A Short Guide to the Sixth Mass Extinction – is the Anthropocene an extended suicide?

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Abstract

Living in an epoch of forcible human-instigated transformations, we can witness their effects both on the Earth's geology and its ecosystems. So significant are these changes that we are often said to be witnessing the birth of a new epoch – the Anthropocene. This era is believed to be driven by the "Great Acceleration" that sees human population grow rapidly, which results in a drastic increase in the demand for energy, land, and water. The expanding human population enters areas previously inhabited by other organisms and displaces them from their natural habitats. This has already led to the sixth mass extinction, Insectageddon and an explosive spread of pathogens attacking native populations of plants, animals, and humans. Ongoing coronavirus pandemic and other diseases triggered by viruses, bacteria, and fungi are linked to the worldwide destruction of ecosystems. Humans' autodestructive behaviour also poses a threat to other species and wildlife in general.

Keywords: Anthropocene, Great Acceleration, Insectageddon, sixth species extinction, pandemic

Nowadays, a lot of terms sprung up describing human influence on the planet. The Anthropocene, the Great Aacceleration, Insectaggedon, the Sixth Great Extinction of the

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Species, are only some of the most widespread buzzwords coined to accentuate human influence. The role of nature and biodiversity is commonly referred to as the cornerstone of the stability of life on earth (Daszak et al. 2020; IUCN 2020-3). Even the ongoing coronavirus pandemic is linked to the worldwide destruction of ecosystems (Cyranoski 2020; IPBES 2021; WHO 2021). Is our future to kill all living creatures, including ourselves? Undoubtedly, mankind is conscious and aware of their actions and their effect on ecosystems, which presently borders self-destruction. Suicide is the behaviour which decisively distinguishes us from animals (similarly to the development of sophisticated art and technology). So far, no cases of deliberately causing own death among animals have been confirmed. Animals can suffer from mental health issues in the same way humans do, they feel stress and get depressed (Eilam 2017; Ramsden and Wilson 2014; Malkesman et al. 2009; Preti 2011), they can behave altruistically in a self-sacrificial way in order to defend their population (Shorter and Rueppell 2012). They can behave in a destructive way after parasite infection (Webster 2001), but do not plan ending their lives with full awareness of its irrevocability (Ramsden and Wilson 2014; Malkesman et al. 2009). Every organism instinctively endeavours to preserve its species. And what kind of future do humans want?

The Anthropocene is the term that has been in common usage since 2000 when Paul Crutzen and Eugene Stoermer used it to describe the current geological time span that sees numerous conditions and processes on Earth being suddenly and profoundly altered by human influence (Zalasiewicz et al. 2017; Subramanian 2019; Crutzen 2000; Crutzen 2002). This influence stepped up considerably with industrialisation, which transformed the Earth from the state characteristic of the Holocene glaciation to the state we may be observing now. The term Anthropocene was firstly used by Eugene F. Stoermer, a renowned researcher studying diatoms – unicellular water organisms. This way Stoermer described destructive influence humans have been exerting on the planet Earth. Nevertheless, it was not until 2000 that the term was more broadly used after E.F. Stoermer and Paul Crutzen – a Nobel Prize laureate researching changes in ozone levels – published their report in the 41st bulletin of the International Geosphere-Biosphere Programme, IGBP. Highlighting the central role that humanity has played in modern geology and ecology, the paper postulated using the term the Anthropocene to specify the current geological epoch. They proposed that the second half of

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the 18th be considered as the beginning of the epoch because data from ice cores extracted from ice sheets of the Antarctic and Greenland showed the beginning of an increase in concentrations of several greenhouse gasses in the atmosphere, in particular CO_2 and CH_4. This also seemed a useful watershed moment as it overlapped with James Watt's invention of the steam engine in 1784 (Zalasiewicz et al. 2017; Subramanian 2019; Walker 2019).

Presently, discussions are continued on three alternative boundaries marking the onset of the Anthropocene: (a) the early Anthropocene theory postulates that the time of the rise of first agricultural civilisations, i.e. several thousand years BC, should be adopted as the starting point for the new epoch (Ruddiman 2003; Smith and Zeder 2013); (b) the common era theory dates the Anthropocene at the beginning of the industrial revolution in the 1800s (Zalasiewicz et al. 2015); (c) proponents of the Great Acceleration see the beginning of the new epoch as the second half of the 20th century which saw an unprecedented increase in the influence humans exerted on ecosystems and geology of the planet Earth. Primarily, there has been a steep rise in human populations, which has been driven by industrial development and has triggered a drastic increase in the demand for energy, land, and water. In turn, this has been intensifying emissions of greenhouse gasses (carbon dioxide, methane, and nitrous oxide), a depletion of the ozone layer, a rise in the temperature of the Earth's surface, a loss of tropical forests, extinction of many species and a degradation of the biosphere (Mcneill 2014; Steffen et al. 2015). The time of the Great Acceleration is most likely to mark the beginning of the new epoch. Scientists postulate that the boundary between epochs need not have a specified stratotype (A Global Boundary Stratotype Section and Point, GSSP), but may be defined through the Global Standard Stratigraphic Age (GSSA) and propose the first detonation of a nuclear bomb on 16th July 1946 in Alamogordo in New Mexico to mark the new beginning. Subsequent detonations occurred until 1988, on average every 96 days, which caused radionuclide fall to be observed in worldwide chemo-stratigraphic records (Zalasiewicz et al. 2015).

Presently, the Anthropocene is used in scientific contexts with a view to show a growing influence human exert on the lands they use, ecosystems, biodiversity, and extinctions of some species. Scientists believe that it is human influence that may be considered to be the main marker of the Anthropocene. Human actions:

- have accelerated the pace of erosion and sedimentation
- have disrupted the circulation of numerous elements in nature, for instance carbon, nitrogen, phosphorus
- have triggered global climate and sea level changes.

Human actions are considered to be the seventh most important factor behind soil formation, being only surpassed by the matrix, climate, time, land relief, living organisms, and water (Amundson and Jenny 1991). According to the International Committee for the Classification of Anthropogenic Soil ICOMANTH, anthropogenic soils (anthrosols) are the soils whose creation was clearly influenced by human activities such as river regulation, modifications in plants, logging woods, persistent ploughing, fertilisers, pollutants, waste, and progressive urbanisation contributing to covering soils with various materials i.e., asphalt and concrete, both of which prevent gas circulation (Dazzi and Lo Papa 2015; IUSS 2015).

Not only has human activity influenced geological features, but it has also considerably affected flora and fauna. Biotic changes which have been observed concern species going rapidly extinct and also foreign species invading new ecosystems at an unprecedented pace. Invasive species are often introduced purposefully into an ecosystem as crops or farm animals. However, many of them equally often use conveniences offered by modern means transport in order to colonise new terrain.

The loss in biodiversity is often described as the sixth mass extinction which is comparable in its scope with the five previous great extinctions – Ordovician (approximately 438 million years ago), Devonian (approximately 374 million years ago), Permian (approximately 250 million years ago), Triassic (approximately 201 million years ago), and Jurassic (approximately 66 million years ago) (Barnosky et al. 2011; Kolbert 2014). However, each great extinction has yet been caused by a natural calamity, and presently it is impossible to pinpoint a single cause behind such a dramatic loss in biodiversity. There seem to be numerous factors that transform environment in such a violent way that species are unable to adapt (Ceballos 2018). The 2019 Global Assessment Report on Biodiversity and Ecosystem

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Services points out that approximately a million species of animals and plants are pushed to the brink of extinction by anthropogenic influences.

At least 86 species of mammals have gone extinct for the recent 500 years (Barnosky et al. 2011) (categories EX and EW in IUCN (IUCN 2020-3), 182 species of birds, including 4 species having gone extinct since 2000 (BirdLife International 2019; Regan et al. 2015), 33 species of reptiles (categories EX and EW in IUCN (IUCN 2020-3)), 37 species of amphibians (IUCN 2020-30), however, according to the Global Amphibian Assessment (Global Amphibian Assessment 2020) as many as 160 amphibians species have gone extinct, and threatened with extinction is thought to be over 40% species, which makes amphibians the most endangered vertebrates. Among invertebrates, 64 species of insects (Insecta), 32 species of bivalve (Bivalvia), and 281 species of slugs and snails (Gastropoda) face extinction (categories EX and EW in IUCN (IUCN 2020-3)). It is publications concerning endemic Hawaiian land snail family going extinct that drew attention to the scale of present extinctions and triggered discussions on the consequences of the 6th Great Extinction (Régnier et al. 2015a; Régnier et al. 2015b). Extrapolating research findings on the extinction of Hawaiian species helped to commonly accept the conclusion that the crisis connected with biodiversity is very real and as many as 7% of all species on Earth, including many that had never been described might have been lost due to changes caused by human activity (Régnier et al. 2015a).

Naturally, it is not only animals that go extinct as 21 monocotyledonous (Liliopsida) and 132 dicotyledonous (Magnoliopsida), 4 from Cycadopsida, 3 from Polypodiopsida, 4 from Bryopsida, 1 from Florideophyceae species have gone extinct (categories EX and EW in IUCN (IUCN 2020-3)). General survival forecasts for all organisms on Earth are also gloomy as 40% of the listed plant species (i.e., 20,360 out of 50,369) are threatened (categories CR, EN and VU IUCN (IUCN 2020-3)), and over 19% of the listed animal species, i.e., 15,166 out of 78,126 species face extinction, including 1,848 out of 10,105 insect species (IUCN 2020-3).

Analysing changes that occurred only last year, one may be horrified to find 6 mammal, 3 amphibian, 8 Liliopsida and 5 Magnoliopsida species in the EX (Extinct) and EW (Extinct in the Wild) categories (categories EX and EW in IUCN 2020 (IUCN 2020-3; IUCN 2020-2) vs. IUCN 2019 (IUCN 2019-Jul)). Other statistics seem equally alarming, 3,154 plant species and 1,005 animal species were added to the threatened with extinction category (categories CR, EN and VU) only last year (categories CR, EN and VU, in IUCN 2020 ((IUCN 2020-3; IUCN 2020-2) vs. IUCN 2019 (IUCN 2019-Jul)).

Unfortunately, insects seem rather inconspicuous in the statistics showing so many other endangered organisms. Nevertheless, the message that species deserve to be protected in a special way seems more and more widespread and the question arises whether mass extinction of insects is so spectacular that the term Insectaggedon is appropriate to describe the trend. Firstly, a broader perspective needs to be adopted – looking at the general tendency in a given group of organisms rather than only the statistics concerning individual species going extinct. Recent research shows insects to be dying out eight times faster than mammals, birds or reptiles (Pimm et al. 2014). The slump in the general population is also staggering. German scientists routinely monitoring protected areas proved total insect biomass to have declined by 76% within 27 consecutive research cycles, and the total biomass of the flying species to have slumped by 82% (Hallmann et al. 2017). Similar tendencies were observed worldwide. Having compared 73 long-term investigations into insects Sanchez-Bayo and Wyckhuys (2019) proved the pace of extinction in this group of animals to be so huge that even 40% of all insect species in the world might go extinct within several years. Insects from Lepidoptera, Hymenoptera and Coleoptera orders are most endangered in terrestrial ecosystems. Major taxons connected with water such as Odonata, Plecoptera, Trichoptera and Ephemeroptera have already lost most of their biomass and biodiversity in every location being observed. Not only are highly specialised species threatened, i.e., those inextricably connected with a single ecological niche, but numerous cosmopolitan species are also endangered, which shows the gravity of the present situation (Sanchez-Bayo and Wyckhuys 2019).

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Some researchers question the prodigious scale of the phenomenon described by Sanchez-Bayo and Wyckhuys (2019) pointing to inappropriate research methodology and computing errors (Komonen et al. 2019). Nonetheless, a slump in insects' mass and biodiversity has been observed for a long time. This trend may be illustrated by pollinators, which have been rather comprehensively researched due to their fundamental role in their ecosystems. Over 87% of angiosperm plants are predominantly pollinated by insects, mostly by honeybees, and to a lesser extent by birds, mammals, and reptiles. Crops coming from 70% out of 124 cultivated plants depend on pollinating species (Klein et al. 2007; Eilers et al. 2011). A lack of pollination would reduce vegetable crops by 40% and fruit crop by 16% (Klein et al. 2007). Social insects, honeybees, bumblebees, and stingless bees are predominant pollinators in numerous ecosystems because of sheer numbers of individual insects comprising families (Velthuis and Van Doorn 2006; Potts et al. 2010; Breeze et al. 2011; Pitts-Singer and Cane 2011). Nowadays, anthropogenic landscape changes caused by large enterprises as coal mines on a par with large-scale, monocultures plantations are responsible for insect extinctions and Insectageddon (Ptaszyńska et al. 2018; Ptaszyńska et al. 2021; Gancarz et al. 2021; Fig. 1).

Undoubtedly, factors that are responsible for the Insectaggedon also affect other organisms and cause a general decline in the biodiversity of plants, insects, amphibians, birds, mammals, and other species that have been present in our landscapes (Losey and Vaughan 2006; Fox 2013; Benton et al. 2002; Thomas et al. 2004; Hallmann et al. 2014; Ptaszyńska et al. 2021; Tauber et al. 2021). Considering that some species have lost over 80% of their habitats over the last 100 years, some scientists estimate that 50% of local populations might have already gone extinct (Ceballos et al. 2015; Ceballos et al. 2017; Ceballos and Ehrlich 2018). Nearly 200 vertebrates are documented to have gone extinct over the last 100 years, which makes for approximately 2 species annually. The present speed of extinction is unprecedented in the history of the planet – bar natural disasters. At the average speed of extinctions calculated for the last 2 million years, the extinction of 200 vertebrate species ought to have taken at least 10,000 years rather than merely one century (Pimm et al. 2014; Ceballos et al. 2015).

Sizes of populations have also slumped drastically. Among mammals, 60% of their total biomass are farm animals, the further 36% are humans and merely 4% are wild animals (Bar-

On et al. 2018). Similarly, sizes of populations and biodiversity in other groups of organisms have also been falling dramatically, which is why present extinctions fit even narrowest definitions of a mass extinction (Barnosky et al. 2011; Williams et al. 2015).

Incidentally, globalisation, increases human impact on biodiverse areas and wildlife habitats and thus contributes to the explosive spread of pathogens attacking humans, the most notorious of which has so far been the SARS COV-2 virus triggering the 2020 pandemic (Cyranosky et al. 2020). According to official reports, over 2 m people have died from the coronavirus since it began an epidemic on November 17, 2019 in Wuhan City, Hubei Province, Central China and on March 11, 2020 SARS COV-2 was declared a pandemic by the World Health Organization (WHO 2021). The spread of other pandemics (influenza, HIV/AIDS) and other dreadful diseases of the XX and XXI centuries (i.e. MERS, avian influenza, swine flu, Ebola, Dengue fever, plague) has been caused by zoonoses that disseminated due to globalisation and wildlife destruction [1]. According to Peter Daszak from The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES): "there is no great mystery about the cause of the Covid-19 pandemic, or of any modern pandemic. The same human activities that drive climate change and biodiversity loss also drive pandemic risk through their impacts on our environment" (IPBS 2021). Undeniably, the anthropogenic destruction of wildlife biodiversity is paving the way to the era of pandemics.

Nonetheless, some scientists criticise the idea of postulating a new epoch as exceedingly anthropocentric and thus attributing humanity too big a role in the history of the planet (Malm and Hornborg 2014). Other critics believe similar extinctions have taken place in the past and thus current mass extinctions are hardly exceptional and merely a natural stage in the process of evolution (Thomas 2017). However, it needs to be highlighted that the present pace of changes in the biosphere is extremely high. Most transformations have been triggered by humans, who have been exploiting Earth resources to satisfy their needs without appropriate understanding of ecological processes (Thomas 2017). Undoubtedly, radical steps need to be taken aimed at protecting the Earth and its living organisms (Ceballos and Ehrlich 2018). Turning a blind eye to the exacerbating problem is certainly never going to solve it, or rather the problem might solve itself so radically that *homo sapiens* themselves will end up among endangered species.

Summary

Expanding human populations have been conquering areas previously inhabited by other organisms thus displacing them from their natural habitats, which has led to the sixth massive extinction, including the Insectageddon and an explosive spread of pathogens attacking native populations of plants, animals, and humans. Undoubtedly, unchecked trade, and even tourism play a part in rapid dissemination of such parasites. Incidentally, globalisation also contributes to the explosive spread of pathogens attacking humans, the most notorious of which has so far been the SARS COV-2 virus triggering the 2020 pandemic.

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Authors' contributions

AAP conceptualised the article idea, found all the data and wrote the original draft.

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Figure legend

Figure 1. The Anthropocene landscape - a coal mine. Searching for the causes of the Insectageddon – beehives were located near the coal mine pile under research conducted under a project determining the impact of the mine on the ecology of nearby areas.