were just one billion human beings on Earth, and it had taken many thousands of years to reach that number. By 1930, the human population had doubled. Then, in the span of one human lifetime, the global population tripled from 2.3 billion in 1945 to 7.2 billion in 2015. Concerning energy, in the late eighteenth century, humankind shifted from an organic energy regime, based on human and animal force for power, and wood and biomasses for heat, to a fossil-based energy regime. According to John McNeill and Peter Engelke (2014, 9), coal became the world's primary fuel at the end of the nineteenth century, and then oil took up the position in the mid-1960s. At the same time, energy use increased: by 1870, human beings were using more fossil fuel energy each year than the annual global production from all photosynthesis; today they use about 32 billion barrels of oil each year: 'the burgeoning rate of energy use in modern history makes our time wildly different from anything in the human past' (McNeill and Engelke 2014, 10). Burning fossil fuels and deforestation are the two main ways through which humans add carbon to the atmosphere: as of 7 June 2021, the Research News Webpage of the United States National Oceanic & Atmospheric Administration (NOOA), announced that the atmospheric carbon dioxide measured at NOAA's Mauna Loa Atmospheric Baseline Observatory reached a monthly average of 419 parts per million (ppm) – compared with the 280 ppm pre-industrial baseline (McNeill and Engelke 2014, 64); this is the highest level registered since accurate measurements began.

At first, the increasing human impact on the biosphere was gradual, but since the mid-twentieth century, the so-called 'Great Acceleration' began (McNeill and Engelke 2014; Steffen et al. 2015). The human impact escalated fast, and human actions began to interfere significantly with crucial biogeochemical cycles (the interconnected processes through which the elemental components of organic matter are cycled through the biosphere, such as the carbon, sulphur, nitrogen and water cycles), affecting their capacity for self-

adjustment and hence altering global climate. Humans can hence be compared, according to some, to a 'great force of nature' (Ellis 2018, 2) that is reshaping the planet, putting an end to the relatively stable conditions that characterized the Holocene – the post-glacial geological epoch that started approximately 11,000 years ago.

The magnitude and the pervasiveness of the phenomena described above have led some authors to decree the end of nature by the hand of humans. In particular, the American environmentalist and journalist Bill McKibben – in an early popular book about climate change, entitled *The End of Nature* (1989) – denounced the anthropogenic changes to nature that were affecting the entire planet, to the point that 'we are at the end of nature' (McKibben 1989; rev. ed. 2003, 7). What makes the difference, according to him, is that even though human activities like deforestation and pollution have had an impact on the environment for a long time, they used to occur on a local scale (they altered the places in which they occurred but not those in which they did not), while climate change is a global phenomenon that involves the entire planet, including places not inhabited by human beings.

> Short of widescale nuclear war, global warming represents the largest imaginable such alteration: by changing the very temperature of the planet, we inexorably affect its flora, its fauna, its rainfall and evaporation, the decomposition of its soils. Every inch of the planet is different; indeed, the physics of climate means the most extreme changes are going on at the north and south poles, farthest from human beings (McKibben 1989; rev. ed. 2003, xv).

In 2000, at a conference in Cuernavaca, Mexico, Nobel-prize winning atmospheric chemist Paul J. Crutzen stood up in frustration towards his colleagues still referring to our epoch as the Holocene, exclaiming, 'We are in the Anthropocene!' (Ellis 2018, 1). As illustrated in a brief note published the same year in the 'Global Change News Letter' (Crutzen and Stoermer 2000), during the Holocene human activities 'gradually grew into a significant geological, morphological force'. The global effect of these human activities had become evident in the latter part of the eighteenth century, the conventional starting date of the Anthropocene. And, unless major catastrophes occur, humankind seems destined, according to Crutzen and Stoermer, to remain a major geological force for millennia, maybe millions of years. (Note, however, that the Anthropocene has not yet been formally recognized by geologists and that several criticisms have been raised against the idea – see, for instance, Santana 2019).

If we take seriously the claim that anthropogenic climate change has ended nature, then – as political scientist Steven Vogel argues in *Thinking like a Mall: Environmental Philosophy after the End of Nature* (2015) – we would be left with nothing more to do than mourn nature's end, because, once destroyed, nature cannot be restored. In fact, to restore nature, human intervention would be required, but – by definition – human productions are artifacts, and a newly planted forest, for instance, would be an artifact as well. Accordingly, and paradoxically, restoring nature would result in increasing the number of artifacts on the planet (Katz 1992). The end of nature challenges traditional environmentalism, focused mainly on nature conservation and ecology, studying the workings of intact ecosystems rather than ways to manage them (Editorial 2008). However, such a challenge can be constructive, making us rethink nature and the place of our species in it, and hence helping to better focus our conservation targets and our epistemological tools, bringing to light new possible paths for action.

2. Two Ways of Understanding the Alleged End of Nature

Does the advent of the age of humans mean the end of nature? Is nature *actually* over? The first step in answering these questions is to clarify what 'nature', and hence its end, means. The claim that nature has ended can be understood in both an ontological and epistemological way. While ontology has to do with the world, its entities and processes, epistemology has to do with our knowledge and especially our justified beliefs about the world, its entities and processes.

The ontological reading of the end of nature suggests that once there was something that we called 'nature', and that it does not exist anymore because of our activities, especially anthropogenic climate change. But what was it, that *something*? Limiting our analysis to the western use of the word, there are two main possibilities. The first one is that *nature* is what is opposed to the *supernatural*. According to Aristotle (384–322 BC), who first defined 'nature' (Owens 1968; Lammer 2016), the technical, philosophical meaning of the term has to be limited to things that change. More precisely, 'natural' things have an inner principle of change and being at rest, namely all the – living and not living – things of the visible and tangible universe, as opposed to abstract things, like theorems and numbers, and the unmoved motor. In this sense, since artifacts are not supernatural things, they seem to belong to the ontological domain of natural entities (however – as we are going to see – they do not possess the principle of change in themselves). Similarly, John Stuart Mill (1865–1868) defined 'nature' in its technical meaning, as 'the sum of all phenomena, together with the causes which produce them' (Mill 1874; 2009, 66); in other words, the sum of the phenomena and their causes that inhabit the non-supernatural world.

If we endorse such a scientific understanding of 'nature', Ellis's claim – that humans have become a great force of nature that is reshaping the planet – makes perfect sense. Around 2.4 billion years ago, in the so-called 'Great Oxidation Event', cyanobacteria started changing Earth's atmosphere from a mainly CO_2-based one to an oxygen-based one, reshaping the earth and causing the extinction of organisms unsuited to the new atmosphere, allowing the evolution of life as we know it today. Under the Aristotelian-Millian technical understanding of 'nature', the fact that human beings are changing Earth's atmosphere would be a perfectly natural event – just like the Great Oxidation. While fully coherent from a scientific point of view, it is evident that such an understanding does not leave, at least *prima facie*, much room for manoeuvre: human beings and their activities are as natural as every other non-supernatural entity and process; the claim that anthropogenic climate change has ended nature is simply false; and if we want nature to run its course, we should just let it be. I argue below that this 'let it be' attitude does not necessarily follow from the technical meaning of 'nature'.

Both Aristotle and Mill recognize a second meaning of 'nature', however. Aristotle contrasts natural entities with those entities that are not supernatural, but that do not have in themselves the principle of change, namely artifacts. While a horse embryo has the principle of change, for instance – i.e., the active principle that allows the embryo to become an adult organism – a statue does not: a certain portion of matter becomes a statue only by virtue of a human maker. Mill also introduces a distinction between natural and hand-made entities, recognizing that the technical definition of 'nature' conflicts with 'the common form of speech by which Nature is opposed to Art, and natural to artificial':

> For in the sense of the word Nature which has just been defined, and which is the true scientific sense, Art is as much Nature as anything else; and everything which is artificial is natural … Art is but the employment of the powers of Nature for an end. Phenomena produced by human agency, no less than those which as far as we are concerned are spontaneous, depend of the properties of the elementary forces, or of the elementary substances and their compounds. The united powers of the whole human race could not create a new property of matter (Mill 1874; 2009, 67).

Hence, for Mill, a non-scientific, non-technical sense of 'nature' must be recognized that opposes natural entities and phenomena to other entities and phenomena that take place by virtue of human agency. If everything that takes place by virtue of the – intentional or unintentional – activity of humans is considered artificial, then it is true that, because of climate change, no

nature remains, because no place on Earth remains untouched by human-caused global warming.

What is in play in the ontological reading of the claim that nature has ended is the ontological status of human beings: either human beings are natural entities, together with the products of their activities (as in the first meaning of nature), or they are separate from nature (as in the second meaning of nature). The roots of the alleged divide between human beings and nature can be traced back once again to Aristotle. Humans, for Aristotle, enjoy a sort of twofold status (Owens 1968). On the one hand, being composed of matter (the body) and form (the soul), they belong to the domain of natural entities. However, one part of the human soul, the intellect, is twofold, consisting of passive intellect, which is perishable, and active intellect, which is separate and imperishable. Just like the unmoved motor, the active intellect does not change. The presence of the active intellect calls into question the belonging of human beings to the domain of perishable, changing things, namely natural entities. Despite the serious interpretive difficulties Aristotelian psychological theory has engendered (Shields 2020), the idea that human beings enjoy a peculiar status compared to 'mere' natural entities – either by virtue of a special relationship with some supernatural beings (think of religious narratives like the Hebrew Genesis), or of their minds (think of the Cartesian *res cogitans*, which distinguishes human beings from other animals) – is part of the culture of our species. However, on the basis of Charles Darwin's theory of evolution by natural selection, humans' peculiar ontological status can be questioned. Indeed, the Darwinian theory allows to explain the presence of human beings on Earth together with their mind without invoking a supernatural Creator. Both are the product of million years of natural selection conserving random adaptive mutations and discharging non-adaptive ones. From the point of view of evolutionary biology, we are natural entities just like the cyanobacteria, just different branches of the same tree stemming from a common root.

Two objections can be raised to the claim that human beings do not enjoy any peculiar status compared to 'mere' natural entities, and while the first one misses the target, I argue that the second one can help in finding our way out of the nihilistic outcome that the alleged end of nature seems to engender.

The first objection is that it is possible to find a biologically sound foundation of the difference between humans' and other organisms' *activities*. According to American philosopher Eric Katz, humans are natural entities, but their activities can be both natural and unnatural. They are unnatural when they go 'beyond our biological and evolutionary capacities' (Katz 1995, 95). For instance, 'natural' childbirth is a human activity, yet it can be considered 'natural' because it lies within the scope of humans' biological make-up. On

the contrary, medicalized childbirth should be considered unnatural because it manipulates a natural biological process (Katz 1995, 95). While *prima facie* appealing, this way of distinguishing natural from unnatural human activities faces two limits. First, where to trace the boundary? If a mother learns a position that helps her in giving birth, would her childbirth be unnatural? We would probably answer negatively, but we would probably answer in the positive if the mother were given an epidural. Yet, both the new position and the epidural are the product of human beings learning something – of human culture, so to speak – and hence, why should we distinguish the first from the second? And here comes the second limit: any way of tracing the boundary seems to presuppose a distinction between the products of culture and the products of nature. But why should human culture and the products of it not be within the scope of human biology, the result of human evolution and, hence, perfectly within our evolutionary capacity? Just as a beaver has evolved its capability of building dams, we have evolved ours. To put it in another way, how could we do something which is not within our evolutionary capacity? Unless we are supernatural beings, the only possible answer is that we cannot. In Elliott Sober words, 'If we are part of nature, then everything we do is part of nature' (Sober 1986, 180, emphasis in the original).

The second objection is that, unlike cyanobacteria, we have developed the capability of self-reflection and choice. Like cyanobacteria, humans and human activities are perfectly natural but, while cyanobacteria could not help but emit oxygen, we can *decide* to do something to limit CO_2 emissions. We can decide not to end nature. Provided, of course, that nature has not yet ended. But, as we have seen, in the scientific understanding of 'nature', this claim is false; while in the 'common form of speech' pointed out by Mill, it is unfounded.

It is our – evolved – capability of self-reflection and choice that grants that the 'let it be' attitude mentioned before does not follow necessarily from the first meaning of 'nature'. The fact that human beings and their activities are natural entities and processes does not necessarily imply that humans cannot change the course of their actions. On the contrary, recognising that climate change is anthropogenic means recognising who is factually responsible and who has the means to act to counteract that change. We shall return to this idea in the last Section of the chapter; first, the other possible – epistemological – meaning of the claim that nature has ended has to be clarified.

The epistemological reading of the claim that nature has ended because of anthropogenic climate change is that our beliefs about nature have come to an end because they no longer reflect what nature has become.

> When I say 'nature,' I mean a certain set of human ideas about the world and our place in it. But the death of those ideas begins with concrete changes in the reality around us – changes that scientists can measure and enumerate. More and more frequently, these changes will clash with our perceptions, until, finally, our sense of nature as eternal and separate is washed away, and we will see all too clearly what we have done' (McKibben 1989; rev. ed. 2003, 7).

What is that 'set of human ideas' about which McKibben is writing? According to him (1989; rev. ed. 2003, 61), 'our view' is that nature is separate and independent from human beings: 'Nature's independence *is* its meaning; without it there is nothing but us'. In other words, our view is that nature is wilderness, namely 'pristine places, places substantially *unaltered* by man' (McKibben 1989; rev. ed. 2003, 56, emphasis in the original). This is the view of nature that anthropogenic climate change ended.

Wilderness was defined in the 1964 US Wilderness Act (1964) as follows,

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.

According to the Act, to fall under the definition of wilderness, an area must satisfy the following criteria: bearing unnoticeable human imprint; offering 'outstanding opportunities for solitude or a primitive and unconfined type of recreation'; being at least 5,000 acres of land; and containing 'ecological, geological, or other features of scientific, educational, scenic, or historical value' (Wilderness Act 1964).

Several serious criticisms have been raised against the idea of wilderness (Callicott and Nelson 2008; Merchant 2003). Here I shall briefly present one of them, namely that the idea of wilderness is a myth (Sarkar 2005).

By myth, philosopher of science Sahotra Sarkar (2005, 28) means 'a general story with normative implications, parts of which are known to be false, or at least implausible, but which is nevertheless useful in analysing other, more veridical stories that share some crucial aspects with it'. In the case of wilderness, the lack of veridicality of the narrative lies in the claim that the places designated as wilderness by the Wilderness Act, or the places that we

perceive today as wilderness, have not been occupied by humans – they are pristine. These claims are generally false. To give just one paradigmatic example, when European colonisation began, tens of millions of people were living in North and Central America, with a long history of interaction with the land. Then, mainly because of European-originated diseases, up to 90% of the Indigenous population died: 'Arguably it was only because of this massive depopulation that it even became possible to view the North American continent as a pure wilderness: the land seemed unpopulated by humans simply because they had died' (Vogel 2015, 5). For colonists, the 'wilderness condition' of North America was a negative one, to be eradicated and replaced by neat and tidy farms and cities. Its human inhabitants, the savages, also had to be domesticated and civilised (Standing Bear 1933). When Yosemite in 1864 and then Yellowstone in 1872 were declared national parks, Indigenous people were excluded from them and their land was proclaimed 'to have been unoccupied by humans from the beginning of time' (Sarkar 2005, 40). Today, wilderness is generally loaded with a positive connotation that reflects the needs and desires of the new inhabitants, such as the need for 'solitude or a primitive and unconfined type of recreation' mentioned in the Wilderness Act (1964).

In the introduction to their book on the wilderness debate, environmental philosophers J. Baird Callicott and Michael P. Nelson (2008) explain how the wilderness idea has been accused of being 'a conversation of the West', that is the 'Americanized Western civilization', or the Euro-American one, which is true. However, I would add that a further difference should be considered when speaking of human beliefs concerning nature. As a matter of fact, even limiting our reflections to the present western world, the European view of nature might be quite different from the American one, especially because in Europe nature has been anthropised for much longer than in America. If we look, for instance, at European conservation policies, we can realise that wilderness in Europe started receiving attention only in the 1990s and that an agreement for a common understanding and interpretation of what 'wilderness' means in the European context was only created in 2012, according to the European Wilderness Society website. (For a review of the meaning of 'nature' in European languages, see Ducarme and Couvet 2020).

If the view of nature ended by climate change is a myth rather than an epistemologically well-founded belief, then claiming that climate change ended the idea/myth of wilderness would just imply the end of an unfounded belief. Recognising this fact may turn the epistemological 'end of nature' into an incentive to proceed towards both a better, unbiased knowledge of nature itself and a better understanding of the relation between human beings and the rest of nature.

Let us now sum up the results of the analysis so far. Our starting question was whether anthropogenic climate change had ended nature, as has been claimed. We distinguished two ways of understanding this claim, an ontological one and an epistemological one. Under the ontological reading, the claim is either false or unfounded. Under the epistemological reading, it is true and possibly beneficial. This is good news. From an ontological point of view, nature has not ended – hence, there is more to do than just mourning its end. From an epistemological point of view, some of our beliefs about nature have been proven to be false – hence, we are in the position of replacing them with better ones and rethinking our relationship with other natural entities.

3. Nature Has Not Ended, Action Is Needed

That nature has not ended means that we still have time to act. The ontological and epistemological analysis previously conducted may now help in better focusing the target of our conservation actions and the tools at our disposal.

From the ontological analysis conducted above, it follows both that the focus of our environmental concerns, and more specifically of climate policies, is not nature *per se*. What is it, then? Let us go back to the technical-scientific meaning of 'nature', namely nature as the non-supernatural world. Everyone may agree that our environmental concerns do not involve the entirety of nature (for instance, we are not worried about the state of other planets, which are a part of nature at the same time as the earth is), but just a part of it, namely the biosphere –Earth's 'zone of life' extending from a few kilometres into the atmosphere to the oceans' deep-sea vents, which originated between 3.5–3.8 billion years ago.

According to the founder of the modern concept of the biosphere – the Russian scientist Vladimir Ivanovich Vernadsky (1863–1945) – the biosphere originated together with life: life is a geological force that can – and did – change Earth's landforms, climate and atmosphere. It has transformed the earth from a rocky place with shallow oceans and an atmosphere made of toxic gases into the planet we know and inhabit today. 'Between its inorganic "lifeless" and living parts, inhabiting it, exists continuous exchange of matter and energy, expressed by atomic movement caused by the living matter' (Vernadsky, quoted in Svirezhev and Svirejva-Hopkins 2008, 468). Moreover, our environmental concerns do not involve the biosphere *per se*: for instance, we would not want the biosphere to become as it was about 20,000 years ago, when permanent summer ice covered about 25% percent of the land area, a large part of the world was dry and inhospitable and the atmosphere

was laden with dust. Rather, we are concerned with a particular state of the biosphere, that can be roughly identified with the world as we know it, so to speak, namely the state of the biosphere during the Holocene. It is a relatively warm and cosy state that started when the last ice age ended, the temperature increased by 6°C, sea levels rose by 120 metres and CO_2 in the atmosphere increased by one-third (Maslin 2014, 3-4). This is what we care about; these are the conditions that allow a good life to us and the organisms that we know and cherish.

The previously conducted ontological analysis allows us to recognize that our environmental concerns are not aimed at nature, but rather at a specific state of the biosphere. This state of the biosphere is changing. In 1990, the first report of the Intergovernmental Panel on Climate Change (IPCC) concluded that anthropogenic climate change would soon become evident, but it was not able to confirm that it was already happening. Today, as the last IPCC report reads (IPCC 2021, FAQs Section, 6).

> [the] evidence is overwhelming that the climate has indeed changed since the pre-industrial era and that human activities are the principal cause of that change… the main human causes of climate change are greenhouse gases released by fossil fuel combustion, deforestation, and agriculture.

Recognising human beings as the driver of climate change is the first, necessary step, to cope and possibly control and limit that change.

We clarified how humans and their activities are a part of nature – if 'nature' is understood in its technical sense. If the biosphere is the sum and interaction of all its biotic and abiotic components, considering humans as separate from the rest of nature runs the risk of reflecting an incomplete view of the biosphere. Two caveats, however, are in order.

First, it does not follow from the claim that human beings are natural entities that human activities cannot damage other natural entities and processes, as well as humans themselves. A useful theory to show this point is the Niche Construction Theory (NCT). Organisms, through their metabolisms, activities and choices alter their local environments, 'constructing' their own niches – think of the construction of nests and burrows, but also the alteration of the soil and more generally of local climate by plants. In doing so, they modify the sources of natural selection, generating a form of feedback in evolution (Odling-Smee et al. 1996). Normally, niche construction is beneficial to the constructor, since it counteracts natural selection's pressures on it; however, it can be deleterious for other species, for instance, when the niche

constructor is an invasive species. Sometimes it can even decrease the fitness of the constructor itself, for instance, when in building their niches, 'organisms also partly destroy their habitats, through stripping them of valuable resources or building up detritus' (Laland et al. 2000). This last case is the so-called 'negative niche construction process'. Human beings' activities can be read, like those of any other organism, through the lenses of niche construction theory: their activities aim at improving their own fitness (adaptive niche construction), but – as a side-effect – they can decrease the fitness of other organisms and even their own fitness. However, as mentioned, unlike other organisms, human beings can – in principle – control their niche construction activity to limit its possible negative effects.

Since human beings must be considered a constitutive part of the biosphere, niche construction theory can reveal a useful instrument to proceed towards a better understanding of human interactions with the environment. A recent study has suggested, for instance, that anthropogenic climate change can be understood as a 'monumental niche construction process' (Meneganzin et al. 2020) that is putting present and future generations' at risk. However, while some attention has already been paid to the possible environmental applications of NCT from environmental studies (Ellis 2016) and conservation biology (Boogert et al. 2006), a systematic incorporation of NCT in environmental and climate policies is, to my knowledge, still missing.

The second caveat is that, while recognising that human beings and their activities are a part of nature allows us to consider the biosphere as a whole, it does not imply that a distinction between natural entities and artifacts can't be traced, as John Stuart Mill already recognised.

I suggested elsewhere (Casetta 2020) that the natural/artificial distinction can be *operationally* maintained if conveniently reframed. Following Sarkar,

> Even if humans are conceptualized as part of nature, we can coherently distinguish between humans and the rest of nature. There is at least an *operational* distinction; that is, one that we can straightforwardly make in practical contexts. We can distinguish between anthropogenic features (those largely brought about by human action) and non-anthropogenic ones' (Sarkar 2012, 19, emphasis in the original).

Operationally, the categorical and fixed distinction between natural and artificial entities and processes may be reframed in a more dynamic way that recognizes that naturalness – and artificialness – are matters of degree and that they are relative to time. Different – and context-sensitive criteria – may

then be employed to assess and monitor the naturalness of a place or an ecosystem, such as for instance the degree of change expected if humans were removed, the degree of sustained control and the extent and abruptness of change following the cessation of human activities (Angermeier 2000). To give but one concrete example, from this view it follows that a newly planted forest – a so-called artificial object, since it has been planted by humans – may become, through time, a natural one if its persistence ceases to depend on human support. In such a framework, the concept of wilderness can be rethought as well and its narrative freed from non-veridical elements.

As said, recognizing human beings as the driver of climate change is the first, necessary step to cope and possibly control and limit that change; and acknowledging that they are part of nature allows us to consider the biosphere as a whole, taking into account all its components and processes. In such a perspective, on the one hand, NCT can prove to be a useful descriptive and predictive tool for anthropogenic climate change; on the other hand, reframing the natural/artificial distinction in a more dynamic way can help in facing the challenges that 'the end of nature' poses to both ecology and environmentalism.

The second step consists in knowing how the biosphere works and how it is expected to work in the future, i.e., recognizing and studying the relations between its biotic and abiotic components, and developing reliable climate models. With the second step, we enter the field of epistemology. Once the ontological focus has moved from wilderness to the biosphere, at least two questions may be asked, namely which justified beliefs do we have on the actual state of the biosphere? And which is the best scientific approach to the study of the biosphere as a whole?

Concerning the first question, the last IPCC report – published between August 2021 and April 2022 – maintains that several new instruments have been deployed to collect and integrate data. To give but one example, when the IPCC started in 1990, very little was known about the consequences of climate change on the deep ocean, while today it is known that oceans soak up most of the surplus energy captured by greenhouse gases in the atmosphere and that even the deep ocean is warming. It is known which human activities have the most impact on climate (i.e., greenhouse gases released by fossil fuels, deforestation, agriculture and aerosols from burning coal) and more and better observations of their impact are available. More sophisticated climate models allowing the prediction of patterns of change have been elaborated. For instance, while old-generation models – climate modelling started in the 1950s – focused mainly on the atmosphere, considering oceans and land surfaces only marginally, today models include

detailed considerations of many other variables (such as oceans, ice, snow and vegetation). Models can then now simulate complex interactions between different entities and processes of the biosphere, such as, for instance, the interaction between clouds and air pollutants. As the IPCC (FAQ Section, 20) states, 'Developments in the latest generation of climate models, including new and better representation of physical, chemical and biological processes, as well as higher resolution, have improved the simulation of many aspects of the Earth system'.

The second question stems from considering human beings and their activity as a constitutive part of the biosphere. Studying the functioning of the biosphere requires the cooperation of several sciences – from physics to chemistry, from climatology to Earth System Science, from ecology to evolutionary biology, and so on. Moreover, if human beings are genuinely considered part and parcel of the biosphere in the same way as other natural entities, the humanities come into play. In the light of this, I suggest that a transdisciplinary approach (Klein 2004) that includes natural and social sciences is required. Two kinds of transdisciplinarity can be distinguished. 'Deep' transdisciplinarity aims at building up a total system of knowledge with no constraints at all on the type of knowledge in play: shamanistic practices can be considered together with scientific knowledge (Max-Neef 2005). However, deep transdisciplinarity is an epistemologically risky enterprise because the epistemic status of the resulting discipline would be strongly questionable (Marques da Silva and Casetta 2015). 'Shallow' transdisciplinarity is a more cautious approach, epistemologically, that calls for 'trans-sector problem solving' where the focus of research is a certain global problem such as – in our case – anthropogenic climate change that requires collaboration among a mix of actors from different disciplines, professions and sectors of society.

Conclusions

When McKibben denounced 'the end of nature', his main intention was to shake public opinion, to denounce the consequences of climate change and its anthropogenic nature. It was 1989, the IPCC had just been founded and climate scepticism was widespread. Still in 2003, leading Republican consultant Frank Luntz advised the Bush administration to replace talking about 'global warming' with 'climate change', because the latter phrase was considered less frightening and because 'change' avoids implying human agency (Heink and Jax 2014). The memo also suggested that politicians endorse the view that there was no scientific consensus on the dangers of greenhouse gases (Burkeman 2003). Several things have since changed. Despite any political communication agenda, 'climate change' turned out to

be no less frightening than 'global warming', and evidence that points at the human agency cannot be questioned anymore, as the last IPCC assessment report documents.

McKibben's operation may probably be ascribed to what German philosopher Hans Jonas (1903–1993) called a 'heuristic of fear' (Jonas 1984, x). According to him, while fear seems to be, at least *prima facie*, a negative emotion, it can instead serve as a guide if fear is understood as an 'imaginative-anticipatory' heuristic. In other words, to avert those negative scenarios that we fear, we may be urged to act or re-evaluate our current course of action. While there can be some effectiveness in a heuristic of fear, it may also sort the opposite effect, like the one denounced by Steven Vogel, i.e., mourning instead of acting. For instance, fearing the end of nature understood as wilderness might result in underestimating the importance of the management of our everyday environment, made mainly of cities (that host 55% of the population), which already are local hotspots of global warming (they are generally warmer than their surroundings). More generally, considering human beings as separate from the rest of nature might lead to both an incomplete and partial view of the current functioning of the biosphere and the misrepresentation of the human role in such a functioning.

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