The World Health Organisation must declare climate change a public health emergency: a critical step to mitigate the risk of future coronavirus spillover.

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Executive summary:

Anthropogenic activity is leading to the enhanced greenhouse effect and in turn global climate change. Climate change is an imminent threat to public health. One consequence of changing climates is species range shift. Many bat species have experienced range shift, altering bat species diversity within an area and proximity to humans. With increased bat species richness, bat borne coronavirus diversity also increases, increasing the probability of spillover events to the human population. By 20th August 2021 ~4.4 million people globally have died from COVID-19 which originated from bats, demonstrating the urgent need for action from the WHO: the WHO must declare climate change a public health emergency of international concern to mitigate the risk of future spillover events. In declaring climate change a public health emergency, the WHO should take policy action in three key areas: directly reducing emissions from the healthcare sector through education campaigns, and by lobbying pharmaceutical companies; indirectly reducing emissions through public health campaigns that have co-benefits for the environment; and the establishment of a zoonoses surveillance system to mitigate the probability of a future spillover event leading to an outbreak.

Foundational Science: Discussion and Analysis

Climate change as a planetary boundary

The planetary boundaries framework features nine interdependent boundaries that define a safe operating space for human activity: the boundaries are not equivalent to tipping points, rather they identify the operating space a safe distance from the level of uncertainty (2). The boundary for climate change is defined as: 350ppm of CO_2 in the atmosphere and an increase in top atmosphere radiative forcing of +1.0 Wm^{-2} relative to preindustrial levels (3). Climate change is being driven by anthropogenic activity including combustion of fossil fuels, land use change, agricultural development and

cement production (4). These activities lead to the release of gases collectively known as greenhouse gases, including carbon dioxide, methane, water vapour, nitrous oxide, chlorofluorocarbons and ozone (5). Solar radiation warms the Earth's surface. As the Earth's surface warms it radiates out long wave infrared radiation, which is absorbed by greenhouse gases in the atmosphere. Over time this causes the average Earth's temperature to rise (6). Continued anthropogenic activity has led to the climate change planetary boundary transgression: in 2019 average atmospheric carbon dioxide concentration was equal to 409.8 (+/- 0.1) ppm (7), and human induced radiative forcing has increased by +2.3 Wm^{-2} since preindustrial times (8). Transgressing this boundary means there is a high risk of non-linear and irreversible warming driven by positive feedback cycles within the Earth system (3).

<u>The implications of climate change for human health</u>

Figure 1 illustrates the projected implications of climate change on health (9). One consequence of climate change is increased probability of another coronavirus spillover, (this is represented in the increase in vector-borne disease). Bats are the zoonotic

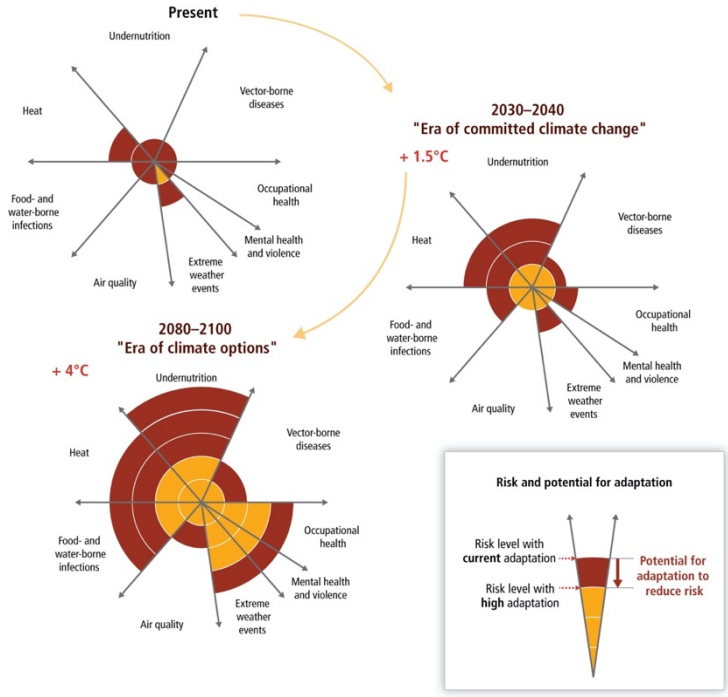

Figure 1: conceptual presentation of the projected impact of increased global temperature on 8 components of health for current and high adaptation pathways. The width of each segment is proportional to the present global burden to ill health (9 p.735).

origin of approximately 100 coronaviruses (10), of which several have the potential to infect humans. Changing climatic conditions, alongside land use change, are altering ecological habitats and therefore bat geographical distribution. In turn this impacts bat species richness: bat species richness is positively correlated to the number of coronaviruses present (11). For example, increasing temperatures and changing weather patterns have led to an increase in bat species richness in the Chinese Yunnan province and neighbouring regions in Laos and Myanmar, as demonstrated in figure 2. This region corresponds with the likely origin of SARS-CoV-1 and SARS-CoV-2. Higher coronavirus diversity within a region increases the probability of a coronavirus with harmful properties for human life spilling over to humans (12). Furthermore, range shift

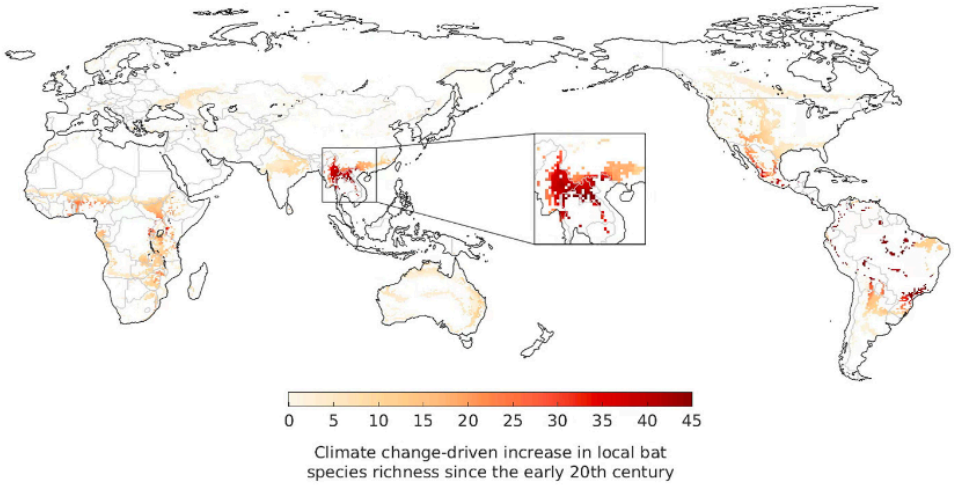

Figure 2: Estimated increase in local bat species numbers due to shifts in their geographical ranges due to climate change between 1901-1930 and 1990-2019 period. The zoomed in area represents the likely spatial origin of the bat-borne ancestors of SARS-CoV-1 and SARS-CoV-2 (12 p.3).

can facilitate novel host and pathogen interactions which may potentially increase the risk of a spillover event through new transmission pathways (12). Figure 3 illustrates how spillover events from bats are becoming more frequent: outbreaks are unpredictable but their increased frequency demonstrates the need for action (13). Globally, health services are accountable for 4.4% of total greenhouse gas emissions (14): action from within the health sector is key to reducing emissions.

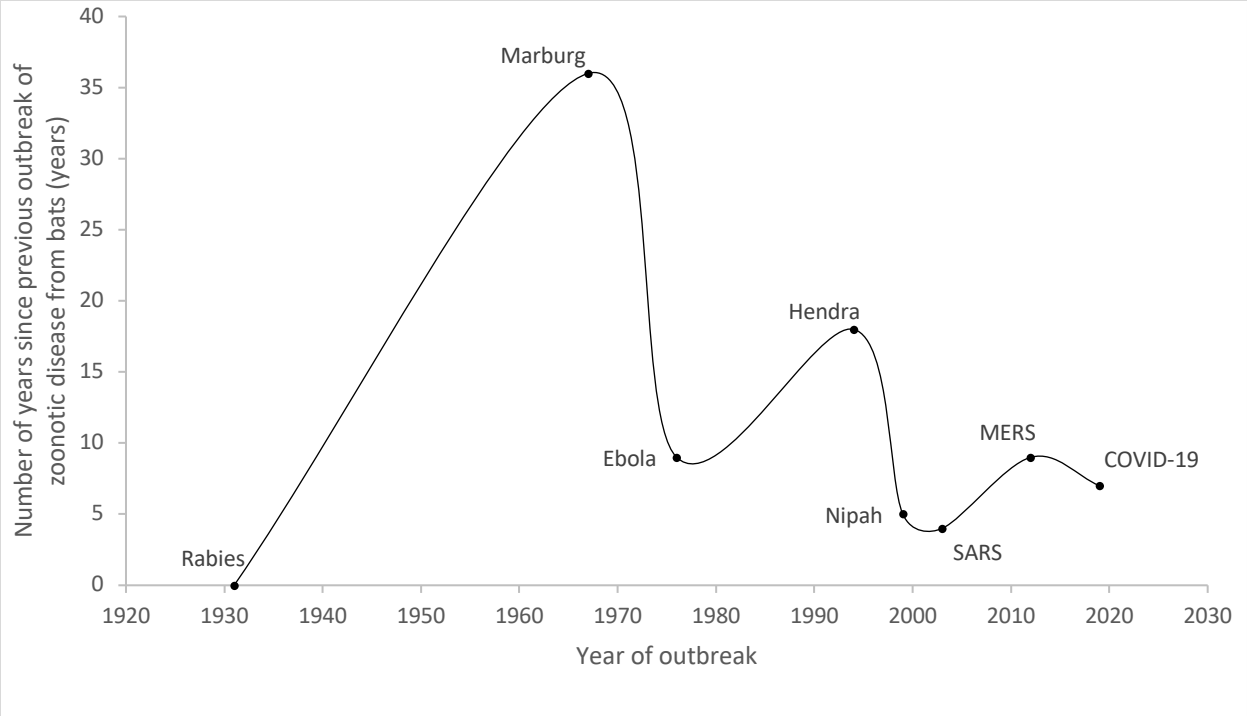

Figure 3: Years between first spillover and outbreak of zoonotic disease originating from bats since 1931. Rabies assigned to 1931 as this was the year rabies virus was identified in bats, adapted from (13 p.4).

Assessment of Existing Governance:

Climate policy:

The Kyoto Protocol (15) was adopted at COP3 and was the first greenhouse gas emissions treaty (16). The Kyoto protocol targeted industrialised nations to reduce their greenhouse gas emissions, following the principle of "common but differentiated responsibility and respective capabilities" (17 p.1). The Kyoto Protocol introduced market-based measures in the form of emission trading permits with the aim of reducing global emissions and stimulating investment by economically developed nations into green technology in less economically developed nations. Another benefit of the Kyoto Protocol was the establishment of rigorous monitoring of greenhouse gas emissions and emission trades which continue to be maintained (17). However, some critics suggest that only requiring developed nations to decrease their greenhouse gas emissions reduced the effectiveness of the policy. Within climate change mitigation lies the prisoner's dilemma as countries do not want to invest economically in climate action

as engaging in climate action has economic costs which countries do not want to be burdened with unless other countries take similar measures, consequently, by not including all countries this reduced incentive to act on the aims of the Kyoto Protocol (18). Also, certain countries experienced significant industrialisation following the Kyoto protocol but were not subject to Kyoto emission targets and therefore reducing the policy's effectiveness. Overall, the success of the Kyoto Protocol was limited (19), and in 2015 the Paris Agreement became the leading global climate policy.

In 2015 the Paris Agreement (20) was adopted: the first universal legally binding climate change legislation, representing a decisive break from the unsuccessful Kyoto protocol (18). The Paris Agreement has been described as "the most important global public health agreement of the century" (21 p.1): the agreement itself recognises the co-benefits of mitigating global climate change for public health (22). The aims of the Paris Agreement, set out in article 2, are to limit average temperature rise to well below 2^{o}C above preindustrial levels (20). The Paris Agreement is structured differently to the Kyoto Protocol. The Paris Agreement features a pledge and review system where states offer Nationally Determined Contributions (NDCs) which are reviewed on 5-year cycle. Despite the Paris Agreement being legally binding, there remains significant capacity for government discretion. Consequently, despite ambition in countries' NDCs to meet the goals of the Paris Agreement, recent research has revealed that these NDCs remain insufficient to meet climate targets (23), and are therefore insufficient to address the risk of future zoonotic spillover events.

<u>Policy from the World Health Organisation</u>

The WHO has identified that due to current warming trends, by 2030, an estimated 250,000 premature deaths will occur per annum due to climate change (24). This figure is an underestimate as it only considers the additional deaths from: malaria; heat exposure in elderly people; diarrhoea; and childhood undernutrition. The increased risk, and respective potential deaths, of novel zoonotic spillover events is not accounted for (25). The current WHO stance on climate change is inadequate given the threat of climate change to public health. Climate change should be declared a public health

emergency. However, the current WHO definition of a “public health emergency of international concern” is limited to “international spread of disease” (26): climate change does not constitute an event appropriate for consideration as a public health emergency, and rather is described as a risk factor (27), this therefore represents an area for strategic policy change.

Governance Recommendations:

Building on the above analysis of current climate policy, it is evident that further policy is necessary to mitigate climate change and therefore the risk of further zoonotic spillover events. The WHO needs to undertake a strategic policy change to mitigate climate change and the associated risks to public health. The WHO must declare climate change a public health emergency of international concern (25), and take policy action in three key areas: firstly, directly assisting in emission reduction of the healthcare sector; secondly, indirectly reduce emissions through public health campaigns that have co-benefits for the climate; thirdly, increase monitoring and encourage the use of taxation to reduce spillover risk.

The WHO needs to change their definition of public health emergency of international concern so that climate change constitutes an appropriate event, rather than a risk factor (25). Declaration of a public health emergency is critical as:

- It frames the climate emergency through a multidisciplinary lens, facilitating a coordinated global response with interdisciplinary action between health and climate policy makers (28).
- It will help mobilise funding towards initiatives focused on planetary health (28).
- The medical community as a trusted community can provide strong leadership through the climate crisis (29).
- Action on climate change will reduce burden on existing healthcare systems, facilitating wider healthcare access (30).
- Action from an supranational body such as the WHO will facilitate a synchronised global response (30).

1. The WHO should support a direct decrease in the emissions from healthcare. In many countries the health care sector constitutes the greatest proportion of greenhouse gas emission compared to any other service sector: reducing emissions from healthcare is crucial for mitigation efforts. Globally carbon intensity of the domestic energy system, the energy intensity of the domestic economy, and healthcare expenditure lead to variance in the emissions from healthcare (31). However, in all countries, the supply chain, specifically for chemicals and pharmaceuticals, represents a significant source or greenhouse gas emissions. For example, in the UK, 19.8% of the NHS's emissions are from chemicals and pharmaceuticals. Two particularly high emitting pharmaceutical categories are metered dose inhalers (MDIs), and anaesthetic gases: when used release un-metabolised greenhouse gases (32). Areas for action from the WHO regarding reducing emissions from metered dose inhalers and anaesthetic gases:
    - Increase awareness amongst healthcare professionals that it is the delivery propellant rather than the medication itself in MDIs that is harmful, and therefore, where clinically appropriate, encourage alternate prescription of dry powder inhalers (33).
    - The WHO should pressure pharmaceutical companies that have not already committed to reducing the emissions from MDIs, to reformulate their inhalers to be used with less environmentally harmful propellants (33).
    - The WHO should lead research regarding measures to reduce the greenhouse gas emissions from healthcare, and work with health leaders to integrate this into policy (25).

2. The WHO needs to further integrate climate and health data to maximise existing understanding of the social determinants of health to develop public health campaigns and recommendations to benefit health and the environment. Critically, public health campaigns should focus on interventions that target less

conscious processes of individual decision making to be more effective, and prevent generation of intervention based inequalities (34). Two key areas that can be targeted for planetary health are diet and physical activity:

- The WHO should establish a scoring metric that evaluates food on health and climate impacts. Food items that score poorly on this metric can be taxed to stimulate a decrease in consumption with respective benefits for health and the environment (35). Tax revenue can then be reinvested in further public health campaigns. Notably, given high levels of meat consumption in countries of high levels of economic development, and existing concerns about the environmental impacts of animal agriculture as well as high dietary composition of animal products, animal products should be reviewed first in the establishment of this metric, and countries of higher levels of economic development should have these measures implemented first (36).
- Tax revenue raised from a tax on food products that cause health and environmental harm can be reinvested in other public health campaigns. For instance, increased investment in secure cycle infrastructure and provision of affordable public transport, will remove barriers to sustainable transport and alter people's modal split. Increased physical activity due to a reduced use of cars will have environmental and health benefits (34).

3. Existing climate policy is insufficient to address the risk of zoonoses, and even if new climate policy is implemented this will not immediately reduce the risk of zoonotic spillover. Consequently, it is necessary for the WHO to establish an effective zoonoses surveillance system.
    - Currently the WHO's global influenza surveillance and response programme monitors the evolution of influenza viruses; this data informs development of the influenza vaccine. A similar surveillance and response network needs to be established for zoonotic viruses, most critically coronaviruses (35). Monitoring primarily should be focused on systematic sampling of animals, people and livestock in pre-identified

hotspot areas. Establishment of a surveillance network will reduce the likelihood of a spillover event resulting in an epidemic or pandemic. The economic, social and environmental impacts of COVID-19 demonstrate the value of further investment in prevention (37).

- The WHO should directly assist with surveillance programmes in countries of lower levels of economic development that have a high risk of zoonotic infection. In these regions, surveillance programmes can be funded from tax revenue where taxes are placed on activities that increase the risk of zoonotic spillover events, in particular, the trade of wildlife (38).

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