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Corona and the climate: a comparison of two emergencies

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Social media summary

Lessons from the corona crisis can help manage the even more daunting challenge of anthropogenic global warming.

1. Introduction

Within a few months, the COVID-19 pandemic caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has brought the everyday lives of billions of people to a halt, inducing great human suffering and unexpected economic shocks. Institutional deficits, including a lack of preparedness and hesitant decision-making, are exposed as the crisis unfolds. As the parallels between this global health emergency and the climate emergency become apparent, we reflect on how global society can manage shared risks and avert emergencies.

The formula that captures why the term 'emergency' is appropriate in the context of climate change can also be applied to the corona pandemic: **E**mergency = **R**isk × **U**rgency = **p**robability × **D**amage × reaction **t**ime (τ) / intervention **T**ime ($E = R \times U = p \times D \times \tau \ / \ T$). As a test case for emergency prevention and management, the current pandemic situation provides valuable insights into climate change action and, more broadly, social susceptibility and resilience to shocks. In this article, we draw parallels between the two emergencies and outline lessons from the corona crisis that can help manage the even more daunting challenge of anthropogenic global warming. Based on this comparison, we discuss the idea that the variables of the emergency formula can be influenced by: mitigation, lowering the probability for damage to occur (p_{mitig}); adaptation, limiting the experience of adverse effects of damages (D_{adapt}); good governance, to be able to efficiently use our reaction time (τ_{govern}); and science, which can increase human perception of the remaining intervention time ($T_{science}$). A contingency plan for an emergency thus constitutes the following elements: $E_{cont} = p_{mitig} \times D_{adapt} \times \tau_{govern} \ / \ T_{science}$. We present our analysis in four steps: diagnosis, prognosis, therapy and rehabilitation.

2. Diagnosis: providing scientific understanding

A first step in taking preventative measures to avert an emergency is identifying risks. This section proposes a diagnosis of both the COVID-19 pandemic and the climate crisis to determine their natures and causes. If governments fail to make correct risk assessments, public welfare is in danger. To assess risk, an understanding of the probability for the damage to be incurred (p) and the magnitude of damage (D) is necessary ($R = p \times D$).

Regarding the novel coronavirus, the probability of damage occurring relates to its contagiousness, whereas the magnitude of damage is largely determined by its deadliness. The virus is thought to spread from person to person primarily through inhaling small droplets and aerosols that are released into the air when infectious people cough, sneeze or speak, and to a lesser degree through touching contaminated surfaces (e.g., see ECDC, 2020). SARS-CoV-2 is thought to be more infectious than SARS-CoV-1 because of special features of the protein forming its spiky crown, making it easier to attach to membranes of the upper respiratory system (Mallapaty, 2020). It appears that, in contrast to SARS-CoV-1, people infected with SARS-CoV-2 become infectious before showing symptoms, which likely contributes to the rapid spread of the novel virus. The contagiousness is described by the basic reproduction number (R0; i.e., the average number of persons infected by each case when there is no immunity in the population and no interventions are carried out). This depends on the duration of infectiousness, the number of contacts during this time and the probability of transmission per contact. For SARS-CoV-2, it has been estimated to be around 3 (Alimohamadi *et al.*, 2020; Y. Liu *et al.*, 2020).

So far, the case fatality rate (CFR) of COVID-19 has not been determined with certainty (Rajgor *et al.*, 2020). It is likely higher than influenza (0.1%) and lower than SARS (9.5%)

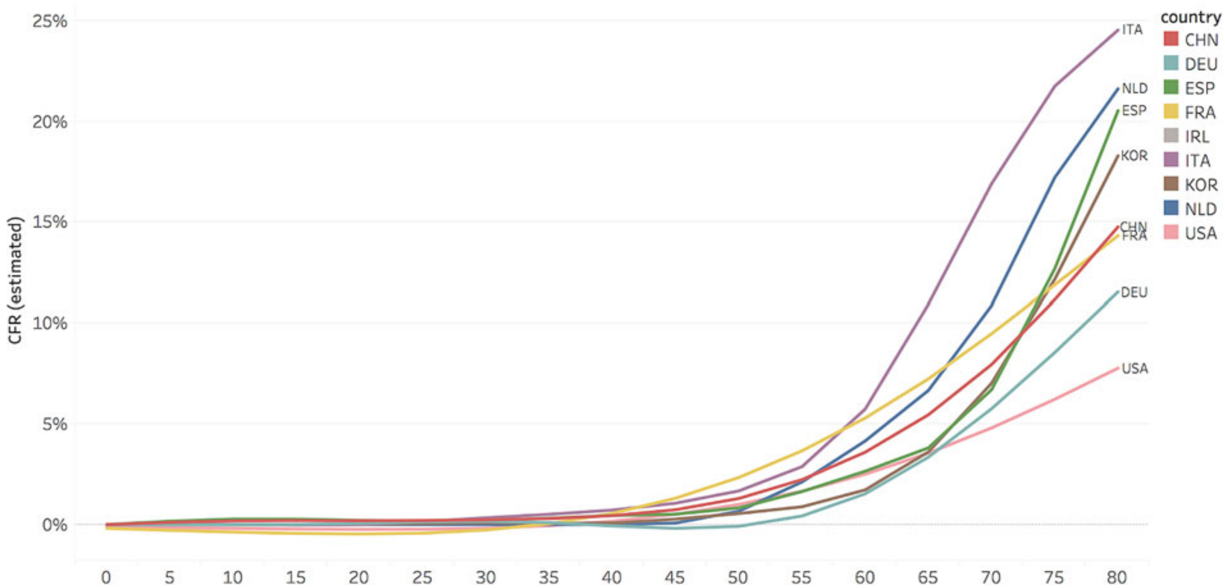

Fig. 1. Case fatality rate (CFR) of COVID-19 by harmonized 5-year age groups in different countries. Source: Natale *et al.* (2020).

(Rajgor *et al.*, 2020). CFR estimates heavily depend on the degree of testing, as that determines the extent to which mild and asymptomatic cases can be identified and hence counted. While the absolute level is less certain, there is abundant evidence that CFR increases dramatically with age (see Figure 1) (Natale *et al.*, 2020).

There is also evidence that pre-existing health conditions such as hypertension and diabetes increase the risk for severe disease and death (Wang *et al.*, 2020). As the prevalence of these conditions and the age structure of the population vary between countries, so will CFR. Despite the remaining uncertainties, it is clear that if containment measures either fail or are inadequate, COVID-19 can quickly overwhelm health systems and lead to a sharp increase in premature deaths, also from other diseases. To an extent, science made it possible to anticipate and weigh the risks of the coronavirus (i.e., the probability of spread multiplied by its potential damage).

For anthropogenic climate change, the cause had been determined as early as the nineteenth century, when scientists like Eunice Foote (1856), John Tyndall (1859) and Svante Arrhenius (1896) described the greenhouse gas effect. Since then, the burning of fossil fuels has grown exponentially, leading to a sharp rise of the greenhouse gas carbon dioxide (CO_2) in the atmosphere to levels not previously seen in human history (Solly, 2019). While effects of the resulting global warming can already be observed today, future emissions pathways will determine the extent of damages. To evaluate the related risks, climate impact assessments are made. In brief, these entail projecting the effects of different degrees of anthropogenic warming on the earth system, and they can also include economic sectors, like agriculture. Generally, a probability calculation is made, establishing the likelihood of an event occurring at a certain warming level. Taken together, the impact assessments reveal that the risks of unabated climate change are enormous. A high-emissions pathway (RCP8.5) is associated, among other impacts, with increasing severity and frequency of extreme events, such as droughts and floods, up to 1.3 m sea level rise by the end of the century (Horton *et al.*, 2020), large harvest losses (Porter *et al.*, 2014) and a range of serious health impacts (Watts *et al.*, 2019). Recently, discussions about the likelihood of the RCP8.5 emissions scenario emerged (Hausfather & Peters, 2020). However, even if an unabated growth of emissions has become less likely in recent years, the associated warming levels have not – because there is evidence that climate sensitivity may have been previously underestimated (Palmer, 2020). Ultimately, the damages of 4°C or 5°C warming would entail a complete loss of human civilization as we know it. The probability for such extreme impacts occurring as a result of higher global warming levels is close to 1 (certainty), given the wealth of evidence (Steffen *et al.*, 2018). For example, already by 2°C warming, most tropical corals would disappear, with severe implications for fisheries around the world (Frieler *et al.*, 2013). The Amazon rainforest could turn into a savannah-type system at 4°C above pre-industrial levels, a change that could also be induced through further deforestation (Lovejoy & Nobre, 2018, 2019). The action taken so far to address the climate crisis is grossly inadequate. Continuing subsidies and increasing reliance on fossil fuels are cases in point. Insofar as global emissions from fossil fuels show no sign of abating, the diagnosis is clear: fossil fuels and, in general, our unsustainable lifestyle are damaging our planet in irreparable ways. To conclude, science has provided a diagnosis of both climate change and the coronavirus pandemic, laying the basis for a correct prognosis.

3. Prognosis: gaining intervention time

The prediction of the probable course and outcome of a disease over time – the prognosis – provides further interesting parallels between the coronavirus and climate change. Urgent action is required when risk of damage is high and reaction time and intervention time converge ($U = \tau / T$). Intervention time is the timespan from the point that a risk is identified to the point of impact. Science can help to determine risks long before the impact occurs ($T_{science}$). Reaction time is the time needed to minimize or avoid the impact, through mitigation and adaptation. A system's reaction time can heavily depend on given infrastructure and technology, but also on soft factors, such as information networks, trust

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in institutions or political leadership. Effective emergency governance can lead to a shorter reaction time (τ_{govern}). Delays in containment are fatal because the aversion of large risks is only feasible in the early stages of emerging threats, which have inherent delays between cause and effect. There are critical points after which a certain level of damage cannot be forestalled anymore. When the time left for intervention T to avoid harm is smaller than the time left needed for reaction τ ($\tau / T > 1$; e.g., the time it takes to formulate and implement policies and regulations), control is lost (Lenton *et al.*, 2019).

Because of the non-linear (exponential) behaviour of unbridled COVID-19 infection dynamics, the intervention time to contain this pandemic was relatively short. Epidemiological models projected how the virus could spread and the number of hospital cases and deaths that could ensue, therefore giving governments crucial weeks to intervene in order to prevent the spread and to prepare their health systems. The ability to anticipate a still invisible crisis made it politically feasible to allocate resources and impose restrictions before a large and possibly uncontrollable outbreak occurred.

The corona crisis exposes how denial of the evidence (diagnosis) and late response can lead to profound and far-reaching consequences, including the loss of human lives. Governments who are denying science, like the Trump administration in the USA or Bolsonaro in Brazil, fare much worse than those who consult and follow expert advice, like Ardern's government in New Zealand or Merkel's government in Germany.

The first critical point in the corona crisis would have been early containment following doctors' advice and alarm in Wuhan, China. Strong measures at that point might have prevented the global spread of the disease, but the intervention point was missed in mid-January 2020, several weeks after cases of unusual pneumonia had been reported in Wuhan in late 2019 (Guo *et al.*, 2020; Rothan & Byrareddy, 2020). A second critical point relates to containment at the national level in various countries. Once a first outbreak is detected, it is crucial to contain the first cases and their respective contacts to break infection chains. If there are too many cases, a local lockdown is needed. A few days can determine whether the outbreak can be limited to the local level or whether so many cases occur in diverse locations that a nationwide lockdown becomes necessary. The later the epidemic is contained, the larger it will grow, and its size increases non-linearly. Small delays in testing and case tracing can thus have large, deadly consequences. The critical points were missed in many countries, such as the USA, Italy, the UK and Spain, where the reaction time was too long for stopping the early spread of the disease.

Besides these critical points for mitigating new infections, there is also a critical timespan for adaptation, which is the reaction time to, for example, procure medical equipment and build up additional hospital capacities. This time varies depending on the existing capacity of the health system and the efficiency of emergency governance. Once the number of critically ill patients exceeds the number of available intensive care beds, mortality will sharply increase, also from other diseases. Therefore, mitigation measures for reducing transmission to a level such that the number of cases remains within the capacity of the respective health system are of utmost importance. Conversely, using the time gained for adaptation is also crucial.

Uncertainty about the level of risk to the population and the intervention time needed were among the obstacles to swift policy actions. Scientific predictions can expand the timespan for intervention, but credible communication of science is crucial to changing the perception of the need to address latent threats. The corona pandemic showed how quickly established institutions reach their response capacities when faced with multiple challenges of exponential damages.

Climate risks can also be anticipated over a much larger timespan. Scientists estimate what amount of anthropogenic CO_2 emissions (also called total carbon budget) will entail a certain change in global mean temperature (Meinshausen *et al.*, 2009). The resulting climate impacts can be projected decades and even centuries in advance, revealing the long-term consequences of today's actions. Earlier predictions have already materialized and can now be observed (Hausfather *et al.*, 2020). Extreme events, like the 2007–2010 drought in Syria, were significantly more likely to occur because of global warming (Kelley *et al.*, 2015). Particularly worrisome are projections that indicate possible non-linear, irreversible changes that could occur at relatively low warming levels (Lenton *et al.*, 2019). For example, the threshold for one of these tipping elements, the Greenland ice sheet, could be crossed at only 1.5°C above pre-industrial levels, meaning a complete melting of the ice sheet could no longer be stopped afterwards (Pörtner *et al.*, 2019). Moreover, we need to consider a domino effect between different tipping elements in the earth system that could push the planet into a new hothouse earth equilibrium, which would drastically reduce habitability (Lenton *et al.*, 2019). Uncertainties around when and with what magnitude large-scale risks could materialize mean that even more cautious risk mitigation is in order. By comparison, containment of a disease outbreak early on is very important when it may still be unclear how contagious or deadly the pathogen really is.

The intervention time to avoid points of no return is running out. At current levels of CO_2 emissions, the carbon budget under the 1.5°C limit would be exceeded in less than 8 years (Mercator Research Institute on Global Commons and Climate Change, 2018). The carbon budget under the 2°C upper warming limit of the Paris Agreement would be used up in approximately 25 years. Decarbonizing the entire global economy could take decades (reaction time), which is why urgency is high. Even the draconian measures imposed to contain the corona pandemic had only moderate side effects on global emissions. While the daily resolution of emissions reductions show dramatic decreases (−17%) by the beginning of April 2020 as compared to the previous year, the effect on the whole year could be relatively small (−4%), depending on the reopening of economies (Le Quéré *et al.*, 2020). Integrated over longer time periods, decreases are more modest, with a 9.1% drop in the first 5 months of 2020 compared to the same months in 2019 (Z. Liu *et al.*, 2020). Transition to carbon neutrality requires systemic change in how we produce energy and food and how we power our transportation systems. It cannot simply be achieved through reduced economic activity. The emissions reductions during the corona pandemic are side effects of the disease control measures that incurred extremely high economic, cultural and societal costs.

Exponentially growing challenges of a much greater order of magnitude are on the horizon in a changing climate. Due to the inertia of the earth system, decades and even centuries after CO_2 is released into the atmosphere its harmful effects will continue to materialize (Stocker *et al.*, 2013). Once stronger climate impacts occur, the reaction time for adaptation to protect people from experiencing the worst effects of climate change and for mitigation to stay within the Paris temperature range of 1.5–2.0°C may have run out. International cooperation would then also be

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hampered by the need for nation-states to address crises within their own territories. During the beginning of the COVID-19 pandemic, competition for protective gear, unilateral border closures and a lack of communication characterized much of the international response. The withdrawal of the USA from the World Health Organization, executed by the same administration that announced its exit from the Paris Climate Agreement, shows how scapegoating mechanisms that aim to conceal a dearth of national governance can harm multilateralism. Several countries also used the pandemic to implement authoritarian repression, ordering arrests and limiting civil liberties under the cover of disease control. For example, in the relative absence of international scrutiny, autocratic governments used the lockdown to further curtail rights and silence opponents (German Advisory Board to the Federal Government on Civilian Crisis Prevention and Peacebuilding, 2020). However, there were also signs of international cooperation, from the treatment of a small number of Italian and French COVID-19 patients in German hospitals, to the joint European recovery plan (European Commission, 2020b) and the calls for a global armistice. But the support for the most vulnerable groups in developing and emerging economies, such as in Brazil, falls short and can even be hindered by national or local elites. The COVID-19 pandemic is a test for the international system. Despite some success stories of international collaboration, it has already revealed the shortcomings of the global community's ability to respond to a rapidly evolving global emergency and in effectively addressing situations in which governments fail to protect their populations.

When producing a prognosis, science has a double role: (1) to define the biophysical characteristics (e.g., estimating the reproduction number of a virus or at what temperature catastrophic climate impacts occur) and intervention times (how far away are we from damage); and (2) to assess reaction time (e.g., what policies are needed to protect populations and how rapidly can they be implemented). Simply put, the scientific prognosis both for corona and the climate shows that cascading impacts could overwhelm capacity; thus, immediate action is required.

4. Therapy: 'avoiding the unmanageable and managing the unavoidable'

The response to the COVID-19 outbreak speaks to the varying capabilities of states to overcome crises as well as to underlying vulnerabilities of populations. Deficiencies in governance and public health systems are being quickly exposed in the pandemic. The difficulties in Europe and North America to contain and treat infections foretell the even more profound challenges to be faced by low- and middle-income countries. Countries in which there is limited access to healthcare, large economic disparity or few fiscal resources are more affected by the virus (Raga & te Velde, 2020). International humanitarian and development frameworks appear to be worryingly ill-equipped to live up to such a tall order. For example, aid organizations and governments have to channel funds and human resources to respond to the coronavirus, which in turn may then be lacking elsewhere.

Evidence indicates that for both climate change and the corona pandemic, the global community has already missed the point in time to avoid all serious risks. Therefore, avoiding the unmanageable and managing the unavoidable will have to guide future action. Only rigorous mitigation will provide options and time for adaptation. However, prevention can be much more challenging to implement politically than adaptation and repair because the successful aversion of harm is difficult to measure and explain to the public. Moreover, there is a trade-off in foregoing immediate benefits in the present for a better but uncertain future. Some may harbour hopes for a technological equivalent of a *deus ex machina* to solve the climate problem. However, this appears, at best, to be wishful thinking. In the case of climate change, it is the cost of transforming, *inter alia*, energy and transport systems and the agricultural sector sooner for the sake of climate stability. For containing the coronavirus spread, physical distancing and economic losses were widely accepted in the short term in order to avoid the overwhelming of health systems. Because the threats of the corona pandemic are perceived as imminent and personal and measures are expected to last only a few months, they are easier to implement than the long-term, albeit less drastic, changes that are necessary for protecting the climate in the apparently distant future. These transformations can be realized through a combination of: (1) bottom-up approaches whereby people change their habits; and (2) top-down coordinated systemic change, redefining the very governance of the global commons.

The corona pandemic reminds us once more that the sum of many individual actions matters. The mitigation power thus rests with the mass of individuals who can collectively decrease transmissions through having fewer contacts, maintaining distance, using protective gear and adhering to hygiene measures. The policies enforced by countries and duly observed by large swaths of the world's population underscore our capacity to transform in fundamental ways. The same is true for the mitigation of global emissions, which are partly the result of individual use of fossil fuels and personal consumption. In fact, the depth and velocity of changes in people's lives away from seemingly entrenched social conventions and inclinations highlight one important lesson with direct bearing on climate change: if there is a will, there is a way. In both cases, however, governmental action is necessary in order to guide, facilitate and enforce measures of collective and coordinated action.

In fact, crisis prevention requires strategic coordination at the system level. For the corona pandemic, this means the strategic use of testing and contact tracing to contain the epidemic and prevent the collapse of the healthcare system due to umpteen more patients than capacity ('avoid the unmanageable'). At the same time, health system capacities need to be increased in order to be prepared for treating waves of patients resulting from past inaction ('manage the unavoidable'). Similarly, strategic transformation of our economies and lifestyles away from fossil fuels is needed to limit global warming to 1.5°C above pre-industrial levels and to stay clear from tipping points in the climate system ('avoid the unmanageable'), while adapting to sea-level rise, more frequent heatwaves, droughts, floods and storms, water scarcity and other consequences of global warming that we are already facing ('manage the unavoidable'). Because of the non-linearity of the corona pandemic and climate change, the creation of capacities for adaptation to these crises does not suffice. Only if the unmanageable is avoided is there a chance to stabilize the system.

The corona crisis has indeed magnified deficiencies in the governance of the global commons. Biodiversity is fundamental for the functioning of the planetary system. Disturbances of natural habitats through land-use change and wildlife trade can have far-reaching repercussions. These not only materialize through species extinction, but also through more close interactions between humans and wild animals, and thus they create an increased risk

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of emerging zoonotic diseases. Governance of the global commons thus needs to be guided by a risk perspective that is informed by scientific research and that can partially anticipate and thus address still invisible risks. While science evolves over time and its diversity of views is a source of its strength (de Vries, 2019), scientific advice can provide informed guidance to address, *inter alia*, climate and health risks. To achieve this, decision-makers need solid information on the different variables of the emergency formula in order to be able to prevent and manage emergent crises. Yet even with increasing information at hand, some do not take action. The preconditions for grounding policymaking in scientific evidence include societal trust in the scientific system and freedom of speech for scientists to ring the alarm bell when needed, as well as the critical discussion of scientific findings in public.

Through existing frameworks like the United Nations Framework Convention on Climate Change (UNFCCC) or the Convention on Biological Diversity, it has not yet been possible to halt the deterioration of the global commons. The current crisis has again shown that, without their protection, as outlined in Sustainable Development Goals 6, 13, 14 and 15, realizing the other social and economic Sustainable Development Goals will be impossible. A violation of the global commons (e.g., through destruction of natural habitats and wildlife trade) and its global ramifications will ultimately affect everyone. In this sense, the corona crisis and the climate crisis are very similar. We all depend for our livelihoods on the global commons, such as stable ice sheets, intact forests and living oceans. Similarly, we all depend on the responsible management of zoonotic virus spill-over risks from wildlife and livestock. Just as the climate crisis is a manifestation of the Anthropocene, so is the corona crisis. Both are the result of increasing human pressure on the planet.

The synchronicity of stressors, be they multiple disease outbreaks or climate impacts, could hinder international cooperation and the development of effective governance mechanisms to safeguard all countries against more devastating shocks. The therapy rests on the willingness of people to reconsider and overhaul their lifestyles, as well as systemic changes to be promoted at the highest political levels that make those lifestyle and industrial changes easier. A shift away from consumerist lifestyles and the excessive exploitation of natural resources for short-term gains is necessary (de Vries, 2019). In the case of the climate emergency, science has sketched potential pathways out of the crisis, but more societal discussions are needed to determine local, regional and national implementation (Rockström *et al.*, 2017). Citizens have been willing to take on large short-term lifestyle changes to reduce the impact of the pandemic. Conversely, citizens have been reluctant to commit even to smaller long-term changes to avert the climate emergency. But as we will argue below, the synchronicity of stressors can indeed unleash new social dynamics and patterns of cooperation to address latent problems. The magnitude of the climate challenges before us, especially relative to the ongoing pandemic, warrants nothing less.

5. Rehabilitation: healing body and soul across generations

In a memorable scene, on Friday, 27 March 2020, Pope Francis delivered poignant words before a "vast and empty" San Peter's Square in the Vatican: "We have realised that we are in the same boat, all of us fragile and disoriented, but at the same time important and needed, all of us called to row together, each of us in need of comforting the other" (Horowitz, 2020). Although people from all socio-economic backgrounds have been affected, some groups face much greater adversity than others because of the unequal access to basic health and social services, as well as dissimilar living conditions. The existential challenges in urban slums, impoverished rural areas and in temporary settlements experienced by, *inter alia*, refugees and asylum seekers speak volumes of the deep inequalities that the pandemic further exacerbates.

Debates on the reopening of industries and public life are grounded in the profound ethical dilemma of weighing economic, cultural and societal sacrifices, which again have health consequences, against the direct protection of lives from the infection. Because of the immanency of policy actions' consequences on life and death, these issues have now come to the centre of public debates. This moment thus provides an opportunity to shift the course of the increasingly neoliberal capitalist global order in which business profits and individual wealth have been the key indicators for economic success, even when they are built on immense human suffering and an unprecedented ruthless exploitation of the global commons. If we follow Immanuel Kant's counter-utilitarian principle whereby "considerations of individual rights temper calculations of aggregate utility," a number of stark choices are ahead of us. It has become clearer than ever that, without moral and political stewardship, the human project could fail. Based on the union of reason, compassion and social justice, we call for the establishment of an intergenerational Climate Corona Contract to avert the climate emergency.

Reason and compassion have to guide crisis prevention efforts. Both could be observed in the corona crisis, but transferring this approach to climate change is not simple. Decision-makers were quick to implement measures to contain the pandemic because they could be personally held accountable for rising death numbers. Citizens largely obeyed the newly imposed constraints, also because they perceived COVID-19 to be an imminent threat to their closest social circle or themselves. Divergently, other regulations, such as stricter speed limits on highways in Germany, which would save lives and support climate protection, were vehemently opposed by many politicians and parts of the population. Because the effects of the decision to drive (namely possible deaths from accidents and rising sea levels) are more dispersed, public opinion and our judicial system are seemingly unable to trace causality. A lack of perceived individual responsibility and of a reasoned approach is hindering appropriate mitigation measures. In order to take serious action on climate change, human compassion needs to expand in time and space, beyond the present and national borders. Better science communication and less polarized political dialogue are needed to accept the evidence and act upon it with empathy. Only through reason and compassion can global emergencies with differential impacts be resolved. The two form the basis for another component of the ethical compass guiding policymaking for crisis aversion: *social justice*.

The *sine qua non* element for crisis aversion is *social justice* as a shared overarching framework to inform policy decisions. Historical analyses of previous pandemics underline the importance of social justice to inform decision-making (DeBruin *et al.*, 2012; Kayman & Ablorh-Odjidja, 2006; Thompson *et al.*, 2006). The COVID-19 emergency is a wake-up call for rethinking the underpinnings of our social and economic systems in order to achieve fair distributions of wealth, opportunities and privileges. As part of this, reconciliation is imperative for a sustainable resolution of the crisis. On the one hand, exemplars of generosity and selflessness have been reported across the world. On the other hand, however, when either death or unbearable suffering are felt to be all the more imminent, cooperation may well give way to competition. At the international level, the obstacles to cooperation to counter the pandemic and surges in nationalist sentiment are becoming increasingly obvious. In other words, the strains placed on society by the response to COVID-19 can further widen existing social, economic and political inequities. The same applies to climate change. The extreme lifestyle changes triggered by the COVID-19 emergency foreshadow how fragile our system is to shocks and that all parts of society can be affected if prevention is not prioritized (see also the speech at Peterberger Klimadialog by Guterres, 2020). Social justice thus underpins the motivation for empathetic collective action needed for crisis aversion.

In particular, intergenerational solidarity is key to addressing diametrically opposed levels of risks for the young and old. As argued by Clark and Harley (2020), society cannot achieve the Sustainable Development Goals without giving more attention to the challenges of achieving fair and just distributions of well-being both within and between generations. This applies to the possible solutions for both crises. When contracting COVID-19, older people are at much higher risk than young people of developing severe symptoms and dying (Natale *et al.*, 2020; Robert Koch-Institut, 2020). In contrast, the younger generations are more affected by climate change because even more severe impacts will unfold in a few decades. For their common future, both generations should enter a social contract (Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen, 2011) that is based on mutual solidarity. In such a Climate Corona Contract, the younger generations would agree to protect the elderly and other at-risk groups from COVID-19 by adhering to restrictions, such as physical distancing measures. Conversely, the older generations would vow to rigorously implement measures to keep global warming between 1.5°C to 2.0°C above pre-industrial levels in line with the Paris Agreement signed by most governments. This would require halving global CO_2 emissions each decade (Rockström *et al.*, 2017). Whereas considerations of distributional equality between countries would require deeper emissions cuts by industrialized nations (e.g., see Climate Equity Reference Project, 2020), at a minimum, the new European Union emissions reduction target of 55% by 2030 as compared to 1990 should be met (European Commission, 2020a). A postponement of CO_2 pricing, delaying the European Green Deal and similar obstructions would mean a breach of such a contract, as would disregard for the regulations aimed at containing the pandemic. Public investments to revive the economy post-pandemic need to support social and environmental sustainability transformation. In brief, the long-term rehabilitation from both crises warrants the 'redistribution of access to resources' and the pursuit of greater equity (Clark & Harley, 2020). During the lockdown, signs of extending solidarity and empathy beyond an individual's inner circle could also be witnessed, *inter alia*, through healthcare workers risking their lives for strangers, neighbourhood support groups and from younger people in form of their widespread acceptance of containment measures. The experience of the corona pandemic has exposed the relevance of individual action for broader society and in shaping the course of a crisis. Understood as a social justice framework based on reason and compassion, the Climate Corona Contract would thus compel all age groups to take responsibility for the common good, even if they cannot discern immediate personal benefits.

6. Conclusion

To summarize our four-step analysis, the COVID-19 outbreak helps us to formulate a contingency plan for the climate emergency that necessitates the following core elements: lower the probability of damage through mitigation; lower damages through adaptation; increase intervention time through science; and decrease reaction time via a social contract and improved governance of the global commons ($E_{cont} = p_{mitig} \times D_{adapt} \times \tau_{govern} \ / \ T_{science}$).

Besides the climate lessons derived from the corona crisis discussed above, another aspect unites the two crises and brings a glimmer of hope: the recognition of humanity's shared destiny. Both crises are testing our resilience and humanity in extreme ways. The COVID-19 outbreak has generated an outpouring of generosity among people and states, and at the same time new dynamics of competition are at play.

For both the corona crisis and climate change, despite uncertainties, science helps us to establish a diagnosis, prognosis and therapy. Yet it remains to be seen whether societies and governments around the world are willing to take up the challenge that climate change poses as vigorously as they are addressing coronavirus. In fact, it is a matter of intergenerational social justice. The Climate Corona Contract recognizes that, in the face of risks to which nobody is immune, a renewed commitment and related institutional mechanisms to safeguard the right to life are all the more essential. Experience is a hard teacher, but the lessons from the corona crisis should be taken forward to protect our planet and preserve it for future generations. The outbreak has brought to light the potential to transform some of the foundations of our society. This can serve systemic change, not just in the short term. In a time when 'social distancing' is the new norm, 'new ways of coming together' (Yong, 2020) are being ingenuously found. This renewed appreciation of our shared destiny may well help us to think in the long term about the very value of the only planet we have and our role therein.

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