Elgar Handbook of Critical Environmental Politics

Marija Brajdić Vuković
Mladen Domazet

Anthropocene

INTRODUCTION

This chapter deals with the concept of Anthropocene, a techno-scientific label proposed by specialists in earth system sciences, as a technical name for a geological epoch marked by a significant impact of purposeful human activity on Earth's geology and ecosystems. In environmental politics it is also a conceptual framework within which to observe the constraints and potentials of contemporary natures and societies through the interrelationship between ecology and justice. The simplistic reading of the Anthropocene is one in which humanity's propensity for broadly understood development (as an instrument of emancipation), resulted in a systemic destabilizing of non-human nature.

This, in turn, is now undercutting the attainments of that very development and threatening to bring down the whole process. Yet with a multitude of subsistence, control, learning, conflict, contraction and expansion activities taking place in the everyday interactions between 7+ billion humans themselves (with varying consequences for the biosphere: human + non-human life) a new way of presenting some of that interaction is needed so as to fight for extinguishing of the destructive and unjust ones whilst amplifying those that are regenerative and emancipative. The hegemonic conception of development is unable to articulate a globally just and sustainable universal format of the said interactions, differentiating between the political and economic obstinacy to deviate from destructive path and the existing instances of climate-restorative livelihoods.

In the chapter we overview the concept of Anthropocene in the literature, from the origins in geology to contemporary variations in social sciences and humanities, presenting questions and critique with the aim to propose a systemic paradigm shift (in the Kuhnian sense) in how science explains its reproduction and origins. Such a paradigm shift leaves open the details of applicability of the surveyed critiques to particular instances and experiences. At the same time it is proposing a loose intellectual structure of constraints on historical progress of human emancipation and sociometabolic patterns, and through it provides holistic future perspective without invalidating the complexity of particular present and historic instances.

It proposes to leapfrog the intricacies of explaining how Anthropocene happened to the Earth (let alone by whom exactly it has been brought about and when) by focusing on explanatory unification of seemingly widely disparate phenomena associated with it and explanatory conceptual clarification provided by a principle theory model [i](cf. Van Camp 2011, Domazet et al. 2020). We argue that Anthropocene is a condition of combined ideological (through growth for profit accumulation) and socio-technical organization (capital-driven fossil fuel combustion), whose non-catastrophic conclusion requires regeneration, degrowth and commons governance in diverse locally meaningful ways. Otherwise, the hegemonic growth ideology remains intellectually locked-in in the paradox of emancipation and self-destruction on multiple levels of scale.

EVERYDAY REALITY OF THE ANTHROPOCENE: THE CONCEPT OR THE TECHNO-SCIENTIFIC LABEL

According to Steffen, Crutzen and McNeill (2007), in 1873 an Italian geologist and priest Antonio Stoppani wrote about the 'anthropozoic era'. The first to use the word *anthropocene* was a Russian geologist Aleksei Pavlov in 1922, describing the 'present day' as a part of an "Anthropogenic system (period) or Anthropocene" (Lewis and Maslin 2015). It was brought to general attention by the Ukrainian geochemist Vladimir Vernadsky as an idea that the biosphere, combined with human cognition, had created the Noösphere (from the Greek for mind), with humans becoming a geological force (Vernadsky 1945). However, the chronostratigraphic Anthropocene Working Group (AWG), founded by the International Committee on Stratigraphy (subfield of geology), sees the term as widely used since its 'coining' by Paul Crutzen and Eugene Stoermer in 2000 to "denote the present geological time interval, in which many conditions and processes on Earth are profoundly altered by human impact".

As is explained by Cruzten and Stoermer, this impact has intensified significantly after 1800 c.e. with the Industrial revolution's rapid course, taking us out of the Earth System state typical of the climatically remarkably stable Holocene Epoch. In that sense, geological changes hitherto only attributed to asteroids, tectonic plate shifts and volcanoes are now causally ascribed to gross human activity with a cumulative intensity of a geophysical force profoundly affecting the planet, from major biogeochemical cycles to the evolution of life (Lewis and Maslin 2015). Today we are witnessing visible human alterations of the biological fabric of the Earth (increased erosion and sediment transport associated with urbanization and agriculture), of stocks and flows of major elements in the planetary machinery such as nitrogen, carbon, phosphorus and silicon, and of energy balance at the Earth's surface (Steffen et al. 2007).

Environmental changes caused by these include global warming, sea-level rise, ocean acidification and spreading of oceanic 'dead zones', rapid changes in biosphere both on land and in the sea as a result of habitat loss, great loss of biological diversity (the sixth mass extinction), and the proliferation and global dispersion of new minerals such as concrete, fly ash and plastics

(Zalasiewitz et al. 2010). Lewis and Maslin (2015) note that human actions may well constitute the Earth's most important evolutionary pressure, as "the development of diverse products, including antibiotics, pesticides, and novel genetically engineered organisms, alongside the movement of species to new habitats, intense harvesting and the selective pressure of higher air temperatures resulting from greenhouse gas emissions, are likely to alter evolutionary outcomes" (p. 172).

The term Anthropocene has been widely used in Environmental Sciences in the last 15 years. It has been popularised in top science journals and even in popular periodicals such as *The New York Times*. There have been many conferences on the topic, as well as art exhibitions and performances. As a concept, the Anthropocene caused debates in the field of Earth Sciences, and has been contested, and even renamed, within the social sciences. Nichols and Gogineni (2018) notice that natural sciences and social sciences/humanities have different motivations for establishing a new geological era, and different parameters for identifying it. There have been voices advocating for a more interdisciplinary definition coming from both camps (Trischler 2016, Elis et al. 2016, Nichols and Gogineni 2018). Although the differences in conceptual delineation and use of the term in Earth Sciences and Social Sciences/Humanities are primarily ontological and epistemic, their consequences are also thoroughly political.

The problem with the natural and technical sciences, the STEM fields, is related to their capacity to change methods, paradigms, but especially - the point of view of the culture/nature distinction and/or boundaries. In 2007, Steffen, Crutzen and McNeill described the Earth System (the holistic approach to the Earth adopted by scientists in the 1980s) as "the suite of interacting physical, chemical and biological global scale cycles and energy fluxes that provide the life support system for the life on the surface of the planet (...)", but in the last paragraph of the description the authors add "(...)Finally, the Earth System includes humans, our societies and our activities; thus, humans are not an outside force perturbing an otherwise natural system but rather an integral and interacting part of the Earth System itself" (p. 615).

This addition was novel for geologists who are socialized into thinking from the so called 'third person point of view on the world' in which humans are detached from nature, as opposed to a 'first person point of view of the world' in which humans are inseparable from nature (Bilgrami, 2014). Anthropocene scientists now challenge this long standing disciplinary view of nature, and are presently changing the main standpoint related to nature in the STEM fields. The conceptual standpoint that paradoxically, resulted in human domination over nature and in its irreversible damage through a 400 years long detachment from nature (Nichols and Gogineni 2018). Of course this change has moral and political implications, and many argue for a firmer 'paradigm shift' in the natural sciences (Hamilton 2016).

However, geologists from the Anthropocene Working Group (AWG) remain mostly interested in the methodology of defining the start of an epoch (stratigraphy), as they have been trying to

establish the so called ‘golden spike’ – a signal in geological data that would indicate a change in the Earth System related causally to *Homo sapiens.* After agreeing that the Holocene Epoch is not best suited for the present times, there are intense and lasting debates within the community of exactly when, in terms of a geological timescale, the new epoch - Anthropocene - started. There are two main perspectives, called the Orbis spike and the bomb spike (Lewis and Maslin 2015).

The Orbis (‘the world’ in Latin) spike dates the beginning of the Anthropocene epoch in 1610, when the wide-scale swapping of species between continents that began in 1492 was first truly felt, and the core samples of the Antarctic ice showed a dramatic dip in atmospheric carbon dioxide levels at that point. Scientists theorize that this was caused by the rampant death that followed the colonizers in the New World as around 50 million people were exterminated, by a combination of warfare, enslavement and infectious diseases (Newson 1992, Lewis and Maslin 2015). Because many of those people were farmers -- especially in South America -- when their fields were no longer tended, trees were able to grow back and suck carbon dioxide out of the atmosphere. Many argue that this view of the Anthropocene is wrong because it divorces the concept from the modern industrialisation and burning of fossil fuels.

According to a recent AWG report (Subramanian 2019), it seems that for the majority on the panel the bomb spike[ii] is considered as a better candidate for the beginning of the epoch in a geological time scale. The bomb spike denotes starting of the new epoch in the mid-twentieth century. At that point rapidly rising human population accelerated the pace of industrial production, the use of agricultural chemicals and post war construction boom. Also, the first atomic-bomb blasts littered the globe with radioactive debris that became embedded in sediments and glacial ice, becoming part of the geologic record. All of this marks the beginning of the Great Acceleration, the sharp rise in the destructive environmental effects of human industry since the second half of the twentieth century (Steffen et al. 2015).

This, almost purely technical, use of the Anthropocene in the field and subfields of geology, becomes re-interpreted for different purposes within the fields of social sciences and humanities. As Lorimer (2017) sums up, the scientific categorization question in natural sciences provoked an intellectual fury in social sciences, precisely because of political consequences of a seemingly disinterested naming and dating issue. From the perspective of social sciences these can be described as issues related to intellectual zeitgeist, as an ideological provocation, as new ontologies of shared planet and culture, and science fiction. Anthropocene in social sciences has connections and implications for family, education, politics, social movements, class, gender, race, law, work, culture, care, history, time, space, science, technology, language, the arts, religion, and what it means to be human on this endangered planet (Sklair 2017).

As an ideological provocation (Lorimer 2017), the Anthropocene becomes contested as a grand narrative about human-environment relations and recast as Capitalocene (Moore 2015, 2017,

Malm 2016, Angus 2016), Anthrobscene (Parikka 2014), Chthulucene (Harraway 2015, 2016) and Plantationcene (Harraway 2015). Researchers are focused on the debates about the social, ecological and planetary implications of development, capitalism, modernity, humanism. The arguments for Capitalocene and Anthrobscene are predominantly related to 'metabolic rifts' and social inequalities caused by capitalism, recently in neoliberal form and related to half of cumulative emissions of climate altering gasses. This perspective rooted in structure of ownership of the means of production and structure of its output distribution, warns that humanity cannot go on living on and consuming as we do now, that we must radically change our lifestyles and socio-economic organization by changing/ending capitalism and creating new types of societies.

However, there are persuasive warnings that although capitalism makes anthropogenic damage to the planet worse (by exponentially intensifying growth of throughput, for example), its cessation is a necessary but not sufficient condition for overcoming the injustice and unsustainability of the Anthropocene (Chakrabarty 2009, Harraway 2015). We also need new types of relationships with nature and other non-human beings, as elaborated by Chtulucene (Tsing et al. 2017; Haraway 2015), which invites a subsequent epoch devoid of human exceptionalism in a multiple species world. Furthermore, feminists have contested the notion of Anthropos being linked to all of humanity, rather than the narrow masculinist logic of resource extraction (Gibson-Graham 2011), with Kate Raworth even suggesting the neologism 'Manthropocene' (2014).

For the postcolonial researchers, Anthropocene becomes Anglocene, a problem caused, named and only discussed by Northern, Anglophone 'anthropocenologists' (Bonneuil and Fressoz 2016); and Plantationocene – a problem started with the colonisation and social and ecological predations of colonial capitalism (Lewis and Maslin 2015, Harraway 2015). We should also mention the group still wedded to the third person perspective on historical roots of the contemporary global challenges, tightly related to the AWG of stratigraphy geologists (predominantly Caucasian men), proclaiming a 'Good Anthropocene'. Self-described as ecomodernists, they imagine the epoch in which humans achieve their Enlightenment destiny as the 'Good Species' through efficient, but not polluting technology, urbanisation and decoupling of human subsistence from nature (Bloomquist et al. 2015). Obviously, ecomodernists fail to acknowledge the links between the global environmental destruction and the social metabolism of capitalist modernity, which is why critics describe their vision as a Promethean technofix (Hamilton 2015).

(RE)THINKING OF THE ANTHROPOCENE

Anthropocene as a concept on a metaphorical level successfully connects deep time with the future of humans (Lorimer 2017). However, the concept within itself contains paradoxes, seemingly strikingly implausible conceptions indicating a hidden and important truth such as the

universal human distribution of benefits and impacts containing waste inequalities, comparison of meagre humans and their short lives with mighty tectonic events, development through destruction, and the like (Domazet 2017). As Bonneuil (2015) argues, it seems that we need a plurality of narratives from many voices rather than a single grand narrative, but that would invite a plurality of concepts leaving us without the signifier for a unique global situation we are all in (though not all directly experiencing it in the same way).

Who are 'we' in the Anthropocene

Even positioning oneself in relation to Anthropocene is a harder task than simply accepting that one is an individual from a species that plays a special role in a recent, though specific, geological epoch. Consider an analogy to Lewis' (2019) illustration of a well-known cultural reference from a book on surrogacy and feminism. Lewis (2019) portrays Atwood's *The Handmaid's Tale,* as a kind of wishful dystopia, or 'dystopia that functions as utopia'. Although counterintuitive (i.e. somewhat paradoxical) at first, Lewis asks us to imagine how much easier politics would be if the only thing standing in the way of peace and harmony were 'evil religious fundamentalists with guns'. One would not need to worry about capitalism or racism, one's own complicity in both or either, all women are equally oppressed. Applying this to climate change and environmental degradation, how much easier it would be if all of humanity were equally responsible for, and vulnerable to the environmental degradation and breakdown of stable climatic conditions. Wouldn't it be easier if the only thing standing between unified humanity and mitigation of climate catastrophe were some 'fundamentalists with smokestacks'? To think like that we would have to completely ignore the history of colonialism, oppression, capitalism, extractivism, together with the everyday social inequalities related to race, gender and poverty. But we'd also have to ignore our daily reliance on benefits of modernity.

Climate change universalizes the future of humanity (Jasanoff 2011), and the Anthropocene conceptualized as a consequence of 'human' activities universalizes the guilt for the far reaching and deadly changes to all of humanity. When humanity is portrayed as a unified historical and political body, we end up hiding the vast inequalities in wealth and power that characterize the contemporary 7+ billion people on the planet. The educated and well-fed few then end up speaking for all, in terms of constructing the history of how humanity got to the present state, and what ought to be done to overcome it (Domazet et al. 2014). Less than a fifth of the presently living humans live in nation states whose economies account for more than a half of greenhouse gas emissions and command most of the military and political power (UNDP 2013).

Even the educated and well-fed are of different socio-demographic backgrounds, if they are women, women of color, or represent some other 'minority group', the fact that they are probably well situated, and that their norms echo the hegemonic norms deeply rooted in the political institutions of their society, makes them prone to be in favour of the (capitalist) status quo. As Magnusdottir and Kronsell (2015) have found when studying the connection between

the representation of women in climate politics and the nature of climate governance policies in the Scandinavian countries; when female policy makers are not 'vulnerable' or 'activists' ('virtuous' as authors say), but are a part of a high consuming elite with large per capita emissions, they often fit their views to the patriarchal institutional environment, and the outcome is that there is no difference in policies related to climate governance, despite greater female representation in the political bodies.

There are humans on Earth who have at various points in history been considered more disposable than others, but there are also non-human beings who have no voice at all despite significant roles played in the stability of the planetary climate and metabolic circulation (Patel and Moore 2018). Tsing and co-authors (2017) speak of "Ghosts and Monsters" of the Anthropocene. Ghosts are broken interdependencies between species as a consequence of environmental destruction, erosion of soils, industrialisation, and extinction that multiplies across species. The leaky sewers and stinking garbage are also Ghosts of the Anthropocene. Monsters of the Anthropocene pertain to the fact that all the living creatures live in symbiosis with other living creatures. For example, human bodies contain more bacterial cells than human ones, without bacteria our immune system does not develop correctly.

When conditions suddenly shift, once life-sustaining relations sometimes turn deadly, as is explained in the example of the mutating gut bacteria in humans because of low-dose chronic exposure to radioactivity (Tsing et al. 2017, pp. M3). Or in the case of commercial hunting of sea otters off the Pacific North America that scraped the living kelp forests to the bare ground sea urchin barrens due to the fact that otters have a dramatic effect on the kelp ecosystem by eating sea urchins, which was visible only when otters were no more there (Parker 2017). Ghosts and Monsters are exposing the challenges of the Anthropocene in terms of complex relations, intersectionality of culture and nature, past and present times, and entanglements of all lives on Earth. For our purposes here, they are contenders for agents in the conception of Anthropocene beyond simple humans vs. nature perspective.

Questions of scale and of universals in friction

The Anthropocene (as well as the Earth System concept, and the Global Climate Change) is a conceptual construct of world-making in which the living Earth is imagined and represented as a unitary object in need of an integrated governance, and not as a space of agreements among biological and political collectives (Miller and Edwards 2001). As pointed out by Jasanoff (2015) "Seen as a collective phenomenon, aggregated at a global level, [Global Climate Change] reduces the possibility of attributing responsibility to agents at lesser scales, such as specific nations or forms of consumption". It disconnects nature from culture with profound ethical and political consequences (Latour 1993, Kinchy 2014). Dissociation of atmospheric carbon from the activity that produces it completely ignores the actual hybridity of nature-culture networks

(Neimanis et al. 2015), and upscaling also makes the environmental crisis less governable (Kinchy 2014) as hardly anyone lives daily in the global realm.

The reality of the Anthropocene in the globalised world is hard to comprehend. Tsing (2005) writes about friction, encounter between local and global in which a new messy reality is produced depending not only on culture, but also on different actors and their negotiation related to the so-called universals. Universals are universal aspirations, as Tsing says "Capitalism, science and politics all depend on global connections. Each spreads through aspirations to fulfil universal dreams and schemes" (2005, p.1). Those are for example 'prosperity', 'human rights', 'freedom', 'growth', 'environmentalism', but also 'emancipation' and 'development'. However the universal is what we cannot not want, even if it so often excludes us (Spivak 1999). That is, the universals offer us a most direct (and conceptual) chance to participate in the global stream of humanity. We cannot turn universals down, whether we place ourselves inside or outside the West; we are stuck with universals created in a cultural dialogue (Tsing 2005).

However, universal claims do not make everything everywhere the same. As Tsing (2005) reminds us, the global in connection with the local produces a new reality, a reality of a universal co-produced in friction. Frictions are, therefore, "the awkward, unequal, unstable, and creative qualities of interconnections across difference. […] Rubbing two sticks together produces heat and light; one stick alone is just stick. As a metaphorical image, friction reminds us that heterogeneous and unequal encounters can lead to new arrangements of culture and power" (Tsing 2005, pp.4- 5). A lot of our understanding of the Anthropocene arises in this way, through a combination of one's and one's community's particular position and the global material and historical flows.

There are, nonetheless, considerable efforts in descaling, and at the same time integrating and managing the problem of the mentioned complexities. We know the global phenomenology of the Anthropocene and we know it is connected to contingent human activity, it did not just spring up on any of us. In spatial, rather than temporal, and geographical, rather than historical, thinking we find the connected concept of 'anthromes' (as opposed to more familiar biomes). Anthromes, or "anthropogenic biomes", present the view of the terrestrial biosphere that takes into account the "sustained direct human interaction with ecosystems" (Ellis and Ramankutty 2008 p. 439), providing an alternative global framework for ecological understanding of the terrestrial biosphere as it exists today. Unlike biomes, anthromes form heterogeneous landscape mosaics, which are moreover fractal in nature, reproducing the said heterogeneity across spatial scales from family units to global extent of networked human civilisation (Domazet et al. 2020).

We can attempt to understand the concept's familiar patterns even when instantiated at different scales, from local to continental. When combined with a mapping of human cultural institutions collating the intentional aspect of human populations inhabiting an anthromic unit, this conception allows us to model the sustainability potential of a chosen unit under the global

constraints. This puts the concept to use in constructing a mental model of a downscaled (e.g. nation level) and therefore operational Anthropocene thinking (Domazet et al. 2020). Culture thus emerges as a key to explanation of how 'we' got here, how our aspirations and fulfillment led the planet to Anthropocene dead ends, and how and where to we could advance from this point on. Culture interprets the past and is making futures.

Human agency

The history of how we got here is necessarily related to (i) the technological (material and intellectual) structures of energy conversion (incoming solar into intentional human use), (ii) social structures that distribute energy and maintain the energy conversion structures, and (iii) cultural institutions of governance of energy and society (Domazet 2017). Ever since there have been stable human groups, as humans are essentially social animals, there have been forms of (i)-(iii), however basic from a present-day perspective. For Anthropocene to be a special configuration on the face of the planet, something radically different had to have taken place in them.

The technoscientific understanding of Anthropocene (above) tends to argue that a discovery, an abrupt change, innovation in the domain of energy conversion technology (i, above) pushed the changes in the social organization of energy conversion (ii, above) and the imaginary of social reproduction (within (iii), above). Following on from the structure outlined in Domazet (2017) human agency's most direct impact on (i)-(iii) is in the domain of cultural institutions of governance of energy and society, i.e. (iii) above. Anthropocene, material, biological and socio-structural is an effect of how some humans wanted to govern energy distribution and maintenance of socio-technical structures in their own community, and eventually most of the world. Predictably, it is a question of power and agency. Anthropocene is an age of intense power accumulation (through profit) resting on intense utilization of energy from fossilized stocks of historical solar energy input.

This framing matters as we need new intellectual paradigms within which to seek reversals of Anthropocene's devastating impacts on the stability of the biosphere, without consigning human communities to misery. In the short time available for the deep structural change required, we are forced to try out novel reorganizations of the interaction between technology, society and cultural imaginary without waiting for lengthy causal-mechanical analyses of how exactly their multiple hypothesized fundamental entities around the globe impact each other. We can bridge the gap between the shock warnings of imminent catastrophe and a purposeful reaction to them by the principle theory paradigm, summarizing the basics of the unexceptionable generalizations of the global phenomena. The fundamental intellectual task within such a paradigm is to generate explanations of the Anthropocene and its possible non-catastrophic outcomes, derived from a set of formally expressed necessary conditions or constraints on possible phenomena in ontological domains (i)-(iii) sketched above (cf. Domazet 2017 for a lengthier exposition).

Rather than debating the possible past alternative trajectories, it is of crucial importance to understand what kind of cultural aspirations, universals, got us here, and drove the development in those domains. Who got where? (How) can we change? In what way should some change, and what should others do? This is the type of urgent questions within the concept of Anthropocene. Urgency but not described as a crisis, for which the technocratic solutions would be sought (as proposed by the ecomodernists and other techno-managerialists), but as a grand challenge in need of radical solutions, first and foremost mental - normative, followed by structural and technical ones. For one, we ought to discuss development, growth, technological innovation, freedom, humanity and nature.

Second, we have to discuss not just universal aspirations toward human development, but also capitalist narratives of growth and the aims of technological innovation. Vying for dominance here are narratives of extraction of resources from nature's cyclical processes through increasing collective knowledge of these cycles' causal-mechanical structure (Mokyr 2017), aspiration to understand world-ecology from the perspective of autonomous individuals dependent solely upon each other for survival (Pagden 2013), or from the perspective of capitalism's hunger for constant cheapening of nature and labour (Patel and Moore 2018). In all of these it was the change in cultural institutions of governance of energy and society that initiated the phase shift in the dominant technological mechanisms of energy conversion, and the distributional structures of useful energy and technology maintenance (i and ii, above).

Bruno Latour (1993) argued that the separation of nature from culture is a constitutional move of modernity. The rise of the Enlightenment ideals, primarily of rationality, has indeed brought to the (Western) modern world a new medicine, and science and technology, making a significant contribution to what we today understand as health and wealth we enjoy. However, this was powered by the fossil fuels, and the expectations of capitalist production. We did not produce a culture dematerialised and ontologically separated from nature, but a change in our cultural institutions which was sustained by a change in distributional structures and energy conversion technologies. Growing widespread use of fossil fuels through the 19th and 20th centuries was not driven by population growth – more healthy, long-lived people wanting more stuff – but by the competitiveness of capitalist production and an ever increasing effort to lower the cost of input: energy and labour, while accumulating profit (Malm 2016, Domazet 2017, Patel and Moore 2018). Without the cultural promise and desirability of profit accumulation, fossil energy's technological infrastructures would not have been widely installed even if the growing human population had clamored for their direct and indirect output. This does not pertain to humanity's Enlightenment ideals of useful knowledge expansion and emancipation, but to expansion of capital through continuous incorporation of cheap nature and cheap humans (labour) (Moore 2015).

Consequently, modernity brought us illnesses, dominance of economic values, especially of the growth paradigm, the exploitation of humans, and alienation. The effects were industrialization, technological innovation as an instrument and utility of mass production and consumption, and exponential exploitation of natural resources. It resulted in environmental degradation, increasing scarcity of essential materials (like agriculturally useful phosphorus), terrifying loss of biodiversity to the point of the sixth mass extinction, global sea-level rise and climate change, and unprecedented wealth inequality. The West has been aggressively exporting its ideal of modernity, its universals, to other peoples, and now we have come to understand that to continue and further spread the modern way of life we would soon require more than one planet, three wouldn't be enough.

In such concept of modernity, we end up with the planet we have tarnished and soon struggle to sustain livelihoods for all humans on it. Is this the modernity that we were all aspiring to as humans? Can we envisage any other kind of modernity that can arise from facing the consequences of the 'modern' choices, and contingencies and paradoxes that it yielded? We must, but should clear the air of the paralysing intellectual myths that economic growth driven mitigation of climate change will suddenly become just, that the Anthropocene condition was inadvertently produced by rational technological improvements in human livelihoods world over, and that a technological change within the same distributional and cultural structures will neutralize the drivers of climate and biodiversity catastrophe (Domazet 2018).

In *Fossil capital* (2016), Andreas Malm argues that the characteristics of a capitalist organization of the economy were the dominant drivers of the shift from water (renewable) to coal (fossil) in the early industrial period. Malm claims that the modern fossil economy may not have started as such if it were not for other social, distributional and interpersonal factors favouring a push for its development against other readily available 'useful-energy' resources (flowing water). This implies that if we had organised our production around different energy transformations and their associated social distribution and governance aspects, the Anthropocene expansion might not have happened the way it did. The aim is not to open the argument here whether it would have happened in some other damaging way given capitalism's historical precedence to fossil energy based industrialization (cf. Patel and Moore 2018), but to point to the role of cultural and distributional drivers of the technological change.

The problem with the fossil economy is not just the pollution, environmental degradation and carbon dioxide, but also subjugation, exploitation, inequality and injustice. The established fossil fuel industry drove the expansion of production and capital, and created instruments for its own further expansion into new territories. Heede (2014) shows that productive organizations (corporations in many cases) that have extracted, refined and sold the fossils fuels driving the climate change of the Anthropocene, account for nearly two thirds of all the carbon dioxide emitted since 1750. Half of the culpable emissions of these giants have been released since 1986, almost within our lifetimes and well after political action to stop irreversible climate damage had

been initiated (Rich 2019). Some humans, by this account, take vastly greater benefits from this than the rest of the human population. While some humans lack the energy for self-realisation, others trade it as surpluses. At the same time, the available solar energy is sufficient for everyone's nutrition, shelter and education. However, alternative renewable resources have been too often pushed out of the competition with the help of the political, psychological, cultural and economic power of the fossil fuel capital. This is the story of the Anthropocene, an epoch in which particular human power aspirations and parts of human distributional structure dominated the Earth to the 6th mass extinction.

CONCLUSION

The community level strategies of rapidly converting the biophysical, social and cultural characteristics of the Anthropocene into a more sustainable world-ecology outlook will require constructing a functional causal-mechanical understanding of interactions between justice and renewable energy technologies. For example, from a global longue durée perspective such strategies combine understanding of constraints in energy-distribution-aspirations into a unified narrative with the decoupling of human self-fulfillment from the capitalist ideology of indefinite exponential economic growth. Given the lack of miraculous and rapidly scalable impactless energy conversion technologies that would simply replace the useful energy supply without affecting distributional structure and the hegemonic conception of a good life, our change must begin with the cultural imaginary and distributional reorganization to make the fairest use of the available technological mechanisms.

A change of the conceptual framework built around energy transformations, social structures, and social expectations and aspirations along the lines of degrowth thinking (Kallis et al. 2015) aims to combine the Enlightenment ideals with the possible society-energy sustainable futures. This won't instantaneously end the Anthropocene, but will steer it towards Anthropocene 2.0 with a non-catastrophic ending. We propose that a way out of paradoxes of the Anthropocene is to view the concept in terms different from a caricature humanity's expansion against nature in a zero sum environment of a finite planet. Anthropocene is a paradox felt in friction of past and future, local and global, nature and humanity. It is a novel epoch in geological history given our understanding of human emancipation and cultural intentions, and our observation of the material changes in the biosphere.

The key is to retell the story of Anthropocene with understanding of the contingencies in historical causal interactions between culture, society and energy (all broad signifiers for domains (i)-(iii) presented above), rather than as a geologically deterministic effect of a noble cultural cause. Transformations of the incoming and stored solar energy, distribution channels of that energy within human communities and the human world system, and governance institutions framing justifying and maintaining the transformations and distribution will play a key conceptual role in that retelling. The aspects of justice and injustice, colonization and

decolonization as reflected in these concepts will provide the entry points for dissolving the paradox; opening up to a plausible conception based on the concealed truth of how some humans brought all humans to the point of geological significance.

BIBLIOGRAPHY

Angus, I. (2016). *Facing the Anthropocene: fossil capitalism and the crisis of the earth system.* New York, NJ: NYU Press.

Bilgrami, A. (2014). *Secularism, identity, and enchantment.* Harvard: Harvard University Press.

Bloomquist L., Nordhausand T. and Shellenberger, M. (2015). *Nature unbound: Decoupling for Conservation.* Oakland: Breakthrough Institute.

Bonneuil, C. (2015). Geological turn: Narratives of the Anthropocene. In: C. Hamilton, F. Gemmene and C. Bonneuil, *The Anthropocene and the Global Environmental Crisis: Rethinking modernity in a new epoch*, 1st ed. New York, NJ: Routledge, pp. 17-31.

Bonneuil, C. and Fressoz, J.B. (2016). *The Shock of the Anthropocene: The Earth, History and Us.* London, UK: Verso books.

Chakrabarty, D. (2009). The Climate of History: Four Theses. *Critical Inquiry,* 35(2), pp. 197-222.

Chakrabarty, D. (2012). Postcolonial studies and the challenge of climate change. *New Literary History*, 43(1), pp. 1-18.

Crutzen, P.J. and Stoermer, E.F. (2000). The "Anthropocene". *Global Change Newsletter,* 41, pp. 17-18.

Domazet, M., Dolenec D., Cvijanović V., Tomašević T., Walton J.F., Doolan K., and Žitko M. (2014). We need to change: ideas of growth and development in a time of crisis of fossil energy and capitalism. *Etnološka tribina,* 44(37), pp. 37-71.

Domazet, M. (2017). Re-reading the Anthropocene in Ecology and Justice. In: M. Domazet, ed., *Ecology and Justice,* 1st ed. Zagreb: Institute for Political Ecology, pp. 15-46.

Domazet, M. (2018). Degrowth – a sober vision of limiting warming to 1.5ºC. *Radical realism for climate justice*, 44.4. Berlin: Heinrrich-Böll-Stiftung.

Domazet, M., Rilović, A., Ančić, B., Andersen, B., Richardson, L., Brajdić Vuković, M., Pungas, L., and Medak, T. (2020) Mental Models of Sustainability: The Degrowth Doughnut

Model. In: M. Goldstein and D. DellaSala, eds., *Encyclopedia of the World's Biomes,* vol. 5, sec. 10, 1st ed. New York: Elsevier, pp. 276-286.

Einstein, A. (1919). Time, space, and gravitation. *Times (London).* 28 November 1919, 13–14. Reprinted in Einstein, A. (1954). *Ideas and opinions*. New York: Bonanza Books, pp. 227-232.

Ellis, E. C. and Ramankutty N. (2008). Putting people in the map: anthropogenic biomes of the world. *Frontiers in Ecology and the Environment*, 6(8), pp. 439-447.

Ellis, E., Maslin M., Boivin N. and Bauer A. (2016). Involve social scientists in defining the Anthropocene. *Nature,* 540(7632), pp. 192-193.

Gibson-Graham, J.K. (2011). A Feminist Project of Belonging for the Anthropocene. *Gender, Place & Culture,* 18(1), pp. 1-21.

Hamilton, C. (2015). Getting the Anthropocene so wrong. *The Anthropocene Review,* 2(2), pp. 102-107.

Hamilton, C. (2016). Define the Anthropocene in terms of the whole Earth. *Nature,* 536(7616), pp. 251-251.

Haraway, D. J. (2015). Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making kin. *Environmental humanities,* 6(1), pp. 159-165.

Haraway, D. J. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Durham and London: Duke University Press.

Heede, R. (2014). Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854-2010. *Climatic Change,* 122(1), pp. 229-241.

Jasanoff, S. (2011). Cosmopolitan knowledge: Climate science and global civic epistemology, in J.S. Dryzek, R.B. Norgaard, and D. Schlosberg eds., *The Oxford handbook of climate change and society,* 1st ed. Oxford: Oxford University Press, pp. 129-143.

Jasanoff, S. (2015). Science and Technology Studies. In K. Backstrand and E. Lovbrand, eds., *Research Handbook on Climate Governance,* 1st ed. Cheltenham, UK: Edward Elgar Publishing, pp. 36-48.

Kallis, G., Demaria, F. and D'Alisa, G. (2015). Introduction: degrowth. In: G. D'Alisa, F. Demaria and G. Kallis, eds., *Degrowth. A Vocabulary for a new era,* 1st ed. Abingdon and London, UK: Routledge.

Kinchy, A. J. (2014). Political scale and conflicts over knowledge production. In: D. L. Kleinman and K. Moore, eds., *Routledge Handbook of Science, Technology, and Society,* 1st ed. Abingdon and New York: Routledge, pp. 246-262.

Latour, B. (1993). *We have never been modern.* Cambridge, MA: Harvard University Press.

Lewis, S. L. and Maslin, M.A. (2015). Defining the anthropocene. *Nature*, 519(7542), pp. 171-180.

Lewis, S. (2019). *Full surrogacy now.* London, UK: Verso Books.

Lorimer, J. (2017). The Anthropo-scene: A guide for the perplexed. *Social Studies of Science,* 47(1), pp. 117-142.

Magnusdottir, G. L. and Kronsell, A. (2015). The (in) visibility of gender in Scandinavian climate policy-making. *International Feminist Journal of Politics*, 17(2), pp. 308-326.

Malm, A. (2016). *Fossil capital: The rise of steam power and the roots of global warming*. London, UK: Verso Books.

Miller, C.A. and Edwards P.N., eds. (2001). *Changing the Atmosphere: Expert Knowledge and Environmental Governance,* 1st ed. Cambridge, MA: MIT Press.

Moore, J.W. (2015). *Capitalism in the web of life*. London, UK: Verso.

Moore, J. W. (2017). The Capitalocene, Part I: on the nature and origins of our ecological crisis. *The Journal of peasant studies*, 44(3), pp. 594-630.

Mokyr, J. (2017). *A Culture of Growth*. Princeton, NJ: Princeton University Press.

Neimanis, A., Asberg C. and Hayes S. (2015). Post-humanist imaginaries. In: K. Bäckstrand and E. Lövbrand, eds., *Research Handbook on Climate Governance,* 1st ed. Cheltenham, UK: Edward Elgar Publishing, pp. 480-490.

Newson, L. A. (1992). The Demographic Collapse of Native Peoples of the Americas, 1492-1650. *Proceedings of the British Academy*, 81, pp. 247-288.

Nichols, K. and Gogineni, B. (2018). The Anthropocene's dating problem: Insights from the geosciences and the humanities. *The Anthropocene Review,* 5(2), pp. 107-119.

Pagden, A. (2013). *The Enlightenment and why it still matters*. Oxford: Oxford University Press.

Parker, I. M. (2017). Remembering in our amnesia, seeing in our blindness. In: A. L. Tsing, N. Bubandt, E. Gan and H.A. Swanson, eds., *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene,* 1st ed. Minneapolis: University of Minnesota Press, pp. M155-68.

Parikka, J. (2014). *The anthrobscene*. Minneapolis: University of Minnesota Press.

Patel, R. and Moore, J. (2018). *A history of the world in seven cheap things: A guide to capitalism, nature, and the future of the planet.* London: Verso.

Rakowski, A.Z., Nadeau, M. J., Nakamura, T., Pazdur, A., Pawełczyk, S., & Piotrowska, N. (2013). Radiocarbon method in environmental monitoring of CO2 emission. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* 294, pp. 503–507.

Raworth, K. (2014). Must the Anthropocene be a Manthropocene, The Guardian, 20. October 2014 (online). Available at: https://www.theguardian.com/commentisfree/2014/oct/20/anthropocene-working-group-science-gender-bias [Accessed 15. Jan. 2020].

Rich, N. (2019). *Losing earth: The decade we could have stopped climate change*. London: Picador.

Steffen, W., Crutzen, P.J., and McNeill, J.R. (2007). The Anthropocene: are humans now overwhelming the great forces of nature. *AMBIO: A Journal of the Human Environment*, 36(8), pp. 614-621.

Steffen, W., W. Broadgate, L.Deutsch, O. Gaffney and C. Ludwig (2015), The trajectory of the Anthropocene: the great acceleration, *The Anthropocene Review,* **2**(1), 81-98.

Spivak, G.C. (1999). *A critique of postcolonial reason*. Cambridge, MA: Harvard University Press.

Subramanian, M. (2019). Anthropocene now: influential panel votes to recognize Earth's new epoch. *Nature*, 21, 2019.

Trischler, H. (2016). The Anthropocene. *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin*, 24(3), pp. 309-335.

Tsing, A. L. (2005). *Friction. An Ethnography of Global Connection*. Princeton: Princeton University Press.

Tsing, A. L., Bubandt, N., Gan, E. and Swanson, H.A., eds. (2017). *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene,* Minneapolis: University of Minnesota Press.

United Nations Development Programme [UNDP]. (2013). *Human Development Report 2013. The Rise of the South: Human Progress in a Diverse World.* New York: UNDP.

Van Camp, W. (2011). Principle theories, constructive theories, and explanation in modern physics. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics,* 42(1), pp. 23-31.

Vernadsky, V. I. (1945). The biosphere and the noosphere. *American Scientist*, 33(1), pp. 1-12.

Waters, C. N., Zalasiewicz, J., Summerhayes, C., Barnosky, A. D., Poirier, C., Gałuszka, A., and Wolfe, A. P. (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science,* 351(6269).

Zalasiewicz, J., Williams, M., Steffen, W. and Crutzen, P. (2010). Response to "the Anthropocene forces us to reconsider adaptationist models of human-environment interactions". *Environmental Science & Technology*, 44(16), pp. 6008-6008.

Sklair, L. (2017). Sleepwalking through the Anthropocene. *The British Journal of Sociology*, 68(4), pp. 775-784.

i It proposes to leapfrog the intricacies of explaining how Anthropocene happened to the Earth (let alone by whom exactly it has been brought about and when) by focusing on explanatory unification of seemingly widely disparate phenomena associated with it and explanatory conceptual clarification provided by a principle theory model (cf. Van Camp 2011, Domazet et al. 2020). Principle theory model is a visionary understanding in the physical sciences that can, according to Einstein's reflection on the development of Special Theory of Relativity, offer a breakout from a conceptual blockade in times of crises of (Kuhnian) paradigms (Einstein 1919). As an explanatory model it does not speculate about a detailed causal mechanism (such as mechanistic gears and pulleys) through which constituent elements of the phenomena are connected, but establishes process generalizations about universal constraints of change of the said phenomena (thus, rules, principles and flow patterns). The latter are "based on the self-evident rationalizations of the experiences and axiomatic relationships in the conceptual structure" (Domazet et al. 2020, p. 279). In an intellectual crisis of paradigm change, advantages of principle theories over constructive theories, according to Einstein, are "logical perfection and security of foundations" (Einstein 1919, p.13). The principles are generalizations extrapolated from empirical observation of phenomena that have been found to hold without exception, and are thus elevated to status of postulates on which to build interpretative understanding of the situation (Van Camp 2011). We argue that Anthropocene is a condition of combined ideological (through growth for profit accumulation) and socio-technical organization (capital-driven fossil fuel combustion), whose non-catastrophic conclusion requires regeneration, degrowth and commons governance in diverse locally meaningful ways. Otherwise, the hegemonic growth ideology remains intellectually locked-in in the paradox of emancipation and self-destruction on multiple levels of scale.

ii The bomb spike refers to the peak of the excess radiocarbon signal arising from atom bomb tests in 1964. As Watson et al. (2016) explain detonation of the Trinity atomic device at Alamogordo, New Mexico, on 16 July 1945 initiated local nuclear fallout from 1945 to 1951, whereas thermonuclear weapons tests generated a clear global signal from 1952 to 1980, the so-called "bomb spike" of excess 14C, 239Pu, and other artificial radionuclides that peaks in 1964. The bomb spike is, suggested by Lewis and Maslin (2015), a competing explanation to the dip in atmospheric CO2 in 1610 named the Orbis spike. This 'bomb spike' approximation is based upon a peak in atmospheric radiocarbon recorded in annual tree rings from pines in the park by Niepołomice Castle, Poland (Rakowski et al., 2013).

Dr Marija Brajdić Vuković is Senior Research Associate at the Centre for Social Inequalities and Sustainability - Institute for Social Research in Zagreb, and Associate Professor at the Faculty of Social Sciences and Humanities, University of Rijeka. She is a sociologist of knowledge, science and technology, and a social research methodologist interested in methodological innovations and improvements of social research tools and approaches. Her main field of research is sustainability transitions based on values and knowledge frameworks of citizens and institutions, and the role of science and technology in current and future societies.

Dr Mladen Domazet is Research Director at Zagreb's Institute for Political Ecology and leader of international research team developing a modified doughnut visualisation for a safe and just operating space under constraints of 21st century development challenges. He graduated in Physics and Philosophy from the University of Oxford and completed a doctorate in Philosophy of Science at the University of Zagreb. His publications reflect a career of diverse interdisciplinary interests and collaborations, from analysis of Wikipedias as complex networks, through analyses of sustainability practices in marginalised European regions to structural aspects of depth of explanation in contemporary (socio-metabolic) realism.

ABSTRACT

Key words: Anthropocene, Enlightenment ideals, Capitalism, justice, energy transformations

In a simplistic reading, Anthropocene is a geological period, in fact a comparatively brief geological micro-epoch, in which humans realize their inherent humanity (as a species group), only to see it destroyed by human organic and inorganic nature, which cannot coexist with humanity thus realized. This chapter overviews, questions and critiques this concept of Anthropocene. The key is to retell the story of Anthropocene by showing the contingencies of material and cultural instantiations of the

Enlightenment ideals and universals that created the present crisis by historical step, rather than as geological deterministic effect of a noble cultural cause. Transformations of energy, distribution channels of that energy within human communities and human world system, and governance institutions directing and maintaining that transformation and distribution will pay an important role in that retelling. As will the stories of justice and injustice, colonization and decolonization of both narrative and reality.