



Unprecedented: the toxic synergism of Covid-19 and climate change

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Purpose of review

To review and compare the constellations of causes and consequences of the two current pandemics, Covid-19 and climate change.

Recent findings

There has been a transient counterbalancing, in which the response to Covid-19 has briefly mitigated pollution and greenhouse gasses. This divergence belies multiple commonalities of cause and effect.

Summary

The convergence of these two pandemics is unprecedented. Although at first glance, they appear to be completely unrelated, they share striking commonalities. Both are caused by human behaviors, and some of those behaviors contribute to both pandemics at the same time. Both illustrate the fact that isolation is not an option; these are global issues that inescapably affect all persons and all nations. Both incur prodigious current and anticipated costs. Both have similar societal impacts, and disproportionately harm those with lesser resources, widening the gap between the 'haves and the have-nots.' One can only hope that the devastation caused by these unprecedented pandemics will lead to increased awareness of how human beings have helped to create them and how our responses can and will shape our future.

Keywords

climate change, Covid-19, pandemic

INTRODUCTION

With the concurrence of climate change and Covid-19, human beings are witnessing two simultaneous cataclysmic pandemics for the first time in modern history. Both are existential threats not just to human beings but to the collective species that inhabit our planet. As of October 2020, COVID-19 has killed over one million people worldwide. (The United States has at the time of writing the sad distinction of being the nation with the greatest death toll.) Global economies have been devastated. At the same time, the earth's climate is changing at an unprecedented rate [1,2^{***},3^{***}]. Global warming and its consequences are visibly apparent – as of October, 2020, California was burning with unprecedented wildfires and the United States had seen in 2020 an unprecedented hurricane season [4,5].

For those whose opinions are based on evidence and data, there is now ample evidence that both climate change and the Covid-19 pandemic are caused by human activities and that they are inextricably intertwined [2^{***},3^{***},4,6^{***},7^{***},8^{***}].

ANTHROPOGENIC CAUSES AND COMMONALITIES OF THE TWO PANDEMICS

SARS-CoV-2 emerged in Wuhan, China in December, 2019 and subsequently caused our global pandemic. SARS-CoV-2 is a zoonotic virus; the available literature suggests that an interface with wild animals in the live-animal markets of Wuhan facilitated the transmission of this novel virus to human beings [6^{***},7^{***},9^{***}].

A specific anthropogenic factor(s) responsible for disease emergence can be identified for Covid-

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KEY POINTS

- For the first time in the history, the earth has been beset by two pandemics, climate change and Covid-19.
- Both climate change and Covid-19 have anthropogenic roots, some of which overlap.
- Although there has been a brief period during which the response to Covid-19 has had a beneficial environmental impact, Covid-19 and climate change have massive and overlapping present and future impacts upon global health and the global economy.

19 and for virtually every recent infectious pandemic [6[•],7^{••},8[•],9[•],10,11]. Population growth and needs of more land for use by human beings have led to rampant deforestation and encroachment into previously wild habitats, intensifying interactions between wildlife and human beings [7^{••},8[•],9[•],10]. The reservoirs and pathways for zoonoses are also increased by a more domesticated environment, that of animal agriculture; antibiotics given to livestock select for resistant organisms, the crowding of livestock facilitates animal–animal transmission, and there is intensive human–animal contact [7^{••},10,11,12[•],13]. These factors combined with globalization and International travel in the 21st century create ample opportunities for pathogen spillover from animals and dissemination into the world community; in the last two decades, new infectious diseases have emerged at an unprecedented rate [7^{••},14^{••},15,16].

The intersection of disease emergence/dissemination and climate change is clear. There is a commonality of causation. Deforestation and destruction of natural habitat contribute to greenhouse gasses and limit the absorption of carbon dioxide [1,2^{••},3^{••}]. In addition to being a petri dish for pathogens, animal agriculture is the second largest anthropogenic cause of greenhouse gas emissions (fossil fuel use being the largest) [1,2^{••},3^{••}]. Globalization and international travel are possible (at present) only because of the extensive use of fossil fuels. There is also a commonality of consequences. Both COVID-19 and climate change are creating social impairment, with social isolation, place and sex inequality, and food and shelter insecurity occurring disproportionately in vulnerable populations, especially women and children [17,18^{••},19[•],20[•],21,22[•],23[•]] (Fig. 1). The economic impacts of these two crises, such as unprecedented job losses, shrinkage in the world's gross domestic product (GDP), and income inequality, have created sharp conflicts at regional, national and global levels

[22[•],23[•]]. The wealth gap between haves and have-nots is wider than ever [22[•],23[•]].

The costs of these pandemics are prodigious. With respect to Covid-19, an estimated \$10 trillion economic response has been allocated by national governments worldwide (including \$3 trillion by the United States and \$4 trillion by Europe Union member states) – almost entirely for immediate relief measures [24]. Both economic losses and the future costs of medical care and containment will add dramatically to this initial total. The costs of climate change are sometimes blatant, as with increased forest fires, and sometimes more insidious, as with the slow rise in ocean levels and the accompanying destruction. Recent models suggest that the cost of climate change for the year 2030 will likely be roughly 1% of America's GDP per year. Meanwhile, current estimates for the cost of Covid-19 to the United States this year range between 7 and 10% of GDP. Thus, over the next 10 years, the two pandemics will have similar costs. If the increasing incidence of zoonotic infections translates into a new disruption similar to Covid-19 once every 10 years, then the economic burdens could be equal on an ongoing basis [25].

Both pandemics have dramatic death tolls. Once again, the deaths from Covid-19 are acute, whereas those from climate change can be both acute (as in death from flooding) and insidious (increasing death rates related to pollution and direct and indirect impacts of global warming). The estimated global death projection is ~2.5 million from Covid-19 in 2020 [26–28]. The climate change crisis is estimated to cause a similar number of deaths over the next decade [22[•],25,29]. Furthermore, climate change could be responsible for 73 deaths per 100,000 people (several times more deadly than COVID-19) by the end of the century if emissions continue to increase at current rates [25].

THE SHORT-TERM IMPACT OF COVID-19 ON POLLUTION

Air pollution caused is not only the major anthropogenic driver for global warming and climate change but also poses the greatest environmental risk to human health [30[•],31,32[•],33[•],34[•]]. As per the State of Global Air report, air pollution was the fifth leading risk factor for mortality worldwide in 2017 [30[•]]. According to the WHO, air pollution kills an estimated seven million people worldwide every year [31]. https://www.who.int/health-topics/air-pollution#tab=tab_1 WHO data show that, worldwide, 9 out of 10 people breathe air that exceeds WHO guideline limits for pollutants, with low- and middle-income countries suffering from the highest exposures [31].

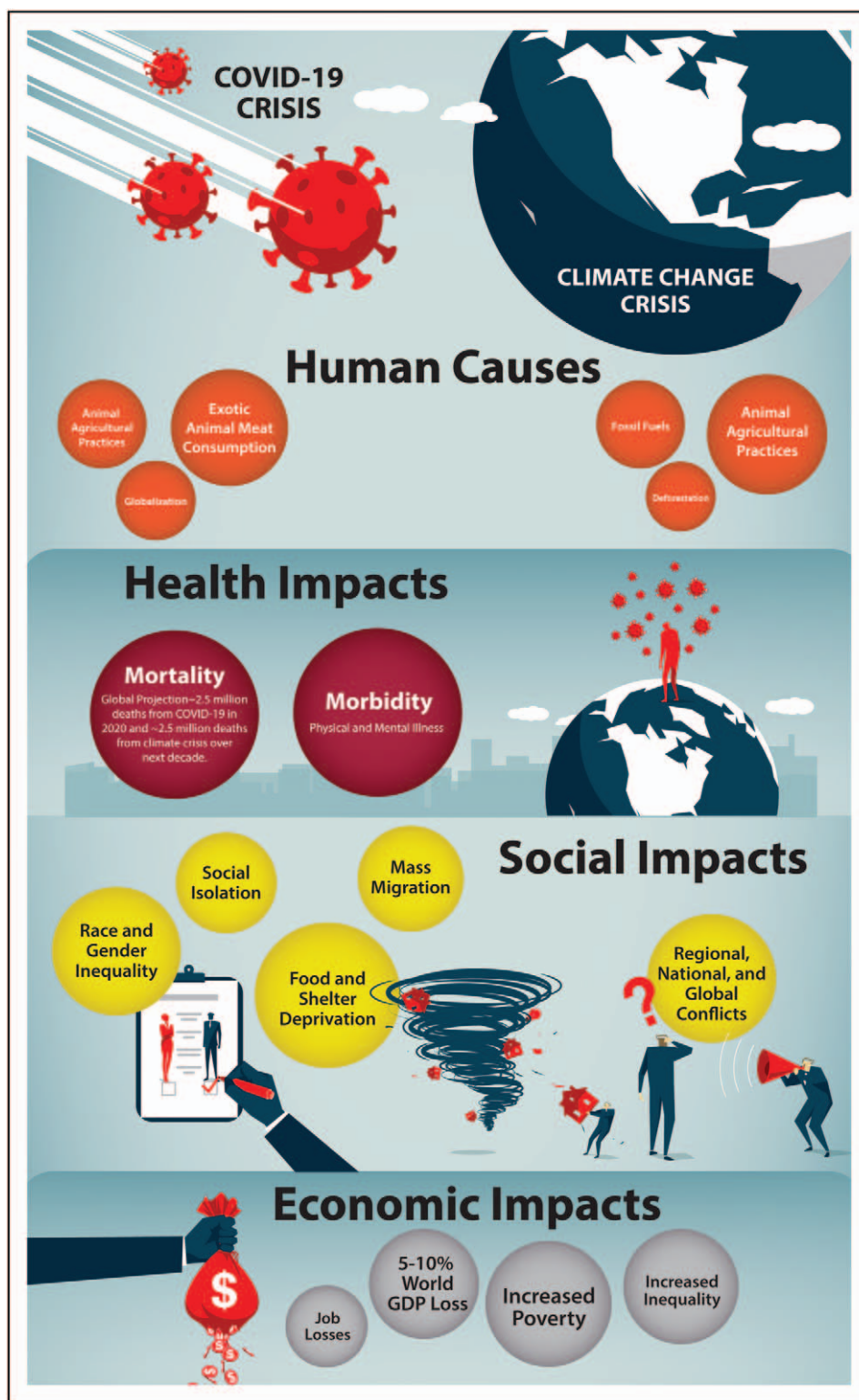


FIGURE 1. Overview figure summarizing the commonalities and anthropogenic causes of climate change crisis and Covid-19 crisis.

Air pollution is one area in which the two pandemics have had a transient divergence in effects. Air pollution can be broken down into two major components; the amount of particulate matter in the air and the concentrations of deleterious gasses

[32^o,33^o]. The burning of fossil fuels generates both of these – in addition to gasses, burning generates very small particles less than 2.5 microns in diameter (concentration measured as ‘PM_{2.5}’) that can remain suspended in the air for extended periods and that

cause significant morbidity and mortality [32[■],33[■]]. The unprecedented global lockdowns in the first half of the year 2020 in response to the COVID-19 pandemic had a significant positive impact on both aspects of global air quality [35[■],36[■],37[■],38[■],39[■],40,41[■]]. Kumar *et al.* [35[■]] studied the impact of lockdown on ambient PM_{2.5} ambient air quality in five Indian cities (Chennai, Delhi, Hyderabad, Kolkata and Mumbai) by comparing spring 2020 data with those of preceding years. The study found a marked decline in PM_{2.5} – up to 54%. In a similar study, Shi and Brousseau [36[■]] reported approximately 35 and 60% decreases in PM_{2.5} and nitrogen dioxide, respectively, in northern China (where the COVID-19 pandemic originated) over the period January 23–February 29, 2020 when compared to the period January 1–January 22, 2020.

Bauwens *et al.* [37[■]] reported unprecedented global NO₂ decreases over China, South Korea, western Europe and the United States from January to April 2020. The average NO₂ column drop over all Chinese cities was ~ 40% relative to the same period in 2019; western Europe and the United States saw decreases of 20–38%.

In a recent study by Liu *et al.* [38[■]] (an international team of researchers), global estimates of daily, sector-specific, country-level CO₂ emissions from January 1st, 2019 to June 30th, 2020, were reported based primarily from near-real-time activity data. The study found that the Covid-19 pandemic led to an 8.8% (1551 million ton) CO₂ decrease in global CO₂ emissions in the first half of 2020 compared to the same period in 2019 (Fig. 2 a,b). The results were astonishing; authors concluded that the 1551 million ton decrease in CO₂ was the largest ever decline in emissions over a 6-month interval, larger than for any recent economic downturn and larger than the annual decrease (790 million ton CO₂) during World War II, although mean emissions are much larger than now at that time (Fig. 2c). The study also found, not surprisingly, a rapid increase in CO₂ levels in most countries by the end of June – except in the United States, Brazil and India, where the number of Covid-19 cases continued to remain high. In fact, they observed a complete rebound of emissions to above 2019 levels in China as early as the beginning of May, 2020.

FUTURE GLOBAL CLIMATE IMPACTS RESULTING FROM COVID-19 AND THE MITIGATION RESPONSE

The Covid-19 crisis has caused unprecedented global disruption. The whole world came to standstill from massive lockdowns and the closing of national and international borders. The global

economy took a major hit due not only to loss of income caused by shutdown of large and small businesses and other economic activities but also to massive spending on healthcare systems, including personal protective equipment and other resources to fight Covid-19 [23[■],24,25]. Emergency rescue packages aimed at protecting balance sheets, reducing bankruptcies and addressing immediate human welfare concerns during lockdown periods have cost trillions of dollars [23[■],24,25]. The climate change crisis is also unprecedented in its level of disruption [2[■],3[■],22[■]]. One could argue that both of these crises require coordinated responses by policy makers, businesses and society at large and that those responses need to be integrated. Forster *et al.* [42[■]] examined the temperature response of a direct recovery to pre-Covid-19 national policies and emission levels and also explored models for which the economic recovery to Covid-19 is driven by a green stimulus package versus an increase in fossil fuel use. Their study results showed a negligible long-term climate effect of immediate Covid-19-related lockdowns and restrictions. However, a strong green stimulus recovery with reductions in fossil fuel investments would have the potential not only to avoid future warming of 0.3°C by 2050 but also of limiting the temperature rise to 1.5°C above the preindustrial era.

The data to date have led to a redundancy of both findings and conclusions. Le Quéré *et al.* [43[■]] looked at 69 countries, 50 American states and 30 Chinese provinces (representing 85% of the world population and 97% of global CO₂ emissions). The authors estimated that for 2020, the global CO₂ result of the Covid-19 pandemic was a 4–7% decrease in emissions. As others have concluded, this sounds positive but is transient; a long-term reduction in CO₂ emissions would require postpandemic government actions and economic incentives promulgating net-zero emissions [43[■]].

CONCLUSION

Human beings are the most dominant animals on this planet. We can, via intellect and tools, literally change the face of the earth, and we have done so. The world community has been slow to acknowledge the negative consequences of our actions. This is not now possible; we now face two simultaneous pandemics, Covid-19 and climate change. For the most part, Covid-19 has been more ostensibly abrupt and brutal and climate change has been more insidious. Climate change and Covid-19 may at first appear to be disparate events, which by chance are occurring simultaneously. Upon closer scrutiny, this is not true. There are commonalities of cause and

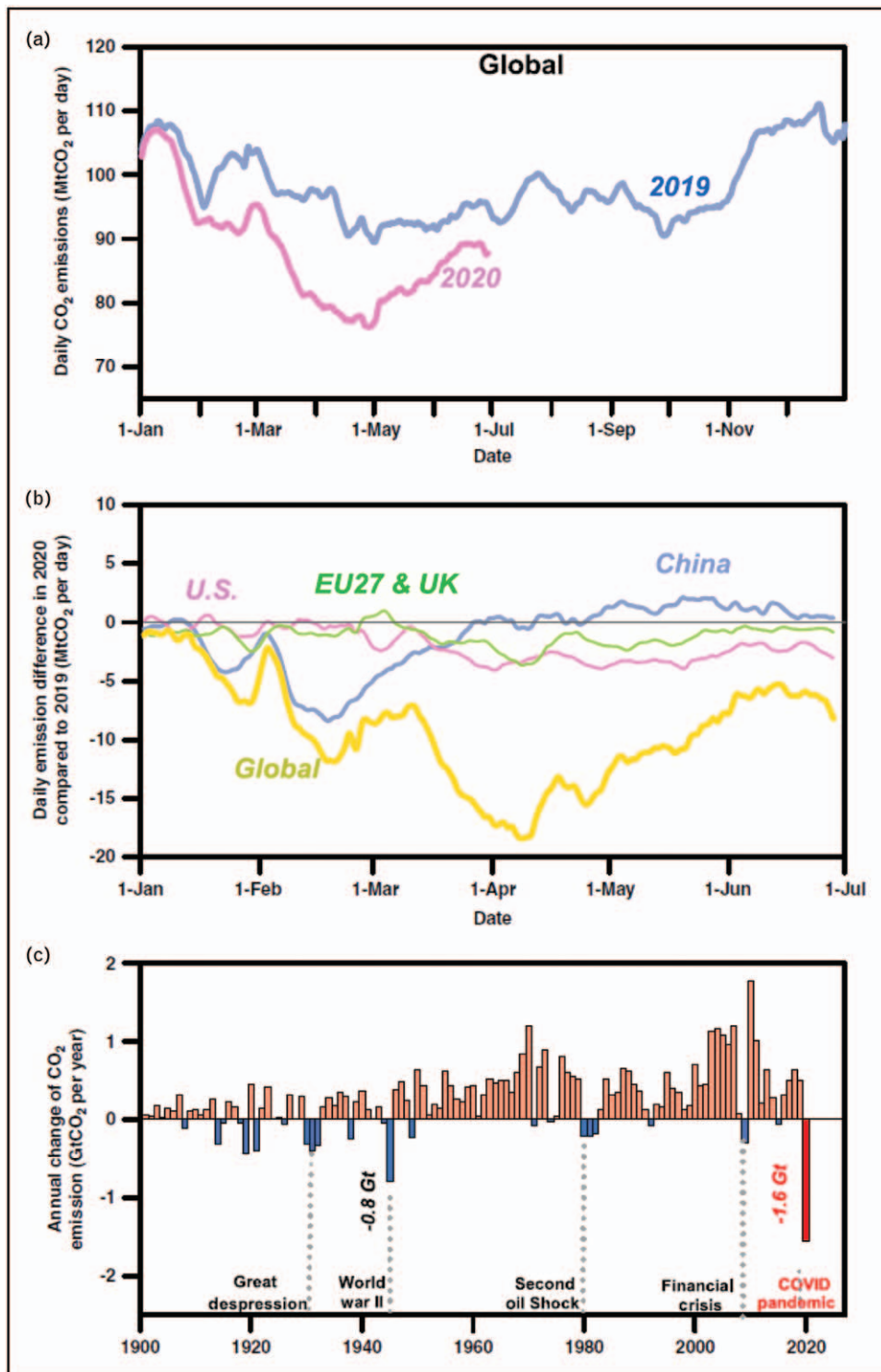


FIGURE 2. Effects of COVID-19 on global CO₂ emissions. (a) Daily CO₂ emissions in 2019 and 2020 (7-day running mean); (b) global emissions aggregate different timing of effects in different regions (7-day running mean); (c) COVID-19 causes the largest annual decrease of CO₂ emission since 1900. Adapted from Liu *et al.* [38^{***}] with permission.

effect (with one brief and unsustainable window of counterbalance). Both have anthropogenic roots. Both incur massive costs with respect to economies and human health, and for both, the initial victims

of these costs are, disproportionately, those with fewer resources and fewer options; there is an increasing divide between the ‘haves’ and the ‘have-nots.’ This divide could in turn have social

and economic consequences yet unseen. Our power to change the planet has given us the responsibility to be its custodians. We can only hope that the devastation being caused by these concurrent pandemics will raise awareness to the point that we can be more proactive and do a better job of protecting the house that we live in.

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Conflicts of interest

There are no conflicts of interest.

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