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The effects of the COVID-19 pandemic on biodiversity loss and ecosystem health and drivers of Zoonotic disease emergence

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Abstract:

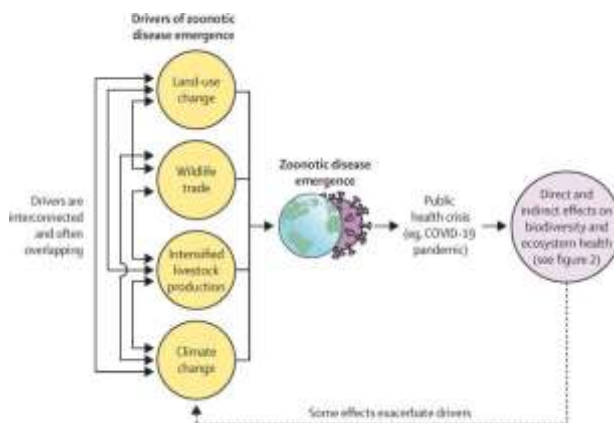
The ongoing COVID-19 pandemic, caused by zoonotic SARS-CoV-2, has important links to biodiversity loss and ecosystem health. These links range from anthropogenic activities driving zoonotic disease emergence and extend to the pandemic affecting biodiversity conservation, environmental policy, ecosystem services, and multiple conservation facets. Crucially, such effects can exacerbate the initial drivers, resulting in feedback loops that are likely to promote future zoonotic disease outbreaks.

Introduction:

The emergence of a zoonotic pathogen in humans, such as SARS-CoV-2, was not unpredicted.^{1, 2, 3} Of the novel or re-emerging infectious diseases affecting humans in the 21st century, most (75%) have been zoonotic in origin,^{4, 5} with their natural reservoirs being other vertebrates.⁶ The majority (over 70%) of these diseases with zoonotic origin have originated from wildlife,⁷ such as HIV/AIDS, the Ebola virus, and severe acute respiratory syndrome (SARS).⁴ Globally, known events of zoonotic disease emerging from wildlife have significantly increased over the past 80 years,^{7, 8} raising public health, economic, societal and environmental concerns, as exemplified by the COVID-19 pandemic. The current weight of evidence suggests that SARS-CoV-2, or its progenitor, probably emerged in humans from a zoonotic source in Wuhan, China, where it was first identified in 2019. Although evidence on the origins of SARS-CoV-2 are inconclusive, bats have been suggested to be the most probable evolutionary source

for the virus. Alignment of the full-length genome sequence of SARS-CoV-2 showed the closest relationship (identity 96%) was with the bat SARS-like coronavirus strain BatCov RaTG. An unknown intermediate host might have played a role in the emergence of SARS-CoV-2 in humans.

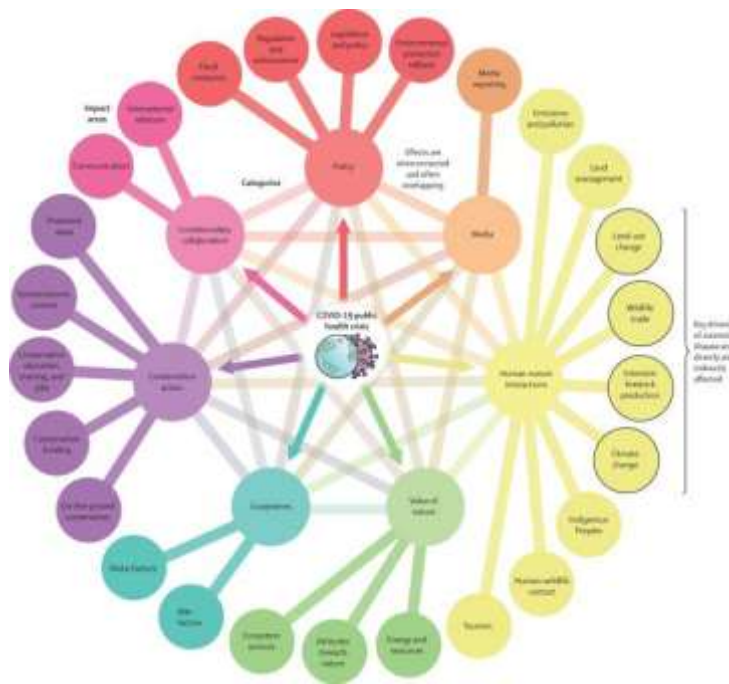
Zoonotic disease emergence feedback loop:



Key anthropogenic drivers of zoonotic disease emergence (eg, including land-use change, wildlife trade, intensive livestock production, and climate change) increase the likelihood of zoonotic disease emergence, which could result in public health crises, such as the COVID-19 pandemic. Such crises could have negative effects on biodiversity and ecosystem health, as COVID-19 has had and could continue to have (appendix pp 11–21). These effects can consequently exacerbate the drivers, leading to further emergence of zoonosis and potential future health crises with their own suite of effects. The continuation of this cycle would reinforce a feedback loop with substantial implications for human health, economies, society, and the environment.

Effects of the COVID-19 public health crisis related to biodiversity loss and ecosystem health:

The figure shows multiple interconnected areas related to biodiversity loss and ecosystem health, which have been or are likely to be affected by the COVID-19 pandemic. The impact areas (outer circle) were assembled into seven categories (inner circle; connected via corresponding colours to relevant impact areas) for ease of visualisation and interpretation. Impacts areas could, in reality, correspond to multiple categories. The human-nature interactions category includes the key drivers of zoonotic disease emergence and-use change, intensive livestock production, wildlife trade, and climate change, as shown in [figure 1](#). Semi-transparent lines between categories show that effects are interlinked, with many effects directly or indirectly affecting others, including the drivers of zoonotic disease emergence.



Human life across local, regional, and global scales has been greatly affected by the COVID-19 pandemic. As of Oct 25, 2021, more than 243 million confirmed COVID-19 cases and almost 5 million COVID-19-attributed deaths have been reported globally. Despite rapid progress of vaccine development and delivery, many countries are still experiencing high transmission rates and repeated resurgences with new SARS-CoV-2 variants arising. Since early 2020, in an attempt to reduce spread, countries worldwide have enforced varying degrees of travel restrictions, with approximately 75% of nations completely shutting down their borders at some point.¹¹ Governments globally have implemented a range of quarantine measures and many have reallocated funding to health-related services and industries.¹¹ Lockdowns, curfews, and restrictions of a range of economic activities deemed non-essential have been enacted. Many industries have required employees to work from home. Simultaneously, governments have been striving to mitigate the inevitable economic, social, and political repercussions of these restrictions, delivering fiscal packages directed toward individuals, as well as public and private sectors. This suite of COVID-19-related activity has broad direct and indirect effects on biodiversity loss and ecosystem health. Identifying the diverse repercussions of such effects is important for better understanding how they might feed back into the drivers of zoonosis emergence and re-emergence. Many of these effects could further promote the drivers of zoonotic spillover, hence, reinforcing a feedback loop further contributing to the rising trend of disease emergence.^{7, 8}

Indigenous Peoples and biodiversity:

Indigenous Peoples own or are involved in the management of around 40% of the world's terrestrial protected areas. Indigenous Peoples' engagement in biodiversity conservation corresponds with:

- (1) enhanced conservation outcomes for many of the world's most biodiverse regions;

(2) more innovative and cost-effective conservation and management;

(3) support of climate change abatement objectives; and

(4) realisation of Indigenous Peoples' interests. Inadequate efforts to protect Indigenous communities from COVID-19 and related issues are evident in regions such as the Brazilian Amazon and in Canada, where conflicts between the interests of Indigenous Peoples and extractive industries have intensified during the pandemic. Such inadequacies are not only damaging to the wellbeing of Indigenous People in many areas around the world, but can also feed back into the key drivers of zoonotic disease emergence. As a result, ecosystems managed by Indigenous Peoples could become more susceptible to land-use change from resource extraction and agriculture, more accessible to those engaged in the wildlife trade, and the Traditional Knowledge held about biodiversity stewardship and resilience to historic disease outbreaks could be threatened.

Rural and low-income populations

Also relevant to biodiversity loss and ecosystem health, and ultimately zoonotic disease drivers, are the effects of COVID-19 on the world's rural and low-income populations. Due to financial, cultural, and a host of other factors, people in some cases participate in activities promoting deforestation and wildlife trade to support their livelihoods. Research on the effects of the Global Financial Crisis in Cameroon, for example, showed multiple effects on livelihood and biodiversity indicators. Although global demand for timber products decreased, workers laid-off from the logging industry turned to poaching and slash and burn agriculture. As the economy recovered in 2010–11, biodiversity indicators improved more slowly than livelihood indicators, suggesting a lag in environmental recovery following the events. Understanding previous examples can help forecast and prepare for the future trajectories of environmental health recovery from COVID-19 effects. Addressing issues specific to the world's low-income and rural populations is required to prevent adverse results for these groups, and flow-on effects for the environment, which ultimately could increase the risks for zoonosis emergence in the future.

Building a planetary health future

The devastating worldwide effects of the COVID-19 pandemic underline the necessity of minimising risks of future zoonotic disease emergence and re-emergence that could engender similar health, societal, and economic consequences. Doing so involves addressing the anthropogenic factors known to increase the risk of spill over events and-use change, wildlife trade, intensive livestock production, and climate change and, crucially, addressing COVID-19's effects on biodiversity loss and ecosystem health, which in turn, can exacerbate these drivers.

If global efforts to address these drivers are inadequate, humans could perpetuate a feedback loop that results in increased risk of zoonotic disease emergence. Therefore, the goals of leaders, the health community, and the conservation community globally should better align now, more than ever. To achieve common goals however, we need to take an

integrative One Health approach, which focuses on appropriate fiscal recovery responses, policy, legislation, and regulatory actions that prioritise the safeguarding of biodiversity and ecosystems. Communication across international, regional, and interdisciplinary boundaries at all scales, including a willingness to collaborate, is necessary. Despite the adverse nature of the COVID-19 pandemic, the crisis presents some unique positive opportunities, which governments, decision makers, and citizens can leverage. Society must more readily accept the health of biodiversity and ecosystems as a high priority, not only for the preservation of biodiversity, but as a public health measure of global importance to human health and wellbeing. Without immediate and sufficient reform of our response to zoonotic disease emergence and high-impact events, such as the COVID-19 crisis including efforts to return to business as usual biodiversity, ecosystems, and human health will continue to suffer. As the links and feedback loops between biodiversity and ecosystem health, COVID-19 and emerging infectious diseases are becoming clearer, conservation actions and a One Health approach are urgently needed to manage zoonotic risk and avoid further feedback loops that can negatively impact human health, biodiversity and ecosystem health.

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