Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Discussion

Covid-19, and the climate change and biodiversity emergencies

Robert Watsona, Zbigniew W. Kundzewiczb, Lidia Borrell-Damiánbc,⁎

a Department of Environment, University of East Anglia, Norwich NR4 7TJ, Norfolk, UK
b Meteorology Lab, Faculty of Environmental Engineering and Mechanical Engineering, Poznan University of Life Sciences, Poznan, Poland
c Science Europe AISBL, Rue de la Science, 14, 6th floor, 1040 Brussels, Belgium

ABSTRACT

This paper addresses the question, can lessons be learnt by studying the responses to COVID-19 and the human-induced climate change and loss of biodiversity emergencies? It is well recognized that to successfully address each of these issues requires sound scientific knowledge based on strong national and international research programs, cooperation between the research community and policy makers, national, regional and global evidence-based policies and coordinated actions, an informed and receptive public, and political will. A key question is how research and innovation can most effectively inform decision-making leading to cost-effective and socially acceptable action on pandemics, climate change and loss of biodiversity.

This paper first describes how the COVID-19 pandemic has been addressed compared to the loss of biodiversity, and climate change, and then considers the use of scientific knowledge for policy-making and communication with the public. The paper then discusses human health and the natural environment as a global responsibility, and concludes on the need for an enhanced virtuous set of interactions between science, economy, politics and people.

1. Pandemics, biodiversity, climate change and human health protection

The COVID-19 pandemic mobilized the research community, policy-makers, and public in an unprecedented effort to find rapid solutions. Among the positive outcomes of the pandemic, were (i) the development of models that could simulate the spread of the disease, hence help limit the spread, and (ii) the rapid development and approval of effective vaccines – an example of an excellent interplay between the scientific community and governmental health authorities. Until COVID-19, the fastest time to produce an effective vaccine (from viral sampling to vaccine approval) was four years. Effective COVID-19 vaccines were developed in less than a year due to carrying out rapid trials (Ball, 2021a). This is a
success story, which has changed the paradigm of what is possible. How-
 ever, while the initial distribution and uptake of the vaccines were
 successful in many countries, they were unsatisfactory in others, either be-
cause governments were slow to purchase and distribute the vaccine, or
 the vaccine was not available, e.g., in most developing countries due to a failure
 of developed countries to provide vaccines to developing countries. It is fair
to state, though, that some developing countries bought the vaccines and
 vaccinated most of their population (e.g. Chile, Uruguay) and even devel-
 oped their own vaccines (Cuba). There are analogies of this situation with
 climate and biodiversity emergencies. The scientific community has greatly
 improved our knowledge of climate change and biodiversity loss, their
 implications for human well-being, and identified actions that can be
taken in both the short- and long-term to mitigate and adapt to climate
 change, and conserve and restore biodiversity, but most governments
 have been slow to act. There is no shortage of knowledge – just a shortage
 of political will to act in a responsible manner, and for developed countries
to assist developing countries with financial and technical aid.

The issues of pandemics and biodiversity are closely linked. It is esti-
 mated that there are about 700,000 viruses in birds and animals that
could be transmitted to humans (UNEP, 2021, IPBES, 2020). Thus, it is im-
 portant to limit the direct contact between humans and wild animals, and
 between livestock and wild animals, as livestock can act as a vector for
 the transmission of viruses to humans. Thus, limiting deforestation is
 important not only for reducing the risk of a future pandemic, but also
 invaluable for conserving biodiversity and curbing climate change.

Vaccination does not preclude, but does limit, the spread of the virus,
 and strongly reduces the mortality rates. In the US, the EU, and many
 other countries, national vaccination programs are in place, providing
 effective vaccines free of charge to those willing to take them. But the prob-
 lem is that a significant percentage of the population in many countries
 refuse to be vaccinated, refuse to social distance, and fight against wearing
 masks, undermining efforts to stop the spread of the virus. Thus, many
countries have experienced their third, fourth, and fifth waves of the
 pandemic. Based on Our World in Data, over 11.9 billion vaccine doses
 have been administered globally. As of end of May – beginning of June
 2022, the global average of fully vaccinated exceeds 60%, while the EU
 average exceeds 73 % (ranking for individual EU countries from 92 % in
 Portugal to less than 30 % in Bulgaria). Over 73 % of eligible population
 has been fully vaccinated in the UK and over 66 % in the US. While some
 countries in the Global South have excellent fully vaccination rates,
e.g., Chile 91 %, Cuba 88 %, and China 89 %, in many countries of the
 Global South, the vaccination rate is very low – just a few per cent due to
 lack of access to the vaccine that is simply not affordable to the public
 health systems, e.g., Egypt 32 %, Ethiopia 18 %, Haiti, Congo and
 Burundi all less than 1 % About 80 countries have fully vaccinated rates
 less than 50 %, and about 40 countries have fully vaccinated rates below
 20 %. At the regional level, most of Africa has less than 20 % of its popula-
tion fully vaccinated. Hence, international collaboration is absolutely essen-
tial to ensure that vaccines are freely available in all countries of the world
 in order to bring the pandemic under control. This pandemic is of global
 concern and requires coordinated global action.

2. Scientific knowledge for policy-making and communication

Even when the voice of science is clear and unambiguous, the transfer of
scientific knowledge to evidence-based policies and actions in many coun-
tries is not satisfactory. It seems as if decision makers quite often accept
what information is convenient and disregard the rest. The voice of science
on these issues, COVID-19, climate change and biodiversity, has been
needed by many, if not most, people in government, private sector and pub-
lic, but there are skeptics and contrarians, adhering to pseudoscientific
ideas and conspiracy theories (Ball, 2021b), thus undermining the coordi-
nated actions needed. In the case of climate change, this particularly
holds for countries where coal is an important energy source
(e.g., Australia, US, China, and India), making anthropogenic climate
change an inconvenient truth. However, while all countries need to
reduce/eliminate their fossil fuel emissions, the issue of differentiated re-
 sponsibilities must be recognized, requiring industrialized countries that
have in large part caused the problem to lead the transition to a low-
carbon economy.

Scientific evidence, however good, is of limited use if governments
ignore the information and the advice of the scientific community and
take short-term politically expedient decisions rather than taking a
longer-term perspective – or select the information that supports a pre-
determined position. While it is understood that there are many factors
that go into a decision, it is clear that many governments placed near-
term economic considerations or in some cases support of the voters
above the loss of life in the case of COVID-19 and ignored the advice
from the scientific community of whether and when to introduce obligatory
vaccinations for some people (e.g. seniors, health care personnel), start
and end lock-downs, limit large gatherings, and wear masks in public. There
are some successful experiences, though, when vaccinations were not obliga-
tory, but just strongly recommended. Several governments have taken
strong measures to limit the number of COVID-19 cases, e.g., New
Zealand and Australia, but many governments were not ready to consis-
tently take the hard decisions needed, and in a number of countries there
were sharp divisions within government on how to deal with the pandemic,
e.g., the USA and Brazil. This illustrates the complexity of the governance
of our societies. The performance of various European countries during
the pandemic crisis differed significantly (Coccia, 2022).

Bobbitt (2020) noted that to successfully address the pandemic requires
a competent national/state apparatus, trusting citizens, and leadership. He
then noted the unpredicted “utter foolhardiness of the responses of coun-
tries, including those that might have been expected to do better precisely
because they had enormous state capacity, scientific expertise, and an
educated populace to have fielded the state apparatus, social trust, and
leadership necessary to prevail in this sort of crisis”.

This again is a similar situation with climate change and loss of biodi-
versity, where some governments are taking strong action to limit green-
house gas emissions (e.g., the EU and the UK), and conserve and restore
biodiversity (e.g., Costa Rica), where they have strong state capacity, sci-
cific expertise, educated and trusting citizens, and leadership. However,
many governments are not willing to take the actions needed to reduce
greenhouse gas (GHG) emissions or conserve and restore biodiversity in
the near-term even if they have strong state capacity and scientific
expertise, because the leadership is focused on promoting short-term “un-
sustainable” economic growth, coupled with sharp divisions within the
government, e.g., USA. Hence, in the case of climate change governments
delay action, pledging net-zero emissions by the middle of the century
when the priority must be significant reductions in GHG emissions between
now and 2030. Indeed, to meet the Paris climate target of 1.5 °C (UNPCCC
(United Nations Framework Convention on Climate Change), 2015),
current global emissions must be reduced by about 50 % by 2030 (IPCC
(Intergovernmental Panel on Climate Change), 2018; UNEP (United
Nations Environment Programme), 2020; UNEP, 2021). Unfortunately,
the current pledges and sectoral initiatives made by governments at COP-
26, i.e., Nationally Determined Contributions, do relatively little to reduce
global emissions and, even if fully implemented, place the world on a path-
way well above 2 °C. The recent IPCC WG III report concluded that policies
implemented by the end of 2020 are projected to result in higher global
GHG emissions than those implied by the NDCs announced at and prior
to COP-26, indicating a serious implementation gap. And without a
strengthening of those policies, GHG emissions are projected to continue
rise, leading to a median global warming of 3.2 °C by 2100, well above
the Paris target of 1.5 °C. Climate Action Tracker1 (2021) estimates that if
all the pledges and sectoral initiatives are fully implemented there would
still be an emissions gap of 17–20 GtCO2eq in 2030, compared to a pre-
COP-26 emissions gap of 20–27 GtCO2eq. Since COP-26, China and India

1 https://climateactiontracker.org/.
have demanded an increase in coal production to offset current energy shortages, and the US has requested an increase in oil and gas to offset high energy prices. These actions are completely inconsistent with achieving the Paris targets.

While a significant portion of the public accepted the need for constraints due to COVID-19, and adapted their behavior accordingly, many fought against the lockdowns and masks, and even the need to be vaccinated, undermining efforts to restrict the spread of COVID-19. While the public in general recognizes the need to mitigate and adapt to climate change, in many cases they are not willing to play their part, e.g., change their lifestyles, reduce food, energy and water use and waste, or consider a more plant and vegetable-based diet, or pay slightly more for green energy. In spring 2022, costs of energy from fossil fuels have dramatically increased, so that in many countries green energy would, in fact, be cheaper than coal. This can be a stimulus for a more vigorous transformation of the energy mix towards decarbonization.

A large, and tangible, difference, between the challenges of COVID-19, and the climate change and biodiversity emergencies reflects differences in the perceived status of urgency. Most governments recognized there was a very short time scale to address the COVID-19 crisis if the number of deaths and serious illnesses was to be contained, as the number of new cases grew exponentially within days in each wave of the pandemic. Most, but not all, governments followed, to varying degrees, the advice from science and with the support of the successful development of vaccines, under WHO leadership, to respond to the COVID-19 crisis, while carefully watching what other countries do. In contrast, because the adverse effects of climate change and loss of biodiversity have not been catastrophic as yet, many governments incorrectly feel they have a much longer time scale to address these emergencies. Politicians keep taking decisions thinking of their political futures rather than those needed in the human and planetary interest.

When assessing actions and decisions taken with regards to COVID-19, compared to climate change and biodiversity, the former usually focuses on the national, sub-national and local (e.g., cities) level, while the latter focuses on regional and global scale. One of the main problems in climate change and biodiversity is that government commitments (goals and targets) developed and agreed at international forums are not matched by national policies to achieve these goals and targets. Lieven (2020) noted that only through effective national-level organization can efficient mitigation of global greenhouse gas emissions be achieved. Since the pandemic is accompanied by “infodemic” (Ball and Maxmen, 2020), it is necessary to track paths of transmission of misinformation and to proceed with fact checking and flagging up misleading content. Both corona and climate change are driven from contradictory, seemingly contradictory, or changing, opinions voiced by scientists, media, and politicians. Scientists should take rectification of fake news issued by climate and COVID denialists, skeptics and contrarians as high priority. They should listen to people and enter into argument-based dialogues rather than issuing monologues from their ivory towers.

The importance of consistent messaging between scientists, governments and the public is essential. Unfortunately, in some countries (e.g., USA and Brazil), the public is bombarded with contradictory and changing messages from different political parties and has no clear direction of what is needed and why on issues such as face masks, social distancing, and vaccinations. This is a similar situation with respect to climate change where the public is often given contradictory views – especially from politicians and some in industry (e.g., USA, Brazil and Australia). In the US some eminent politicians argue that climate change is a hoax and there is no need to forgo the use of fossil fuels.

3. Human health and the natural environment are a global responsibility

Human health is the primary concern with COVID-19, but human health is also a key issue with climate change with weather extremes and heat waves. The number of additional deaths caused by severe heat waves in Europe during the summers of 2003 and 2010 reached many tens of thousands (EASAC (European Academies Science Advisory Council), 2019).

As of June 2022, the number of COVID-related fatalities is 6.3 million, globally (Our World in Data), which is much higher than during even the most severe heat waves, but the changing climate also causes an increase in vector- and water-borne diseases, heat stress mortality, malnutrition, deaths from extreme weather events, and morbidity and mortality from air pollution. The loss of life from pollution, especially from indoor and outdoor air pollution, currently exceeds 9 million per year (UNEP, 2021; WHO (World Health Organization), 2016). Coccia (2020) found that, among provincial capitals in Italy, the number of COVID-19 cases was higher in environments with high air pollution and low wind energy production.

It is necessary to undertake risk assessment and risk reduction in the corona crisis and in the climate and biodiversity emergencies at all levels of power – from an individual citizen to a school principal to a CEO of a company to a member of parliament to a minister in a national government. These processes of risk assessment, reduction and management should be informed by the best scientific evidence in order to reduce the risks of future pandemics and to manage them better, nationally and globally, and to mitigate and adapt to climate change, and conserve and restore biodiversity.

The climate and biodiversity emergencies are already upon us. The risks associated with climate change and its adverse impacts are projected to grow significantly in the future, as are the adverse consequences to human well-being of a continued loss of biodiversity. Therefore, there is an imperative to undertake immediate action in order to reduce the risks that would fall on our children and grandchildren. Mitigating climate change is a global responsibility. It is the cumulative global emissions that count so that even if one country becomes carbon-neutral this would not significantly impact the global climate, although it could provide a good example of how to address the issue in an economically and socially acceptable manner. We should aim to mitigate to the ambitious level of 1.5 °C warming, and certainly much less than 2°C, but prepare to adapt to the pessimistic case of 3°C warming. Time is not on our side. The longer we wait to significantly reduce global emissions, the harder and more costly it will be to limit climate change. At some stage, if not already, the 1.5 °C and even the 2°C target will become out of reach.

It has been discussed so far how pandemics, biodiversity, climate change and human health protection are related. These are main reasons to prepare key actions to develop capacity to respond rapidly in case of emergencies, as well as to develop urgently long-term policy action plans on all spatial scales – global, continental, regional (sub-continental), national, regional (sub-national) and local. The main links presented so far and further elements discussed below are synthesised in Table 1.

| Table 1 | Defining preventive measures and preparing response capacity – key actions. |
|-----------------------------|--------------------------------------------------------------------------|
| Long-term policy action plans are needed urgently* | Preparing Response Capacity (reacting fast in emergency situations) |
| Developing Preventive Measures (avoiding emergencies) | • Invest in fundamental research, coordinate international efforts |
| • Develop risk assessments, addressing interlinkages between exploitation of natural resources, economic and societal development (forest, water, fossil fuels, mining, agriculture, fishery). | • Require mono-, multi- and inter-disciplinary scientific advice |
| • Minimise use of fossil fuels | • Rectify fake news and react to statements by denialists |
| • Minimise risky interactions between humans and animals | • Establish permanent committees involving the seven types of societal actors in a virtuous circle (Fig. 1) to define local action plans. |
| • Foster Circular Society (i.e. circular economy and educated, democratic societies) |

* Policy action plans are needed on all spatial scales – global, continental, regional (sub-continental), national, regional (sub-national) and local.
4. An enhanced virtuous set of interactions between science, economy, politics and people is needed

Have we learnt anything that we did not already know from fighting the pandemic that could help mobilize research communities and policy makers to accelerate action on climate change and the transition to net zero emissions? Alternatively, is there anything from the climate or biodiversity policy domain that could be of use in reducing the risks of another pandemic and improving the management of a future pandemic? Finding solutions through shared best practice augurs well and we should take the time to understand the parallelisms (cf. Nay and Barré-Sinoussi, 2022)).

It is clear that the free and open exchange of credible knowledge in a timely fashion is essential for evidence-based decision-making. The agreement to grant open access to all COVID related publications at the beginning of the crisis was very welcomed and should be mirrored in other fields such as climate change and biodiversity. The Intergovernmental Panel on Climate Change (IPCC), and Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) are excellent examples of providing credible up-to-date policy-relevant, but not policy-prescriptive knowledge for decision-makers through open and transparent processes. International assessments carried out by the IPCC and IPBES, and available in free and open access, provide a critical evaluation of information, for purposes of guiding decisions on complex public policy issues. They reduce complexity but add value through synthesis and sorting what is known and widely accepted from what is not known or not agreed.

In the summer of 2021, IPCC issued the first part of its Sixth Assessment Report (IPCC, 2021) providing input to COP-26. The IPCC, which provides policymakers with regular scientific assessments on climate change, its impacts and risks (covered in the second part of its Sixth Assessment Report issued in February 2022 - IPCC, 2022a), as well as mitigation and adaptation options (covered in the third part of its Sixth Assessment Report issued on 1 April 2022 - IPCC, 2022b), was awarded the Nobel Peace Prize in 2007. The IPBES provides a similar function for biodiversity and ecosystems and their services.

The annual conferences of parties of the UNFCCC are less of a success story, although some progress has been made to curb the emissions of greenhouse gases, with the most important outcome being the Paris Agreement to limit human induced warming (UNFCCC (United Nations Framework Convention on Climate Change), 2015). Equally, there has been limited progress on conserving and restoring biodiversity. None of the 2020 Aichi biodiversity targets were fully met (UNEP, 2021, IPBES, 2020, CBD (Convention on Biological Diversity), 2020). Progress was made in some, but in others little or no progress was made, especially in reducing the direct drivers of biodiversity loss (land- and sea-use change, direct exploitation, climate change, pollution and invasive alien species), and in some cases the situation in 2020 was worse than when the targets were established in 2010. Most observers would argue that the three decades since the UN Framework Convention on Climate Change and the Convention on Biodiversity were signed at the Earth’s Summit in Rio de Janeiro, Brazil in 1992 have been wasted.

There is an emerging consensus that national and global citizens´ assemblies, coupled with youth movements around the world, are demonstrating to governments and the private sector that civil society recognizes the seriousness of these issues and wants action not rhetoric now. The situation requires an evolution from demonstrations to the creation of stable platforms to structure constructive dialogue between citizens and governments, intergovernmental organizations, scientific and educational institutions, non-governmental organizations, media, business and finance (Fig. 1). Interrelations are multiple and complex, and ignoring them will not help finding suitable solutions. These have to be addressed in what we call

[Diagram showing interactions between science, economy, politics and people]

Fig. 1. Enhanced virtuous set of interactions between science, economy, politics and people.
here an ‘enhanced virtuous set of interactions’ between stakeholders. The conclusions mention main requirements for addressing the climate and biodiversity emergencies.

On 24 February 2022, the Russian Federation invaded Ukraine, adding an extra emergency to the existing set of burning global issues. This aggression was a new threat to sustainable development and brought death and suffering directly to the people in Ukraine but also generated wide-spread disruption of supply chains in a range of sectors, with agriculture (and global food security) and energy being most affected. Since the war began, prices of energy, food and fertilizers have increased significantly, on top of earlier increases during the pandemic. In many countries, the immediate response was to seek additional sources of fossil fuels to lower the prices. This overshadowed the long-term focus on renewable energy and end-use efficiency, and it is clearly a short-term response incompatible with achieving the Paris climate targets.

There was a general recognition that the economic recovery packages from COVID-19 could be used to accelerate the transition to a greener and more sustainable economy. This is happening in a few countries, but not in most, where short-term ‘unsustainable’ economic growth is taking precedence over longer-term sustainable economic growth. To address the issues of climate change, loss of biodiversity and the UN Sustainable Development Goals, there is a need to transform our economic, financial and productive sectors (UNEP, 2021). Recognizing that GDP is not a measure of sustainable economic growth and does not account for the unsustainable loss of biodiversity, there is a need to recognize the importance of natural capital. This can be accomplished by using inclusive wealth, which is the sum of natural, human, and built capital in decision making (UNEP, 2021; Dasgupta, 2021). There is also a need to eliminate perverse fossil fuel, agricultural, fisheries, mining and other subsidies that cause environmental degradation, to embrace a circular economy, and internalize externalities into the prices of goods and services. It is equally important to recognize the interlinkages among the agricultural, fisheries, forestry, energy, and water sectors, and finance their transformation to sustainable practices (see Table 1).

5. Conclusion

Global issues of climate change, loss of biodiversity and pandemics demand national and global solutions, and nobody is safe until everyone is safe. Actions to address each of these issues in an economically and socially acceptable manner need a sound scientific understanding of the issues, coupled with well-designed response options, and the political will to act.

To reduce the potential of a future pandemic will require minimizing the interactions between humans and wild animals that potentially carry a virus that is transmissible to humans, and decreasing the interaction between livestock and wild animals as the livestock can be a conduit and pass a virus on to humans, and much more hygienic wet markets that keep the different wild animals apart. There is also a need to respond better to a future pandemic at the local, national and global level. The key will be for politicians and the public to listen to scientific advice concerning masks, social distancing and vaccinations.

Addressing the climate and biodiversity emergencies are not just issues for governments and parliaments but for all relevant stakeholders, including the business and financial sectors, international organizations, scientific and educational institutions, non-governmental organizations, indigenous peoples and local communities, individuals, and the media. All voices need to be heard, and the vested interests of those that want to maintain the status quo must be addressed. Governments must lead and take a long-term perspective and be willing to make the decisions needed for a transition to sustainability. This will require the cross-sectoral coordination of policies, legislation, enforcement, financing and monitoring, and transforming the economic, financial and productive sectors.

This will require accounting for natural capital and environmental costs in measures of economic performance and in decision-making, establishing carbon taxes, carbon pricing, markets for carbon trading, and schemes for offsetting of nature and payments for ecosystem services, shifting environmentally harmful subsidies and investments in economic activities, research and development towards low-carbon and nature-friendly solutions, and transforming the food, energy and production systems to provide access to sustainable, affordable and nutritious food, clean energy and safe water for all.

Unless we prepare now for potential future pandemics, reduce greenhouse gases, and conserve and restore biodiversity, our children and grandchildren will never forgive us, as there are economically and socially acceptable solutions to all these issues.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors gratefully acknowledge constructive recommendations of the Co-Editor-in-Chief, Professor Danià Barceló and the anonymous reviewers.

References

Ball, P., 2021a. The lightning-fast quest for vaccines. Nature 589, 16–18. https://doi.org/10.1038/s41586-020-03626-1.
Ball, P., 2021b. What the COVID-19 pandemic reveals about science, policy and society. Interface Focus 11, 20210022. https://doi.org/10.1098/rsfs.2021.0022.
Ball, P., Maxmon, A., 2020. Battling the infodemic. Nature 581, 371–374.
Bobbitt, P.C., 2020. Future scenarios: ‘we are all failed states, now’. In: Brands, H., Gavin, F.J. (Eds.), COVID-19 and World Order: The Future of Conflict, Competition, and Cooperation. Johns Hopkins University Press, pp. 56–71 https://doi.org/10.2330/353.book.77959.
CBD (Convention on Biological Diversity), 2020. Global Biodiversity Outlook 5. Montreal. https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf.
Coccia, M., 2020. How (un)sustainable environments are related to the diffusion of COVID-19: the relation between coronavirus disease 2019, air pollution, wind resource and energy. Sustainability, 12, 9709, https://doi.org/10.3390/su12229709.
Coccia, M., 2022. Preparedness of countries to face COVID-19 pandemic crisis: strategic positioning and underlying structural factors to support strategies of prevention of pandemic threats. Environ. Res. 203, 111678. https://doi.org/10.1016/j.envres.2021.111678.
Dasgupta, P., 2021. The Economics of Biodiversity: The Dasgupta Review (Abridged Version). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/962785/The_Economics_of_Biodiversity_The_Dasgupta_Review_Full_Report.pdf
EASAC (European Academies Science Advisory Council), 2019. The imperative of climate action to protect human health in Europe. EASAC policy report 38. ISBN: 978-3-8047-4011-2.
IPBES (Intergovernmental Platform on Biodiversity and Ecosystem Services), 2020. In: Daszak, P., Amußi, J., das Neves, G.C., Hayman, D., Kuiken, T., Roche, B., Zambrana-Teren, C., Buxi, P., Daza Nova, H., Feferholz, V., Földvári, G., Igbinosa, E., Jungen, S., Liu, S., Sazau, G., Ubart, M., Muanos, C., Woolston, K., Mosig Reidl, P., O’Brien, K., Pascual, U., Stoett, P., Li, H., Ngo, H.T. (Eds.), Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany https://www.ipbes.net/publication/ipbes-report-38.
IPCC (Intergovernmental Panel on Climate Change), 2018. Summary for policymakers. In: Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okaia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gorini, M.J., Lonnøy, E., Maycock, T., Tignor, M., Waterfield, T. (Eds.), Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C Above Pre-Industrial Levels and Related Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicinate Poverty. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.
IPCC, 2021. In: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Cauè, N., Chen, Y., Goldfarb, L., Gorini, M.I., Huang, M., Leitzell, K., Lonnøy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelečić, O., Yu, B., Zhou, B. (Eds.), Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WG1_Full_Report_smaller.pdf.
IPCC, 2022a. In: Pörtner, H.-O., Roberts, D., et al. (Eds.), Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/
IPCC, 2022b. In: Skerj, J., Shukla, P.R., et al. (Eds.), Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg3/.

R. Watson et al. Science of the Total Environment 844 (2022) 157188
Lieven, A., 2020. Climate Change and the Nation State: The Case for Nationalism in a Warming World. Oxford University Press, New York, NY.

Nay, O., Barré-Sinoussi, F., 2022. Bridging the gap between science and policy in global health governance. Lancet 10, e322-e323.

UNEP (United Nations Environment Programme), 2020. Emissions Gap Report 2020 - Executive summary. Nairobi. https://wedocs.unep.org/bitstream/handle/20.500.11822/34438/EGR20ESE.pdf?sequence=25.

UNEP, 2021. Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi. https://www.unep.org/resources/making-peace-nature.

UNFCCC (United Nations Framework Convention on Climate Change), 2015. Paris Agreement. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

WHO (World Health Organization), 2016. Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease. Geneva. https://apps.who.int/iris/bitstream/handle/10665/250141/9789241511353-eng.pdf?sequence=1.