The Climate Emergency, the Biodiversity Crisis and the 'Doomsday Argument'.

By

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Abstract.

This paper will argue that the global capitalist economy was founded, and depends, on the consumption of fossil fuels, and the increase in supply of renewable energy in the next three decades will not alter that fact significantly, given both economic and demographic growth and Jevons' Paradox. The resulting increase in fossil fuel consumption in that time, along with that increased economic activity and human population, which is already unsustainable, will lead to increased greenhouse gas (GHG) emissions, further anthropogenic climate change, and loss of biodiversity. The so-called 'Doomsday Argument' predicts that the deleterious impacts of these effects will be so severe as to result in the extinction of our entire species.

Keywords: global capitalism; fossil fuels; renewable energy; economic growth; demographic growth; Jevons' Paradox; economic activity; human population; greenhouse gas (GHG) emissions; CO_2 emissions; anthropogenic climate change; climate emergency; biodiversity loss; 'doomsday argument'.

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[1] Introduction.

In previous work, the present author has discussed the prospect of a catastrophic global food crisis no later than 2050 due to anthropogenic climate change (Blaber, 2023b [1]). He has also examined political resistance to policies to reduce GHG emissions internationally (Blaber,

2022a [2]) and Christian religious opposition to belief in the existence of climate change (Blaber, 2022c [3]). He has noted that demand for fossil fuels, and investment in fossil fuel extraction, continues to increase, in spite of the increasing supply of renewable energy (Blaber, 2023a [4]). The present world human population of ~8 billion, set to increase to 9.75 billion (US Census Bureau, 2023 [5]) is already, so he argues, unsustainable, and far in excess of its optimum size (Blaber, 2022b [6]).

In a recently published paper (Blaber, 2023c [7]), the present author argues that the current level of atmospheric carbon dioxide (CO_2) is the same as that of the maximum reached during the KM5c marine isotope stage of the Mid-Piacenzian Warm Period (MPWP) of the Pliocene Epoch, some 3.205 million years ago (Mya), yet during that time, global warming reached 3°C above the pre-industrial (1750) norm, even though the Sun was slightly less luminous than it is today. The Earth's orbital parameters were the same then as they are now, only changing during the subsequent Pleistocene Epoch, and then making the Earth cooler, not warmer, during the Ice Ages of that epoch, which ended 12,000 years ago, with the start of the Holocene. *Ceteris paribus*, one would expect the same atmospheric chemistry to produce the same climatic conditions, and the only difference between our atmosphere and that of the MPWP is the presence in ours of aerosols, which have a cooling effect (Andreae, Jones and Cox, 2005 [8]). These, however, are short-lived, and are due to be removed by clear-air legislation, ending what Hansen, Kharecha and Sato (2013 [9]) called the 'Faustian bargain' entailed by the burning of fossil fuels, which produces both CO_2 and aerosols.

The impression one gains is of a supposedly intelligent species heading, lemming-like, for the metaphorical clifftop and mass-suicide. The author has examined the so-called 'Doomsday Argument' which suggests that extinction in the not-too-distant future does indeed await us (Blaber, 2022d [10]). The argument does have its critics, e.g., Lewis (2013 [11]); Northcott (2015 [12]); and Wilson (2017 [13]), but they are all missing the fundamental point, which applies, not merely to humans, but to all living things.

[2] The Struggle of Life Against Death.

All life is a perpetual struggle against death and against entropy, death representing the ultimate triumph of entropy (Schrödinger, 1944 [14]; Brillouin in Buckley, ed., 1968, 2017 [15]).

However, this struggle is doomed to failure, not only for the individual member of each species, but for whole species, genera, tribes, orders and classes of them, and – ultimately – for all life itself. Thus, the large-scale force of continental drift, which will create the super-continent of Pangaea Ultima, located near the Equator, in 250 million years' time, will result in the probable extinction of all terrestrial mammalian life (Farnsworth *et al*, 2023 [16]). All aquatic mammalian life is likely to have become extinct much sooner, without a drastic change in human behaviour (Davidson *et al*, 2012 [17]; Sanders *et al*, 2023 [18]).

Ultimately, regardless of any such changes, *all* life on Earth, right down to the humblest bacterium and virus, is destined for extinction – in 1.1 billion years, when the increase in solar luminosity, by 10% (the Sun increases in luminosity by 1% every 110 million years), will cause all the liquid water on the planet's surface to evaporate, leading – because water vapour is a greenhouse gas – to a runaway greenhouse effect, and soaring temperatures, well beyond the capacity of even the most heat-loving of thermophilic bacteria to tolerate (see Schröder and Connon Smith, 2008 [19], pp.157-9).

Earth is engulfed and destroyed by the Sun (as a Red Giant) 7.59 billion years from now, 6.49 billion years after all life has become extinct, and 3.8 and a million years, respectively, after Mercury and Venus have suffered a similar fate (op.cit., p.160). Zink, Batygin and Adams (2020 [20]) inform us that the Solar System as a whole is due to perish, as the Sun becomes a White Dwarf and thus loses mass, so that the outer gas giant planets, no longer held in place by its gravitational field, are attracted away from it by other, stronger, gravitational forces, this happening an average of 72 billion years, and no more than 100 billion years, from now. As Bertrand Russell declared (Russell, 1903 [21], p.2):

> **'all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and... the**

> **whole temple of Man's achievement... inevitably... buried beneath the debris of a universe in ruins...'**

[3] Extinction in the Near-Term Future?

That we are seeing an anthropogenic mass-extinction of animal and plant species, and indeed of entire genera, is only too apparent, as argued – and documented – by Ceballos, García and Ehrlich (2010 [22]); Ceballos *et al* (2015 [23]); Ceballos, Ehrlich and Dirzo (2017 [24]); Ceballos, Ehrlich and Raven (2020 [25]); Dirzo, Ceballos and Ehrlich (2022 [26]); and Ceballos and Ehrlich (2023 [27]). The *State of Nature Report* (Burns *et al*, 2023 [28]), makes grim reading as far as the UK's biodiversity is concerned. The 2022 WWF *Living Planet Report* (Almond *et al*, eds., 2022 [29]), makes equally grim reading regarding the global picture of biodiversity, in spite of its attempt at an upbeat title ('Building a Nature-Positive Society').

Humans should not – and cannot afford – to view such species declines and extinctions with equanimity, as if they were of no concern, and will have no impact on human life. This is very far from being the case. To take just one example, that of the insects, which, with some exceptions, have been in decline globally, with some species being lost, since the 1950s. Of greatest importance, from the human perspective, is the fact that over 80% of the world's flowering plants are thought to be dependent on insects for their pollination, and ~75% of crop species are dependent on insect pollination, see Wagner (2019 [30]). As Wagner says (op.cit.):

> **'Insects serve essential roles in the food webs of tropical and temperate terrestrial and freshwater ecosystems. The existence of most of the terrestrial vertebrates on this planet is supported by insect life directly or indirectly, and the diminishment of insect numbers would greatly accelerate the sixth great planetary extinction... Another key economic and food security benefit is the role of insects in controlling pest invertebrates, fungi, and weeds.'**

However, some insects – particularly those that are vectors of tropical diseases – continue to flourish, and their spread, along with that of the

diseases they carry, is favoured by anthropogenic climate change, as noted by Caminade, McIntyre and Jones (2018 [31]).

Many of the insect vectors have developed resistance to insecticides, and many, if not most, of the diseases they carry have developed drug and antibiotic resistance in recent years, due to over-prescription and the great ability of the disease organisms to adapt and, in the case of bacteria, to pass genetic material synchronically, as well as diachronically – see Nicoletti (in Nicoletti, 2020 [32], see esp. p.24).

[4] Capitalism and Climate Change.

Karl Marx, in his *The Poverty of Philosophy* (Marx, 1847 [33], Ch.2, 'The Metaphysics of Political Economy,' p.49), informs us that:

> **'In acquiring new productive forces men change their mode of production; and in changing their mode of production, in changing the way of earning their living, they change all their social relations. The hand-mill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist.'**

The steam of the steam-mill was, of course, produced by boiling water by means of burning coal, and the energy from burning coal was also used to power trains, steam-ships and other industrial machinery. Later, coal was largely supplanted by oil and gas, although it is still used in countries such as China and India to provide electricity. Coal accounted for 5,400 TWh of electricity in China in 2022, or ~61% of the total supply, according to Statista, 2023 [34]; it accounted for 66.7% of the 162.7 TWh generated in August 2023 in India, according to Reuters (via *Al Jazeera*, 2023 [35]).

The burning of fossil fuels still provides the bulk of the energy on which the global capitalist economy depends: in 2022, global primary energy consumption totalled 178,899 TWh = 644.0364 EJ (exajoules), of which oil constituted 29.61%, coal, 25.07% and natural gas, 22.03%, making a total of 76.71%.

In addition to these fuels, however, were others which, when burned, produce CO_2: 'traditional biomass', accounting for 6.21%, and 'modern biofuels' – essentially ethanol obtained from soya, maize,

wheat, oil palm and other crops, all of their cultivation for this purpose adversely impacting local biodiversity – which accounted for a further 0.67%. Carbon dioxide-emitting fuels thus accounted, in 2022, for a grand total of 83.59% of global primary energy consumption, or ~538.35 EJ (source: Our World in Data, no date [36]; Tudge, Purvis and De Palma, 2021 [37]). As nuclear power accounted for ~3.75% of the total ([36], op.cit.), or ~24.15 EJ, renewables only accounted for 12.66% of global primary energy consumption in 2022, or 81.535 EJ.

The International Energy Agency (IEA, 2023 [38]) maintain that world oil supply and demand will amount to 97.4 million barrels/day, or 35.551 billion barrels/year (~4.849 billion tonnes/year, using conversion factor supplied by BP, 2021 [39]), in 2050, under their 'STEPS' ('Stated Energy Policy Scenario'), i.e., given governments' present policies for energy and climate change (Chapter 3, Table 3.5, p.130). Natural gas production and demand under the STEPS in 2050, they say, will be 4.173 trillion m^3 (Table 3.6, p.135). World coal demand and production, they inform us, will amount to 3.465 billion tonnes of coal equivalent under the STEPS in 2050 (Table 3.7, p.140). Even accepting these figures without cavil, the IEA would appear to have a strange notion of 'net-zero' – one which permits large quantities of CO_2 to continue being emitted, in the hope that it will be absorbed by carbon sinks, or removed from the atmosphere by CCS technology. Yet already, many of the carbon sinks are disappearing, and even being turned into carbon sources, as is the case with the Amazon rainforest (Gatti *et al*, 2021 [40]). Acidification, caused by the dissolving of CO_2 in water to form carbonic acid (H_2CO_3), is reducing the capacity of the oceans and seas to absorb more of that gas – see Turley *et al* (2006 [41]); DeVries (2022 [42]).

As for Carbon Capture and Storage (CCS) technology, the Institute for Energy Economics and Financial Analysis (IEEFA) produced a damning report on it last year (Robertson and Mousavian, 2022 [43]), which showed that it has been mainly used for enhanced oil recovery or natural gas processing, producing *more* atmospheric CO_2, not less – to the extent that nearly ~75% of CO_2 captured annually by such technology is reinjected into oilfields to push more oil and gas out of the ground. Furthermore, failed and underperforming projects considerably outnumbered the successful ones. The main contention of

Robertson and Mousavian's case is confirmed by a report in *The Washington Post* of Wednesday 25th October 2023 (Osaka, 2023 [44]).

It is frequently argued (by, for example, the IEA, 2022 [45]) that the productive process, in being made more energy efficient, will result in reduced energy consumption, and that fossil fuel consumption – and thus CO_2 emissions – will be reduced that way. This flies in the face of the empirical evidence, as documented by (*inter alios*) Brookes (2000 [46]); Herring (2006 [47]); Herring and Roy (2007 [48]); Hanley *et al* (2009 [49]); and Allan *et al* (in Evans and Hunt, eds., 2009 [50]), which, in turn, only builds on the theoretical foundation established by Jevons (1865, 1866 [51]); Khazzoom (1980 [52]); Brookes (1990 [53]); and Alcott (2005 [54]).

It should, in fact, be self-evident that, in a capitalist economy, where the profit motive is paramount, any gains in the energy efficiency of production would lead capitalists to increase production, in order to maximise output, and thus revenues and profits. However, there is a thermodynamic limit to the extent to which the efficiency of energy production, storage and transmission can be improved, and the energy efficiency of mechanical and productive processes can be improved – see Lior and Zhang (2007 [55]); Cullen and Allwood (2010 [56]).

The dominance of fossil fuels in the energy mix is unlikely to be reduced if the world's governments continue to subsidise them at their current rate. The International Monetary Fund (IMF) has reported that, globally, subsidies to fossil fuels amounted to US$5.9 trillion in 2020, or 6.8% of global GDP (Parry, Black and Vernon, 2021 [57]). They claimed, in that report, that these subsidies would rise to 7.4% of global GDP by 2025. In their latest update (Black *et al*, 2023 [58]), they inform us that, in 2022, global government fossil fuel subsidies rose to $7 trillion, or 7.1% of global GDP. This is $221,968.54 every single second, or $875 p.a. for every man, woman and child on the planet, given the world's human population is ~8 billion. It also dwarfed global military expenditure in 2022 – a mere $2.24 trillion, or 2.2% of global GDP, according to the Stockholm International Peace Research Institute (SIPRI; see Tian *et al*, 2023 [59]).

There are considerable obstacles in the way of the transition to renewable energy, not least the doctrines of free market economists, as Dessler (2022 [60]) points out. Right-wing politics and conservative religion are further obstacles, as are the ambitions of (hardly

disinterested) international bodies such as the Organisation of the Petroleum Exporting Countries, OPEC – see OPEC (2022 [61]). This predicts that global oil demand will be 110 million barrels a day in 2045 (40.15 billion barrels/year), and that the oil sector will require $12.1 trillion of investment in the 22 years from now until 2045 to ensure this supply, or $550 billion a year (see Blaber [4], op.cit., p.2). These predictions are difficult to reconcile with those of the IEA for 2050 ([38], op.cit., see p.6, above). $550 billion is 2.16% of the 2022 US current dollar GDP of $25.46 trillion (source: Bureau of Economic Analysis, US Department of Commerce, 2023 [62]).

As for the right-wing politics and conservative religion, at the first, and televised, Republican Party primary debate for the US Presidential Election in 2024, which took place on the 23rd August, only Nikki Haley, of those present, acknowledged the reality of climate change (and then only to call on China and India to reduce *their* emissions, saying nothing of those of the US), and Vivek Ramaswamy denied its existence outright, saying 'The climate agenda is a hoax' (see Marcus, 2023 [63]). That this is the view of the absentee from the debate, and leading contender for the Republican nomination, in spite of two State and two federal indictments against him, Donald Trump, who has called anthropogenic climate change a 'Chinese hoax', and has said nothing more recently to indicate any alteration of opinion, is clear enough – see Philips (2016 [64]); Dale (2023 [65]); Quinn and Kates (2023 [66]).

Regarding the conservative religious climate change deniers, it is not necessary to repeat here what the present author established in [3], save to note that theological opponents of action to remediate climate change remain as vocal as ever, or – in the case of the American Catholic bishops – as *silent* as ever, even when their spiritual leader, Pope Francis, urges them to speak out on the issue in a positive way, as noted by Danielsen, DiLeo and Burke (2021 [67]). Evangelical Protestants in the US, particularly white ones, align with the Republican Party and with climate change denialism, as pointed out by Bardon (2020 [68]); Veldman *et al* (2020 [69]).

[5] Capitalism and the Rape of Gaia.

As the author claimed in [1], capitalism needs to grow, or it dies, and as the global capitalist economy grows, so, too, must the global human population grow. In fact, the two things are mutually dependent: if the population grows, the economy must grow to supply their increased wants and needs; but a growing economy needs more consumers to purchase its increased output of goods and services, even if – in this age of increasing automation, and of artificial intelligence – it does not need more workers to produce those goods and services in the first place.

Increasing output requires more material resources and more energy, and implies more waste and pollution, yet we live on a finite planet, with finite resources and a finite capacity to absorb that waste and pollution. The 8 billion people on Earth now consume the equivalent of 1.7 Earths in terms of its biocapacity – the amount of resources it can provide and the waste and emissions it can absorb. By 2050, given the expected increase in population, this will have increased to 3 Earths (Foundation Myclimate, 2023 [70]; Rees and Wackernagel, 2023 [71]). We produce 400 million tonnes of plastic waste every year (United Nations Environment Programme [UNEP], no date [72]). Total plastic production is, they say, expected to reach 1.1 billion tonnes by 2050, 98% of single-use plastic products are made from fossil fuels, and between 75-199 million tonnes of plastic waste are found in the oceans, where it constitutes a considerable threat to marine life (Macleod *et al*, 2021 [73]), as it does – so they tell us – to life (including human life) on land. They inform us that some 99.8% of the plastic that has entered the oceans since 1950 is below their surface. The International Union for Conservation of Nature and Natural Resources [IUCN] (2021 [74]) confirms this.

Unfortunately, plastic pollution is far from being the only kind, as there are many others, of the soil, water and air, air pollution (referred to above in relation to the cooling effect of aerosols, see p.2) being responsible for 6.7 million premature deaths every year, according to the World Health Organisation [WHO] (2023 [75]). They list, as air pollutants having an adverse impact on human health, particulate matter (PM10s and PM2.5s), carbon monoxide, ozone, nitrous oxide and sulphur dioxide. Ozone, whilst protecting life from the Sun's ultraviolet radiation in the stratosphere, is harmful when present in the troposphere (Zhang, Wei and Fang, 2019 [76]); nitrous

oxide is also a greenhouse gas and a stratospheric ozone-layer depleting gas (Goyal and Qanungo, 2023 [77]), which is now present in the atmosphere (as of June 2023) at a level of 336.64 ppb (source: US National Oceanographic and Atmospheric Administration [NOAA] Global Monitoring Laboratory, 2023 [78]), an increase of ~0.34% on the previous June.

Other pollutants include the so-called 'gender-bending' chemical substances whose ingestion by humans is impairing the very fertility capitalists like Elon Musk are so anxious to promote (sc., Green *et al*, 2021 [79]; Shead, 2021 [80]).

The truth is, *no* productive process of any kind can take place without generating a measure of waste, of both material resources and energy. Any talk of a 'circular economy', of the kind promoted by the European Commission's Directorate-General for Environment (no date [81]) is pure nonsense, as is any talk of 'sustainable growth' (ibid.), which is a *contradicto in adiecto* (Hickel and Kallis, 2019 [82]; Lange and Berner, 2022 [83]). Biology and physics should have taught the Commissioners this: human metabolism produces solid and liquid waste, and humans, like all animals, exhale CO_2, having once inhaled oxygen. The human body produces surplus energy in the form of heat. *All* metabolic processes generate material waste and surplus energy. A so-called 'circular economy' is a doomed attempt to evade thermodynamic and information entropy, which cannot possibly succeed (Vopson, 2020 [84]; Giampietro in Lehmann *et al*, eds., 2022 [85]).

Gaia (Γαῖα) was, as is well-known, the Greek Earth Mother Goddess (see Graves, 1955, 1960, Ch.3, pp.31-33; Ch.6, pp.37-39, Ch.7, pp.39-41 [86]). Do we humans imagine that she will take kindly to our continued assaults on her, and that we can rape her with impunity? If we do, that is only testament to our folly.

[6] Conclusion: Capitalism Past the Ecological Tipping-Points?

If there is any truth in the Gaia Hypothesis (Lovelock, 1972 [87]; Lovelock and Margulis, 1974 [88]; Lovelock, 1989 [89]), then we would expect that, if the purpose (insofar as it can be said to have a purpose) of the Gaia mechanism is to preserve and sustain the biosphere, then it would automatically eliminate any threat to the

biosphere's continued existence. If our species has become such a threat – which is surely unarguable – then we are imperilled indeed.

Let us be clear that the Gaia mechanism is not some conscious, conative entity. It *is* merely a mechanism, a set of actual or potential positive and negative feedback loops, and we should beware of confusing metaphorical or analogical language with the literal variety.

Recent research has made it clear that humanity's activities have pushed Earth over seven out of eight of what the authors of the paper term 'globally quantified safe and just Earth system boundaries', or 'ESBs' (Rockström *et al*, 2023 [90]). Deutloff, Held and Lenton (2023 [91]) argue that there are no fewer than sixteen 'tipping elements' in the Earth system, and they assess the probability of these events, the global mean surface temperatures at which they are likely to occur, and when they are likely to occur. Already, in the case of the Greenland icesheet and the West Antarctic icesheet, their estimates now seem wildly out-of-date (Bochow *et al*, 2023 [92]; Naughten, Holland and DeRydt, 2023 [93]).

If the so-called 'Kaya Identity' (see Yamaji *et al*, 1993 [94]) is only a version of Holdren and Ehrlich's 'IPAT' equation (Holdren and Ehrlich, 1974 [95]), which may well be disputed, as their work was not confined to the issue of climate change, it is, in one sense, a mere truism, and can be stated thus:

$$\Delta C = \Delta P.(\Delta Y/\Delta P).(\Delta E/\Delta Y).(\Delta C/\Delta E)$$

$$= \Delta E.(\Delta C/\Delta E) \ .$$

Here, Δ represents 'change in', C is global annual carbon emissions, P is global human population, Y is global annual GDP, and E is the total amount of energy used by the human population in any given year. As may quite easily be seen, all the parts of the equation save one cancel out, leaving $\Delta C = \Delta C$. The crucial part of the equation is, in fact, $\Delta C/\Delta Y$, the change in the carbon intensity of global GDP.

It has been the thesis of this work that this will not be reduced sufficiently under capitalism to achieve the reductions in CO_2 and other GHGs required to meet the Paris Agreement targets of 1.5°C and 2°C (United Nations Framework Convention on Climate Change [UNFCCC], 2015 [96]). Indeed, Liu *et al* (2022 [97]) argued that the

remaining carbon budget for 1.5°C was likely to be exhausted in less than ten years, following the emission of 34.9 Gt of CO_2 in 2021, which constituted 8.7% of that budget, and was an increase of 4.8% on the 33.3 Gt of CO_2 emitted globally during the COVID-19 affected 2020. Tiseo (2023 [98]) reports that the world emitted 37.49 Gt of CO_2 in 2022. It should be borne in mind that these amounts are cumulative, leading to a seemingly inexorable rise in atmospheric carbon dioxide, to a level not seen for over 3 million years, as noted in [7].

Given the problems of the spread of tropical diseases, referred to above (p.5), of rising sea-levels, caused by the melting of polar ice-sheets (see p.12), of widespread and acute food and water shortages caused by climate change (see [1]), and food shortages also caused by loss of soil fertility and insect pollinators (see [1] and pp.4-5), it seems almost gratuitous to point out the additional problem arising from excessive heat and humidity, beyond the capacity of the human body to survive. Yet there will be many parts of the world in the coming decades, and particularly (but not exclusively) in the Global South, where, for many days of the year, what is called the wet bulb globe temperature will exceed 32°C, and be hazardous to human health. Some 5 billion people will experience such extreme heat (when outdoors in the Sun) for at least a month by 2050. The figure will be 4 billion in 2030, and 80% of that 2030 population exposed to extreme heat will live in countries with an estimated GDP per capita of <$25,000 p.a. (source: Kommenda *et al*, 2023 [99]).

We are heading for little short of utter disaster, and it only remains to point out that one of the main causes of military conflict is competition for scarce vital resources (Ehrlich, A.H., Gleick and Conca, 2001 [100]). If people are desperate for food and water, and they see their neighbours have these things, the veneer of civilised behaviour will quickly be lost. What applies to individuals, families and small groups will apply also to tribes – and whole nations, and those nations that have will seek to hold on to what they have, and fight off those that have not.

Another such cause is migration, which will be greatly increased by climate change, and if migration is a cause of much angst amongst public and politicians now, how much more angst will that greatly increased flow of migrants generate in future? The potential conflicts between different ethnic, religious and national groups brought into

greater proximity by such migration, especially given the scarcity of vital resources, fill the imagination with the darkest possible forebodings (see: Choi, Poertner and Sambanis, 2019 [101]; Helbling and Meierricks, 2020 [102]; Döring and Hall, 2023 [103]).

REFERENCES.

[1] Blaber, R.M., 'The Coming Malthusian Catastrophe: The Climate and Biodiversity Crises as Global Food Crisis,' Version 6, 4th September 2023, *SocArXiv Papers*, DOI: 10.31235/osf.io/wef2n, https://osf.io/preprints/socarxiv/wef2n/.

[2] Blaber, R.M., 'The Unpolitics of Climate Change: Why the World is Still Heading for Climate Catastrophe, in Spite of All the Conferences, All the Political Rhetoric, and All the Climate Activism,' Version 2, 4th April 2022, *SocArXiv Papers*, DOI: 10.31235/osf.io/tj6ku, https://osf.io/preprints/socarxiv/tj6ku/.

[3] Blaber, R.M., 'The Theology of Opposition to the Existence of Anthropogenic Climate Change,' Version 3, 13th May 2022, *SocArXiv Papers*, DOI: 10.31235/osf.io/ryk2n, https://osf.io/preprints/socarxiv/ryk2n/.

[4] Blaber, R.M., 'Global Demand for Energy and Fossil Fuels in 2045, with Consequent CO_2 Emissions,' Version 3, 22nd July 2023, *SocArXiv Papers*, DOI: 10.31235/osf.io/j5pe6, https://osf.io/preprints/socarxiv/j5pe6/.

[5] US Census Bureau, International Database, World, 2023, https://www.census.gov/data-tools/demo/idb/#/dashboard?COUNTRY_YEAR=2023&COUNTRY_YR_ANIM=2023.

[6] Blaber, R.M., 'Optimum Population Size Revisited,' Version 4, 14th April 2022, *SocArXiv Papers*, DOI: 10.31235/osf.io/b5zfa, https://osf.io/preprints/socarxiv/b5zfa/.

[7] Blaber, R.M., 'Reproducing the Mid-Piacenzian Warm Period Climate in the 2020s,' *Journal of Modern and Applied Physics* **6(4):1-4**, 3rd October 2023 (issue date December 2023), DOI: 10.3752/puljmap.2023.6.4.1-4, https://www.pulsus.com/scholarly-articles/reproducing-the-midpiacenzian-warm-period-climate-in-the-2020s.pdf.

[8] Andreae, M.O., Jones, C.D. & Cox, P.M., 'Strong present-day aerosol cooling implies a hot future,' *Nature* **435(7046):1187-1190**, 30th June 2005, DOI: 10.1038/nature03671, https://nature.berkeley.edu/biometlab/espm298/Andreae-SlimateSensitivity-2005.pdf.

[9] Hansen, J.E., Kharecha, P. & Sato, M., 'Doubling Down on Our Faustian Bargain,' 29th March 2013, https://www.columbia.edu/~jeh1/mailings/2013/20130329_FaustianBargain.pdf.

[10] Blaber, R.M., 'The "Doomsday Argument" and Ecological Catastrophe,' Version 2, 14th August 2022, *SocArXiv Papers*, DOI: 10.31235/osf.io/ne2z9, https://osf.io/preprints/socarxiv/ne2z9/.

[11] Lewis, P.J., 'The Doomsday Argument and the Simulation Argument,' *Synthese* **190:4009-4022**, 25th January 2013, DOI: 10.1007/s11229-013-0245-9, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=a58775d3e39935a31d3bebf887ed86fcf9a91315.

[12] Northcott, R., 'A Dilemma for the Doomsday Argument,' *Ratio* **29(3):268-282**, 12th June 2015, DOI: 10.1111/rati.12104, https://eprints.bbk.ac.uk/id/eprint/12284/3/12284.pdf.

[13] Wilson, A., 'The Quantum Doomsday Argument,' *The British Journal for the Philosophy of Science* **68(2):597-615**, June 2017, DOI: 10.1093/bjps/axv035, https://alastairwilson.org/files/qdaweb.pdf.

[14] Schrödinger, E.R.J.A. (1944), *What Is Life? The Physical Aspect of the Living Cell*, based on lectures delivered under the auspices of the Dublin Institute for Advanced Studies, Trinity College, Dublin, February 1943, London: Folio Society, hdbk. (2000).

[15] Brillouin, L., 'Life, Thermodynamics, and Cybernetics,' in Buckley, W., ed. (1968, 2017), *Systems Research for Behavioral Science, A Sourcebook*, New York: Routledge, eBook ISBN: 978-1-315-13056-9, Part A, Ch.18, 10pp.

[16] Farnsworth, A. *et al*, 'Climate extremes likely to drive land mammal extinction during next supercontinent assembly,' *Nature Geoscience* **16:901-908**, 25th September 2023 (issue date October 2023), DOI: 10.1038/s41561-023-01259-3, https://www.nature.com/articles/s41561-023-01259-3.

[17] Davidson, A.D. *et al*, 'Drivers and hotspots of extinction risk in marine mammals,' *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* **109(9):3395-3400**, 30th January 2012, DOI: 10.1073/pnas.1121469109, https://www.pnas.org/doi/10.1073/pnas.1121469109.

[18] Sanders, E. *et al*, 'Extinction risk of the world's freshwater mammals,' *Conservation Biology*, 11th August 2023, DOI: 10.1111/cobi.14168, https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1111/cobi.14168.

[19] Schröder, K.P. & Connon Smith, R., 'Distant future of the Sun and Earth revisited,' *Monthly Notices of the Royal Astronomical Society (MNRAS)* **386(1):155-163**, 1st May 2008, DOI: 10.1111/j.1365-2966.2008.13022.x, https://core.ac.uk/download/pdf/2715362.pdf.

[20] Zink, J.K., Batygin, K. & Adams, F.C., 'The Great Inequality and the Dynamical Disintegration of the Outer Solar System,' *The Astronomical Journal* **160(5):232** (article number), 29th October 2020 (issue date 1st November 2020), DOI: 10.3847/1538-3881/abb8de, https://iopscience.iop.org/article/10.3847/1538-3881/abb8de.

[21] Russell, B., 'A Free Man's Worship,' first published as 'The Free Man's Worship,' December 1903, in *The Collected Papers of Bertrand Russell*, Vol.12, *Contemplation and Action 1902-14*, London: Routledge (1985), https://www.skeptic.ca/Bertrand_Russell_Collection.pdf.

[22] Ceballos, G., García A. & Ehrlich, P.R., 'The Sixth Extinction Crisis Loss of Animal Populations and Species,' *Journal of Cosmology* **8:1821-1831**, June 2010, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=a60baf53a78569e9b29a4159467eb9128313039e.

[23] Ceballos, G. *et al*, 'Accelerated modern human-induced species losses: Entering the sixth mass extinction,' *Science Advances* **1(5):e1400253** (article number), 19th June 2015, DOI: 10.1126/sciadv.1400253, https://www.science.org/doi/full/10.1126/sciadv.1400253.

[24] Ceballos, G., Ehrlich, P.R. & Dirzo, R., 'Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines,' *PNAS* **114(30):E6089-E6096**, 23rd May 2017, DOI: 10.1073/pnas.1704949114, https://www.pnas.org/doi/pdf/10.1073/pnas.1704949114.

[25] Ceballos, G., Ehrlich, P.R. & Raven, P.H., 'Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction,' *PNAS* **117(24):13596-13602**, 1st June 2020, DOI: 10.1073/pnas.1922686117, https://www.pnas.org/doi/pdf/10.1073/pnas.1922686117.

[26] Dirzo, R., Ceballos, G. & Ehrlich, P.R., 'Circling the drain: the extinction crisis and the future of humanity,' *Philosophical Transactions of the Royal Society of London B: Biological Sciences* **377(1857):2021038** (article number), 15th August 2022, DOI: 10.1098/rstb.2021.0378, https://royalsocietypublishing.org/doi/full/10.1098/rstb.2021.0378.

[27] Ceballos, G. & Ehrlich, P.R., 'Mutilation of the tree of life via mass extinction of animal genera.' *PNAS* **120(39):e2306987120**, 18th September 2023, DOI: 10.1073/pnas.2306987120, https://www.pnas.org/doi/full/10.1073/pnas.2306987120.

[28] Burns, F. *et al* (2023), *State of Nature 2023*, State of Nature Partnership, https://stateofnature.org.uk/wp-content/uploads/2023/09/TP25999-State-of-Nature-main-report_2023_FULL-DOC-v12.pdf.

[29] Almond, R.E.A., Grooten, M., Juffe Bignolli, D. & Petersen, T., eds. (2022), *Living Planet Report 2022 – Building a nature-positive society*, Gland, Switzerland: World Wide Fund for Nature International, ISBN: 978-2-88085-316-7, https://wwflpr.awsassets.panda.org/downloads/lpr_2022_full_report_1.pdf.

[30] Wagner, D.L., 'Insect Declines in the Anthropocene,' *Annual Review of Entomology* **65:457-480**, 14th October 2019 (issue date January 2020), DOI: 10.1146/annurev-ento-011019-025151, https://www.annualreviews.org/doi/full/10.1146/annurev-ento-011019-025151.

[31] Caminade, C., McIntyre, K.M. & Jones, A.E., 'Impact of recent and future climate change on vector-borne diseases,' *Annals of the New York Academy of Sciences* **1436(1):157-173**, 18th August 2018 (issue date January 2019), DOI: 10.1111/nyas.13950, https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1111/nyas.13950

[32] Nicoletti, M., 'Past, present, and future of insect-borne diseases,' in Nicoletti, M. (2020), *Insect-Borne Diseases in the 21st Century*, Amsterdam, Netherlands: Elsevier, eBook ISBN: 978-0-12-818707-4, published online 21st August 2020, DOI: 10.1016/B978-0-12-818706-7.00001-2, Ch.1, pp.2-38, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7442135/pdf/main.pdf.

[33] Marx, K. (1847), *The Poverty of Philosophy, Answer to the Philosophy of Poverty [Misère de la philosophie] by M. [Pierre-*

Joseph] Proudhon, Paris/Brussels, Moscow: Progress Publishers, 1955, https://www.marxists.org/archive/marx/works/download/pdf/Poverty-Philosophy.pdf.

[34] Statista Research Department, 'Electricity generation share from coal in China from 2000 to 2022,' 25th August 2023, https://www.statista.com/statistics/1303368/coal-electricity-production-share-in-china/.

[35] Reuters News, 'India burns more coal for power as dry weather sparks blackout fears,' *Al Jazeera*, Monday 4th September 2023, https://www.aljazeera.com/economy/2023/9/4/india-burns-more-coal-for-power-as-dry-weather-sparks-blackout-fears.

[36] Our World in Data, 'Global primary energy consumption by source,' no date, Global Change Data Lab, Oxford Martin School, University of Oxford, https://ourworldindata.org/grapher/global-energy-substitution.

[37] Tudge, S.J., Purvis, A. & De Palma, A., 'The impacts of biofuel crops on local biodiversity: a global synthesis,' *Biodiversity and Conservation* **30:2863-2883**, 24th July 2021, DOI: 10.1007/s10531-021-02232-5, https://link.springer.com/article/10.1007/s10531-021-02232-5.

[38] International Energy Agency [IEA] (2023), *World Energy Outlook 2023*, Paris, France: IEA, https://iea.blob.core.windows.net/assets/26ca51d0-4a42-4649-a7c0-552d75ddf9b2/WorldEnergyOutlook2023.pdf.

[39] BP (2021), *Statistical Review of World Energy, Approximate conversion factors*, updated July 2021, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-approximate-conversion-factors.pdf.

[40] Gatti, L.V. *et al*, 'Amazonia as a carbon source linked to deforestation and climate change,' *Nature* **595(7867):388-393**, 14th July 2021 (issue date 15th July 2021), DOI: 10.1038/s41586-021-03629-6, https://library.wur.nl/WebQuery/wurpubs/fulltext/550457.

[41] Turley, C. *et al*, 'Reviewing the Impact of Increased Atmospheric CO_2 on Oceanic pH and the Marine Ecosystem,' in Schellnhuber, H.J. *et al*, eds. (2006), *Avoiding Dangerous Climate Change*, Cambridge: Cambridge University Press (CUP), ISBN: 978-0-521-86471-8, hdbk., Section I, Ch.8, pp.65-70, https://pure.iiasa.ac.at/id/eprint/7972/1/avoid-dangercc.pdf#page=79.

[42] DeVries, T., 'The Ocean Carbon Cycle,' *Annual Review of Environment and Resources* **47:317-341**, 25th July 2022 (issue date October 2022), DOI: 10.1146/annurev-environ-120920-111307, https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-120920-111307.

[43] Robertson, B. & Mousavian, M. (2022), *The carbon capture crux: Lessons learned*, Lakewood, Ohio, USA: Institute for Energy Economics and Financial Analysis (IEEFA), 1st September 2022, pdf. available from: https://ieefa.org/resources/carbon-capture-crux-lessons-learned.

[44] Osaka, S., 'Companies capture a lot of CO_2. Most of it is going into new oil,' *The Washington Post*, Wednesday 25th October 2023, https://www.washingtonpost.com/climate-environment/2023/10/25/enhanced-oil-recovery-carbon-capture/.

[45] IEA (2022), *Energy Efficiency 2022*, Paris, France: IEA, https://iea.blob.core.windows.net/assets/7741739e-8e7f-4afa-a77f-49dadd51cb52/EnergyEfficiency2022.pdf.

[46] Brookes, L., 'Energy efficiency fallacies revisited,' *Energy Policy* **28(6-7):355-366**, June 2000, DOI: 10.1016/S0301-4215(00)00030-6, abstract & extracts only at: https://www.sciencedirect.com/science/article/abs/pii/S0301421500000306.

[47] Herring, H., 'Energy efficiency – a critical view,' *Energy* **31(1):10-20**, January 2006, DOI: 10.1016/j.energy.2004.04.055, http://www.fraw.org.uk/data/economics/herring_2006.pdf.

[48] Herring, H. & Roy, R., 'Technological innovation, energy efficient design and the rebound effect,' *Technovation* **27(4):194-203**, April 2007, DOI: 10.1016/j.technovation.2006.11.004, https://oro.open.ac.uk/7182/1/Herring%2526RoyTechnovationNov06v2.pdf.

[49] Hanley, N., McGregor, P.G., Swales, J.K. & Turner, K., 'Do increases in energy efficiency improve environmental quality and sustainability?', *Ecological Economics* **68(3):692-709**, 15th January 2009, DOI: 10.1016/j.ecolecon.2008.06.004, https://dspace.stir.ac.uk/bitstream/1893/7707/1/Hanley%20et%20al%20Ecological%20Economics%202009_turner%20last.pdf.

[50] Allan, G. *et al*, 'The economics of energy efficiency,' in Evans, J. & Hunt, L.C., eds. (2009), *International Handbook on the Economics of Energy*, Cheltenham, Gloucestershire: Edward Elgar Publishing, ISBN: 978 1 84720 352 6, pbk., Ch.7, pp.144-183, https://pure.strath.ac.uk/ws/portalfiles/portal/64505790/strathprints015532.pdf.

[51] Jevons, W.S. (1865, 1866), *The Coal Question; An Enquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines*, London: Macmillan & Co., hdbk., 2nd ed., 1866, https://oll-resources.s3.us-east-2.amazonaws.com/oll3/store/titles/317/Jevons_0546.html.

[52] Khazzoom, J.D., 'Economic Implications of Mandated Efficiency in Standards for Household Appliances,' *The Energy Journal* **1(4):21-40**, October 1980, DOI: 10.5547/ISSN0195-6574-EJ-Vol1-No4-2, abstract only at: https://www.iaee.org/energyjournal/article/1472.

[53] Brookes, L., 'The greenhouse effect: the fallacies in the energy efficiency solution,' *Energy Policy* **18(2):199-201**, March 1990, DOI: 10.1016/0301-4215(90)90145-T, abstract only at: https://www.sciencedirect.com/science/article/abs/pii/030142159090145T.

[54] Alcott, B., 'Jevons' Paradox,' *Ecological Economics* **54(1):9-21**, 1st July 2005, DOI: 10.1016/j.ecolecon.2005.03.020, abstract & extracts only at: https://www.sciencedirect.com/science/article/abs/pii/S0921800905001084.

[55] Lior, N. & Zhang, N., 'Energy, exergy, and Second Law performance criteria,' *Energy* **32(4):281-296**, April 2007, DOI: 10.1016/j.energy.2006.01.019, https://www.seas.upenn.edu/~lior/documents/EnergyexergyandSecondLawperformancecriteriapublished.pdf.

[56] Cullen, J.M. & Allwood, J.M., 'Theoretical efficiency limits for energy conversion devices,' *Energy* **35(5):2059-2069**, May 2010, DOI: 10.1016/j.energy.2010.01.024, abstract & extracts only at: https://www.sciencedirect.com/science/article/abs/pii/S001191641731648X.

[57] Parry, I.W.H., Black, S. & Vernon, N., 'Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies,' 24th September 2021, Washington DC, USA: International Monetary Fund (IMF), https://www.imf.org/en/Publications/WP/Issues/2021/09/23/Still-Not-Getting-Energy-Prices-Right-A-Global-and-Country-Update-of-Fossil-Fuel-Subsidies-466004.

[58] Black, S., Liu, A.A., Parry, I.W.H. & Vernon, N., 'IMF Fossil Fuel Subsidies Data: 2023 Update,' 24th August 2023, Washington, DC, USA: IMF, https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281.

[59] Tian, N. *et al*, 'Trends in World Military Expenditure, 2022,' April 2023, Stockholm, Sweden: Stockholm International Peace Research Institute (SIPRI), https://www.sipri.org/sites/default/files/2023-04/2304_fs_milex_2022.pdf.

[60] Dessler, A., 'How greed and politics are slowing the switch to renewable energy,' *Bulletin of the Atomic Scientists*, Monday 17th January 2022, https://thebulletin.org/2022/01/how-greed-and-politics-are-slowing-the-switch-to-renewable-energy/.

[61] Organisation of the Petroleum Exporting Countries (OPEC), *World Oil Outlook, 2022-2045*, Vienna, Austria: OPEC Secretariat, 2022, ISBN: 978-3-9504890-4-0, pdf. from: https://woo.opec.org/.

[62] Bureau of Economic Analysis, US Department of Commerce, 'Gross Domestic Product, Fourth Quarter and Year 2022 (Third Estimate), GDP by Industry, and Corporate Profits,' Thursday 30th March 2023, https://www.bea.gov/news/2023/gross-domestic-product-fourth-quarter-and-year-2022-third-estimate-gdp-industry-and.

[63] Marcus, J., 'Republican candidates spark outrage with sweeping climate crisis denial at debate,' *The Independent*, Thursday 24th August 2023, https://www.independent.co.uk/climate-change/news/nikki-haley-ramaswamy-climate-change-republican-debate-b2398660.html.

[64] Philips, T., 'Climate change a Chinese hoax? Beijing gives Donald Trump a lesson in history,' *The Guardian*, Thursday 17th November 2016, https://www.theguardian.com/us-news/2016/nov/17/climate-change-a-chinese-plot-beijing-gives-donald-trump-a-history-lesson.

[65] Dale, D., 'Fact check: Trump's latest false climate figure is off by more than 1,000 times,' *CNN*, Monday 24th April 2023, https://edition.cnn.com/2023/04/24/politics/fact-check-trump-sea-levels-ocean-climate-change/index.html.

[66] Quinn, M. & Kates, G., 'Trump's 4 indictments in detail: A quick-look guide to charges, trial dates and key players for each case,' *CBS News*, Tuesday 5th September 2023, https://www.cbsnews.com/news/trump-indictments-details-guide-charges-trial-dates-people-case/.

[67] Danielsen, S., DiLeo, D.R. & Burke, E.E., 'U.S. Catholic bishops' silence and denialism on climate change,' *Environmental Research Letters* **16(11):114006** (article number), 19th October 2021, DOI: 10.1088/1748-9326/ac25ba, https://iopscience.iop.org/article/10.1088/1748-9326/ac25ba.

[68] Bardon, A., 'Faith and politics mix to drive evangelical Christians' climate change denial,' *The Conversation*, Wednesday 9th September 2020, https://theconversation.com/faith-and-politics-mix-to-drive-evangelical-christians-climate-change-denial-143145.

[69] Veldman, R.G., Wald, D.M., Mills, S.B. & Peterson, D.A.M., 'Who are American Evangelical Protestants and Why do they Matter for US Climate Policy?', *Wiley Interdisciplinary Reviews (WIREs) Climate Change* **12:e693** (article number), 30th November 2020 (issue date 2021), DOI: 10.1002/wcc.693, https://deepblue.lib.umich.edu/bitstream/handle/2027.42/166381/wcc693_am.pdf?sequence=1&isAllowed=y.

[70] Foundation Myclimate, 'Earth Overshoot Day: how do we handle our resources?', Wednesday 2nd August 2023, Zürich, Switzerland: Foundation Myclimate, https://www.myclimate.org/en/information/faq/faq-detail/earth-overshoot-day-how-do-we-handle-our-resources/.

[71] Rees, W.E. & Wackernagel, M., 'Ecological Footprint Accounting: Thirty Years and Still Gathering Steam,' *Environment: Science and Policy for Sustainable Development* **65(5):5-18**, 8th August 2023 (online), DOI: 10.1080/00139157.2023.2225405, notes & refs. only at:

https://www.tandfonline.com/doi/abs/10.1080/00139157.2023.2225405.

[72] United Nations Environment Programme (UNEP), 'Our planet is choking on plastic,' no date, https://www.unep.org/interactives/beat-plastic-pollution/.

[73] Macleod, M., Arp, H.P.H., Tekman, M.B. & Jahnke, A., 'The global threat from plastic pollution,' *Science* **373(6550):61-65**, 2nd July 2021, DOI: 10.1126/science.abg5433, https://www.science.org/doi/full/10.1126/science.abg5433.

[74] International Union for the Conservation of Nature and Natural Resources (IUCN), 'Marine plastic pollution,' November 2021, Gland, Switzerland: IUCN, https://www.iucn.org/resources/issues-brief/marine-plastic-pollution.

[75] World Health Organisation (WHO), 'Air quality and health,' 2023, Geneva, Switzerland: WHO, https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/health-impacts/types-of-pollutants.

[76] Zhang, J., Wei, Y. & Fang, Z., 'Ozone Pollution: A Major Health Hazard Worldwide,' *Frontiers in Immunology* **10**, 31st October 2019, DOI: 10.3389/fimmu.2019.02518, https://www.frontiersin.org/articles/10.3389/fimmu.2019.02518/full.

[77] Goyal, A. & Qanungo, K., 'Nitrous oxide as a greenhouse gas: A state of art,' *American Institute of Physics (AIP) Conference Proceedings* **2535(1):040009** (article number), 23rd May 2023, DOI: 10.1063/5.0111978, abstract only at: https://pubs.aip.org/aip/acp/article-abstract/2535/1/040009/2892367/Nitrous-oxide-as-a-greenhouse-gas-A-state-of-art?redirectedFrom=fulltext.

[78] US National Oceanographic and Atmospheric Administration (NOAA), Global Monitoring Laboratory, Earth System Research

Laboratories, 'Trends in Atmospheric Nitrous Oxide,' June 2023, https://gml.noaa.gov/ccgg/trends_n2o/.

[79] Green, M.P., Harvey, A.J., Finger, B.J. & Tarulli, G.A., 'Endocrine disrupting chemicals: Impacts on human fertility and fecundity during the peri-conception period,' *Environmental Research* **194:110694** (article number), March 2021, DOI: 10.1016/j.envres.2020.110694, https://rest.neptune-prod.its.unimelb.edu.au/server/api/core/bitstreams/342d1f7b-1aad-583c-80a8-baec54a5cded/content.

[80] Shead, S.L., 'Elon Musk says "civilization is going to crumble" if people don't have more children,' *CNBC*, Tuesday 7th December 2021, https://www.cnbc.com/2021/12/07/elon-musk-civilization-will-crumble-if-we-dont-have-more-children.html.

[81] European Commission, Directorate-General for Environment, 'Circular economy,' no date, Brussels, Belgium: European Commission, https://environment.ec.europa.eu/topics/circular-economy_en.

[82] Hickel, J. & Kallis, G., 'Is Green Growth Possible?', *New Political Economy* **25(4):469-486**, 17th April 2019 (online), issue date 2020, DOI: 10.1080/13563467.2019.1598964, http://groupelavigne.free.fr/hickel2019.pdf.

[83] Lange, S. & Berner, A., 'The growth rebound effect: A theoretical-empirical investigation into the relation between rebound effects and economic growth,' *Journal of Cleaner Production* **371:133158** (article number), 15th October 2022, DOI: 10.1016/j.jclepro.2022.133158, abstract & extracts only at: https://www.sciencedirect.com/science/article/abs/pii/S0959652622027469.

[84] Vopson, M.M., 'The information catastrophe,' *AIP Advances* **10(8):085014** (article number), 11th August 2020, DOI: 10.1063/5.0019941,

https://pubs.aip.org/aip/adv/article/10/8/085014/990263.

[85] Giampietro, M., 'The entropic nature of the economic process. A scientific explanation of the blunder of circular economy,' in Lehmann, H., Hinske, C., de Margerie, V. & Nikolova, A.S., eds. (2022), *The Impossibilities of the Circular Economy. Separating Aspirations from Reality*, London: Routledge, eBook ISBN: 978-1-003-24419-6, Ch.4, pp.37-47, DOI: 10.4234/9781003244196-5.

[86] Graves, R. von R. (1955, 1960), *The Greek Myths, Volume 1*, Harmondsworth, Middlesex: Penguin Books, ISBN: 0-14-02-0508-X, pbk.

[87] Lovelock, J.E., 'Gaia as seen through the atmosphere,' *Atmospheric Environment* **6(8):579-580**, August 1972 (online 14th May 2003), DOI: 10.1016/0004-6981(72)90076-5, refs. & list of citations only at:
https://www.sciencedirect.com/science/article/abs/pii/0004698172900765?via%3Dihub.

[88] Lovelock, J.E. & Margulis, L., 'Atmospheric homeostasis by and for the biosphere: the gaia hypothesis,' *Tellus* **26(1-2):2-10**, 1974 (online 15th December 2016), DOI: 10.3402/tellusa.v26i1-2.9731,
https://www.tandfonline.com/doi/pdf/10.3402/tellusa.v26i1-2.9731.

[89] Lovelock, J.E., 'Geophysiology, the science of Gaia,' *Reviews of Geophysics* **27(2):215-222**, May 1989,
DOI: 10.1029/RG027i002p00215,
http://www.jameslovelock.org/geophysiology-the-science-of-gaia/.

[90] Rockström, J. *et al*, 'Safe and just Earth system boundaries,' *Nature* **619(7968):102-111**, 31st May 2023 (issue date 6th July 2023), DOI: 10.1038/s41586-023-06083-8,
https://www.nature.com/articles/s41586-023-06083-8.

[91] Deutloff, J., Held, H. & Lenton, T.M., 'The risky middle of the road – probabilities of triggering climate tipping points and how they increase due to tipping points within the Earth's carbon cycle,' *EGU*

(European Geosciences Union) sphere Preprint repository, 14th July 2023, DOI: 10.5194/egusphere-2023-1469, https://egusphere.copernicus.org/preprints/2023/egusphere-2023-1469/egusphere-2023-1469.pdf.

[92] Bochow, N. *et al*, 'Overshooting the critical threshold for the Greenland ice sheet,' *Nature* **622(7983):528-536**, 18th October 2023 (issue date 19th October 2023), DOI: 10.1038/s41586-023-06503-9, https://www.nature.com/articles/s41586-023-06503-9.

[93] Naughten, K.A., Holland, P.R. & DeRydt, J., 'Unavoidable future increase in West Antarctic ice-shelf melting over the twenty-first century,' *Nature Climate Change*, 23rd October 2023, DOI: 10.1038/s41558-023-01818-x, https://www.nature.com/articles/s41558-023-01818-x.

[94] Yamaji, K., Matsuhashi, R., Nagata, Y. & Kaya, Y., 'A study on economic measures for CO_2 reduction in Japan,' *Energy Policy* **21(2):123-132**, February 1993, DOI: 10.1016/0301-4215(93)90134-2, abstract, some refs. & citations only at: https://www.sciencedirect.com/science/article/abs/pii/0301421593901342?via%3Dihub.

[95] Holdren, J.P. & Ehrlich, P.R., 'Human Population and the Global Environment: Population growth, rising per capita material consumption, and disruptive technologies have made civilization a global ecological force,' *American Scientist* **62(3):282-292**, May-June 1974, http://www.jstor.org/stable/27844882.

[96] United Nations Framework Convention on Climate Change [UNFCCC] (2015), *Paris Agreement*, Paris, France: UNFCCC, https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

[97] Liu, Z. *et al*, 'Monitoring global carbon emissions in 2021,' *Nature Reviews Earth and Environment* **3:217-219**, 21st March 2022 (issue date April 2022), DOI: 10.1038/s43017-022-00285-w, https://www.nature.com/articles/s43017-022-00285-w.

[98] Tiseo, I., 'Annual carbon dioxide (CO_2) emissions worldwide from 1940 to 2022 (in billion metric tons),' *Statista*, 12th September 2023, https://www.statista.com/statistics/276629/global-co2-emissions/.

[99] Kommenda, N., Osaka, S., Ducroquet, S. & Penney, V., 'Where Dangerous Heat is Surging,' *The Washington Post*, Tuesday 5th September 2023, https://www.washingtonpost.com/climate-environment/interactive/2023/extreme-heat-wet-bulb-globe-temperature/?itid=sf_climate_climate_Climate%20lab_p002_f003.

[100] Ehrlich, A.H., Gleick, P. & Conca, K., 'Resources and environmental degradation as sources of conflict,' *Pugwash Occasional Papers*, September 2001, pp.108-138, https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=c6057dab6723f35458871c6e00921d4ef505499d#page=110.

[101] Choi, D., Poertner, M. & Sambanis, N., 'Parochialism, social norms, and discrimination against immigrants,' *PNAS* **116(33):16274-16279**, 29th July 2019, DOI: 10.1073/pnas.1820146116, https://www.pnas.org/doi/full/10.1073/pnas.1820146116?doi=10.1073%2Fpnas.1820146116.

[102] Helbling, M. & Meierricks, D., 'Terrorism and Migration: An Overview,' *British Journal of Political Science* **52(2):977-996**, 17th December 2020 (online), issue date April 2022, DOI: 10.1017/S0007123420000587, https://www.cambridge.org/core/journals/british-journal-of-political-science/article/terrorism-and-migration-an-overview/2D92D099D870D7D8E606C39E683D3E89.

[103] Döring, S. & Hall, J., 'Drought exposure decreases altruism with salient group identities as key moderator,' *Nature Climate Change* **13:856-861**, 24th July 2023 (issue date August 2023), DOI: 10.1038/s41558-023-01732-2, https://www.nature.com/articles/s41558-023-01732-2.