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COVID-19: a wake-up call to protect planetary health

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1.1 Emerging infectious disease, COVID-19, and planetary health

While human health research scarcely considers the surrounding natural ecosystems, a relatively new discipline, planetary health, examines the health of human civilization along with the state of the natural systems on which it depends (Vidal, 2020a; Horton et al., 2014). The field of planetary health is gaining attention, as the connections between human well-being and ecosystem health become increasingly evident. Infectious outbreaks, like the novel coronavirus, threaten to become more common as human populations destroy habitats, forcing wildlife into closer proximity to humans (Johnson, 2020). The US Centers for Disease Control and Prevention estimates that three-quarters of new or emerging diseases that infect humans originate in animals, with research suggesting that outbreaks of infectious diseases such as Ebola, SARS, MERS, bird flu, and now Coronavirus disease 2019 (COVID-19) are on the rise (Vidal, 2020b; Smith et al., 2014). As humans continue to encroach on animal habitat and destroy fragile ecosystems, they come into ever greater contact with animals. In addition, illegal wildlife trade and illegal live animal markets are frequent causes of such diseases. COVID-19 is the latest infectious disease of likely zoonotic origin or more simply put to have been caused due to increased interaction between humans and wildlife as a result of anthropogenic activities in terms of environmental degradation and poor planetary health (Murdoch and French, 2020). How did the 2019-nCoV arrive in Wuhan, China is still undetermined, but evidence shows 66% of the 41 initially infected patients had direct exposure to Huanan live animal market (Huang et al., 2020). The COVID-19 pandemic has brought to forefront the urgent need to consider zoonotic and agricultural bridging of novel pathogens along with attention to anthropogenic origins such diseases and human appetite for meat (Kock et al., 2020).

COVID-19 is a contagious respiratory and vascular disease and is currently an ongoing pandemic which has already infected about 63 million people world-wide and resulted in 1.5 million deaths as of late November 2020 (WHO, 2020). “Pandemic is not a word to use lightly or carelessly. It is a word that, if misused, can cause unreasonable fear, or unjustified acceptance that the fight is over, leading to unnecessary suffering and death,” said the Director-General of the World Health Organization on March 11, 2020, when the COVID-19 outbreak was declared a pandemic (WHO, 2020b). His key statements to the world included: “prepare and be ready; detect, protect and treat; reduce transmission; and innovate and learn.” The unprecedented repercussions of COVID-19 pandemic have shown the implications of infectious diseases on not only human health and well-being but also on economies and employment even in remote locations (Biswas, 2020; Watts, 2020). World Economic Outlook by the International Monetary Fund projects a deep recession in 2020 and global growth is projected to be -4.4% (IMF, 2020). The International Labor Organization estimates that global labor income has declined by 10.7%, or USD 3.5 trillion, in the first three-quarters of 2020, compared with the same period in 2019 (ILO, 2020).

Studies have shown that the extent to which the COVID-19 virus induces respiratory stress in infected individuals may also be influenced by the extent to which an individual's respiratory system is already compromised, including due to air pollution. The result of one study attributes air pollution to be an important cofactor leading to increasing mortality risk from COVID-19 (Pozzer et al., 2020). Another study, in China, shows that high levels of particulate matter pollution may increase the susceptibility of the population to respiratory complications of the disease (Chen et al., 2020). A case study from the United States indicates that COVID-19 associated death rates are raised by about 15% in areas where even a small increase in fine-particle pollution level is observed than in the pre-COVID-19 period (Wu et al., 2020). Adsorption of the COVID-19 virus on airborne dust and particulate matter from air pollution could also contribute to long-range transport of the virus (Comunian et al., 2020). Infected stools in wastewater can generate further transmission routes through the generation of virus-laden aerosols during wastewater flushing. Studies have shown that SARS-CoV can survive in stool samples for 4 days (Lai et al., 2005). A study found that in 2003 contaminated faulty sewage system in a high-rise housing estate in Hong Kong was linked to the SARS outbreak of a large number of residents living in the surrounding buildings (Hung, 2003). Another study also found the presence of SARS-CoV-2 in fecal matter and wastewater and raised the possibility of fecal-oral transmission of SARS-CoV-2 (Heller et al., 2020). Yet another study examined linkages with climatic variables and found a negative association between temperature and COVID-19 infections and a positive association between precipitation and COVID-19 infections (Sobral et al., 2020). Increasingly, there is an interest in understanding the role of climate change, habitat destruction, and urban pollution and their play in the appearance and spread of COVID-19.

The objective of this chapter is to examine the trends set in motion by COVID-19 and its implications for planetary health. These will be examined in the context of the long-term environmental and humanitarian repercussions of the pandemic.

1.2 Lockdown as a temporary respite for the environment

A growing body of literature examines the impact of COVID-19 on the environment (Prata et al., 2020; Patrício Silva et al., 2021; Yunus et al., 2020; Jribi et al., 2020; Dutheil et al., 2020). As countries locked down and social distancing was enforced in March 2020, many environmental parameters showed an improvement as pollution levels decreased, energy use dramatically reduced, and greenhouse gas (GHG) emissions fell (Watts, 2020). China, the largest global emitter, witnessed a drop in carbon emissions by 25% due to the lockdown; pollution in New York reduced by close to 50% because of measures to contain the spread of the virus; a nationwide lockdown in India a country with the highest pollution levels in the world resulted in a drop of PM_{2.5} (fine particulate pollutant) by 30% in some cities in just a few days (Mahato et al., 2020). Studies have also documented positive environmental effects such as reduction of air pollution (especially in terms of PM_{2.5} and NO₂) (Mahato et al., 2020; Sharma, 2020), reduction in noise (Zambrano-Monserrate et al., 2020), and clean beaches (Zambrano-Monserrate et al., 2020). On the other hand, the negative impacts of COVID-19 have been the increase in volume of infectious waste during the pandemic outbreak due to the lack of waste management of personal protective equipment (PPE), including masks and gloves (Sangkham, 2020). Emissions of GHG have decreased as a result of the pandemic. But this reduction has also only been short-lived with little impact on the total concentrations of GHGs that have accumulated in the atmosphere for decades (Zambrano-Monserrate et al., 2020).

The recorded decrease in pollution due to national lockdowns seemed like good news for the environment but it does not by any means imply that climate change is slowing down. Tentative estimates, which project that COVID-19 could trigger the largest ever annual fall in carbon emissions, point to the fact that this fall would not come close to bringing the 1.5°C global temperature limit within reach (CB Analysis, 2020). Global carbon emissions would need to fall by more than 6% every year this decade, which is the equivalent of more than 2200 MtCO₂ (metric tons of carbon dioxide) annually, to limit temperature increase to less than 1.5°C above preindustrial levels. Concentrations of carbon dioxide, the gas that is primarily responsible for trapping heat in the Earth's atmosphere, are up from 413 parts per million this time last year to 416 parts per million now (NOAA, 2020a). As Bill Gates rightly noted in early August 2020 "What's remarkable is not how much emissions will go down because of the pandemic, but how little. In addition, these reductions are being achieved at, literally, the greatest possible cost" (Gates, 2020). A staggering cost is the impact of the pandemic on the surge of plastic pollution, which threatens to choke the planet.

1.3 Pandemic reclaiming the plastic usage: demand, production, and usage

Studies estimate that, due to COVID-19, the demand on plastics is expected to increase by 40% for packaging and 17% for medical use and other applications (Prata et al., 2020). Two years ago, the United Nations declared plastic pollution as a global crisis and the year 2020 was meant to mark an ultimate shift away from plastic as countries and cities introduced new bans while scientists and activists argued for positive environmental changes. The coronavirus outbreak and increasing numbers of infections, however, have sidetracked this narrative exerting tremendous pressure on healthcare systems and revealing that plastic is still the most reliable and affordable solution for personal protection (Konov, 2020). Even before the Coronavirus outbreak was declared a pandemic, the global demand for PPE kits saw an upsurge, causing a concurrent uptake in demand for single-use plastics. This escalation in plastic usage has resulted in a global PPE shortage, with a UN task force being constituted to coordinate and scale-up its procurement and distribution. The change in the production trend of PPE between December 2019 and July 2020 was significant as WHO called for industries and governments to increase manufacturing by 40% to meet the rising global demand in March (WHO, 2020). To estimate the number of mask for general public requirements for example the Center for Health Security using a calculation forecasted demand, “10% of the US population of 330 million are essentially house-bound and will not need masks. Of the remaining 300 million, the assumption is 75% will adhere to guidance and wear 1 mask per 5 days on average.” Almost 45,000,000 masks/day, 1,372,500,000 per month until the vaccine arrives and this is for the US population only (Box 1.1).

The magnitude of the global waste crisis can be understood from the radical growth in the manufacturing and production of PPE kits which the pandemic has necessitated in the past many months. The global PPE market that was valued at USD 52.7 billion in 2019 is expected to reach USD 92.5 billion by 2025 (VR, 2020) with some of the key global players who include 3M Company, Ansell Limited, Honeywell International Inc., and others. Some of the key players operating in the global PPE market are the M Company, Ansell Limited, Honeywell International Inc., Sioen Industries NV, Kimberly-Clark Corporation, E I DuPont de Nemours and Co., MSA Safety Inc., Lakeland Industries, Alpha Pro Tech, Ltd., Radians Inc., Delta Plus Group, Uvex Safety, Avon Rubber, and Metric AG (Box 1.2).

Countries such as India with less waste management capacities have also been producing PPE kits (UMHI, 2020). For example, developing countries like India struggled in arranging PPE kits in the month of March when the lockdown was announced when India had not begun manufacturing PPE kit, and was dependent on other countries like Singapore, Korea, and China for the PPE kits. For India alone, the requirement changed from approximately 4 lakhs to 10 lakhs and more, and has now achieved an almost unrealistic goal of producing 2.06 lakh PPE kits daily within 2 months after the coronavirus outbreak (Box 1.3). The latest demand estimated by Empowered Group-3 of the Government of India is a total requirement of 2.01 crore till the month of June.

When WHO provided an update regarding the modes of transmission of the virus, including the possibility of aerosol transmission, face masks were recommended as part of the public health response (WHO, 2020). This led to an enormous increase in the demand for face masks from the public and consequently, their rampant disposal. However, with governments recommending that general populations wear nonmedical, homemade cloth masks to ensure availability of PPE for healthcare workers, it has been forecasted that after adjusting for home-bound individuals, surgical masks will be used by 50% of the population and that they will use, on average, 1 mask per day (Toner, 2020). These figures point to the large magnitude of PPE demand and disposal.

According to estimates by WHO, frontline workers, on a monthly basis would need 89 million medical masks, 76 million examination gloves, and 1.6 million goggles (WHO, 2020b; Fig. 1.1).

Furthermore, reliance on plastic and imperishable materials has only steadily increased with products such as disposable wipes, cleaning agents, hand sanitizer, disposable gloves, and masks being sold and thrown away in unprecedented volumes (Patrício Silva et al., 2021). This widespread utilization of PPE kits and other self-care products has accelerated during the pandemic period as has the consequent waste generation and resulting GHG emissions involved. This reveals our disregard and inattention to environmental implications when dealing with emergencies.

Furthermore, medicine and testing kits have also faced a similar upsurge. On the scale of daily tests conducted in the range of 1000 to 10,00,000, it is found that 50% of the countries are conducting more than 10,000 tests per day and countries like the United States, India, United Kingdom, Russia are conducting 0.5 million tests per day (Fig. 1.2). Lack of stringent regulations and failure to systematically dispose testing kits and other equipment will not only increase the risk of infection, but also increase plastic pollution as all of them ultimately find their way into oceans and landfills. These long-lasting ecological hazards call for governments to focus on sustainable pathways while thinking parallel about the COVID-19 crisis (CSSE-JHU, 2020).

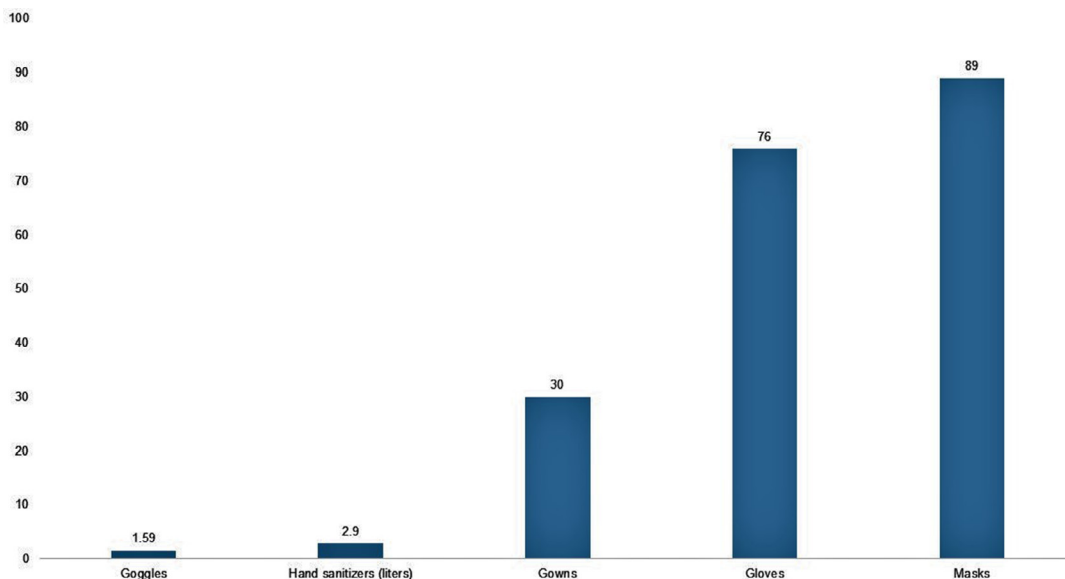


FIG. 1.1 Monthly PPE supplies needed by health workers for COVID-19 response worldwide, 2020.

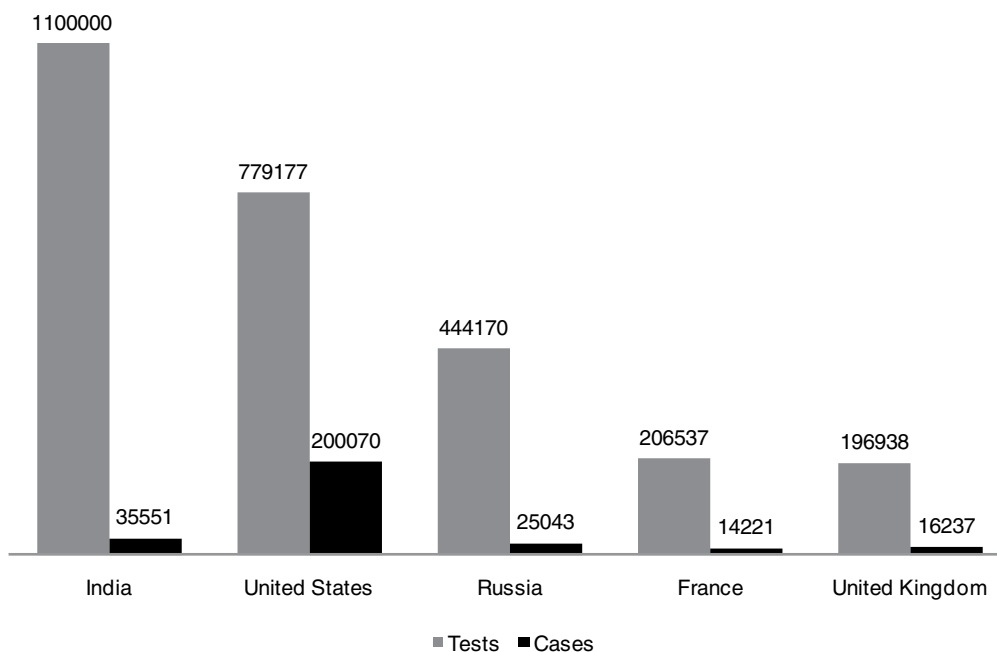


FIG. 1.2 COVID-19: daily tests vs. daily new confirmed cases.

1.4 Waste management: the intensifying crisis

Generally, protective materials used by the population such as gloves, masks, or expired medicines are disposed together with domestic waste and garbage. The United Nations Environment Program’s recommendation is that the population should separate these materials and that the local authorities assign municipal operators for the collection or specialized waste management. This recommendation also points out that the safe handling of biomedical and healthcare waste is essential for the health of the community and the integrity of the environment. In the worst-case scenario, it is pointed out that the incorrect handling of said residues could cause a rebound effect on both human health and the environment. The rebound effect for health in the context of COVID-19 are reinfections

due to poor sanitation and exposure to biomedical waste if the additional waste due to COVID-19 is not treated and handled properly. However, rebound effect with reference to environment means the worsening of environmental parameters due to waste management as well as energy related to waste management if additional self-care and medical waste due to COVID-19 is not treated and handled properly.

On the International Day for Biological Diversity, the UN Secretary-General, Antonio Guterres stated: “COVID-19, arising from nature, has highlighted the intimate connection that exists between human health and our relationship with the natural world” (Guterres, 2020b). He stated that to mitigate climatic disturbances, guarantee food and water security as well as to prevent future pandemics, it is essential to conserve and sustainably manage biological diversity. “Our solutions lie in nature,” he emphasized and recalled that the invasion and human plunder of nature affects the future of humanity (Guterres, 2020a).

For example, in countries like India, where about 78% of biomedical waste used to be treated in 198 Common Bio-Medical Waste Treatment Facilities and 225 captive incinerators, the overwhelming rise in biomedical waste caused by COVID-19 has set an unattainable demand for Common Bio-Medical Waste Treatment Facilities (Singh, 2020). Approximately 30% of the medical waste such as masks, gloves, and PPEs have been found dumped outside the hospitals or even the roads (Sharma, 2020). If mishandled, the large volume of plastic and hazardous waste generated during this period will jeopardize the environment and human health. Proper management of biomedical waste generated by hospitals and by self-care, such as medical packaging and contaminated masks, gloves, and used or expired medicines, is imperative. In addition to treating hazardous waste from treatment, diagnostic and quarantine facilities, the greater challenge arises from household waste during the pandemic (Pachauri et al., 2019). The demand for home delivery services of food and groceries has also led to an increase in the generation of common packaging plastic waste containing polypropylene, low-density polyethylene, high-density polyethylene, polyethylene terephthalate (commonly known as PET), polystyrene, and so on. Usage of single-use plastic has bounced back due to growing concerns about hygiene, particularly from products used for personal protection and healthcare purposes (Sharma et al., 2020a).

Segregation and collection has been an issue till date and now there is an even more urgent need for segregation of hazardous household waste with the proper disposal of protective suits, gloves, masks, and other waste from hospitals, medical facilities, or clinics through appropriate treatment facilities. Management and handling of plastic waste has become a huge challenge for the waste management industry due to reduced recycling activities in this period. Managing the increase in single-use plastic waste will be a struggle for governments, more so in many developing nations, where mismanaged waste aggregates in town centers or leaks into rivers and oceans, thus triggering new public health crises. Recent experiences from SARS-CoV-2, Ebola, and MERS-CoV disease outbreaks highlight the need for safe biomedical and healthcare waste management for infection prevention and control (Weber et al., 2016; Rahman et al., 2020; Ilyas et al., 2020). If safety issues are not adequately addressed, human health can be put at high risk. Apart from the risk of contact transmission, improper disposal practices of biomedical waste can have adverse environmental effects including soil and groundwater contamination, killing beneficial microbes in septic systems, and physical injuries through sharps among others (Sharma et al., 2020b).

1.5 Ocean pollution and landfills

The generation and mismanagement of waste discussed in the sections above have direct implications on water bodies and the state of the ocean. It is known that globally all polluting materials find the ocean as their final destination. In the context of COVID-19, research conducted by the World Economic Forum 6 weeks into the initial outbreak in China, showed that waterlogged masks, gloves, hand sanitizer bottles, and other biomedical and self-care waste was already found on beaches and sea beds in Hong Kong, joining the day-to-day detritus in the marine ecosystems (Stokes, 2020). These materials are transported downstream from upstream by the current of the rivers. Pollutants invariably travel toward the coast no matter how far their original source is located. Furthermore, the dispersion of pollutants also happens by dragging through wind, rain or by direct input via agricultural drains and aquaculture channels (Mallin et al., 2001; Páez-Osuna et al., 1998; Vikas and Dwarakish, 2015; Lu and Turco, 1994, 1995). It is considered that approximately 80% of marine pollution has its origin in terrestrial sources (NOAA, 2020), that is to say that any activity carried out on land will have a significant effect on the ocean-coastal region, threatening not only the health of the great ecosystem but also its productivity and the biodiversity of the marine environment. In other words, the effect of human activities is one of the main causes of marine pollution and its impact on the marine and coastal ecosystems on which the global economy and the health of the ocean depend (Denchak, 2020).

The areas most impacted by pollution are mainly the productive marine ecosystems such as estuaries, mangroves, and coastal waters. That is why the Global Environment Facility Program, which links freshwater to the ocean, currently known as Global Program of Action, was established under the auspices of United Nations Environment Program. The aim of this program is to establish the link between basins and coastal management, particularly in areas affected by the quality, use, and availability of freshwater. This is a link that must be committed to and acknowledged by various actors and governments from local, national, regional, and global levels. An increase in the presence of all types of unsegregated waste is also observed in both rural and urban areas, either in open dumps or in the field, in inland water bodies, or in municipal waste reception plants (NOAA, 2020; Denchak, 2020; Wong, 1998; Otterpohl et al., 1997; Patwa et al., 2020; Han et al., 2018, 2019a, 2019b; Van Beukering et al., 1999). This is commonly observed, particularly in countries that do not have adequate waste management programs. The global community must place long-term implications of unchecked ocean pollution on planetary health (WOO, 2020).

1.6 Exacerbated inequalities and vulnerabilities

The consequences of human-induced climate change and environmental degradation will progressively have indiscriminating impacts on all human populations, sparing no region or community in the coming decades (Gillis, 2020). However, none can ignore the evidence that demonstrates the disproportionate impact on the socially disadvantaged populations who face the risk of increased exposure and susceptibility to the adverse impacts and the damages caused, and decreased ability to cope with and recover from the losses suffered (Islam and Winkel, 2020).

While the field of planetary health fundamentally argues that ecological systems have a bearing on human health, this has become evident not only through the anthropogenic disruption of the natural balance and the consequent pandemic outbreak, but also through the vulnerabilities of poor populations whose lack of power or control over their environment has placed them at the highest risk during this pandemic (Whitmee et al., 2015; Ahmed et al., 2020). The COVID-19 pandemic not only reminds the world of declining planetary health, but as an extension, brings these exacerbated inequalities into the spotlight and ousts the myth that “everyone is in the same boat” (Guterres, 2020b; Mijis, 2020). To begin with, unequal access to safe housing and inadequate access to affordable food aggravates the risk of respiratory conditions, heart diseases, and diabetes, due to a lack of nutrition, and increased exposure to indoor and outdoor air pollution and damp conditions. Scholars have also pointed to climatic factors leading to increased vulnerability to COVID-19 as people who are vulnerable to extreme heat are also vulnerable to COVID-19, this includes the elderly, outdoor workers, and the homeless (Golechha and Panigrahy, 2020). In addition to high-density living conditions that make physical distancing impossible, employment insecurity forces individuals to step outdoors risking contact with the pathogen. This predicament is further compounded by the inability to perform basic, yet essential protective measures like handwashing, which requires assured access to water and sanitation. Unequal access to affordable healthcare is another barrier. This concentration of vulnerabilities to declining planetary health and man-made environmental disasters demonstrates the hamartia of modern society, which is the flawed and disruptive growth structure and development paradigm (Oni, 2020).

In April 2020, a study on the COVID-19 impacts on global poverty predicted that over 140 million people could fall into extreme poverty in 2020, with 80 million in Africa and 42 million in South Asia, if governments fail to provide adequate fiscal stimulus and social safety nets (Laborde et al., 2020). The exponential spread of the pandemic since April 2020 forecasts that this estimate could be much greater. Perpetuated by this socioeconomic deprivation is the looming food security crisis much greater in intensity than ever witnessed in the last 50 years (UN, 2020a). Calling COVID-19 as “the Hunger Virus,” Oxfam published a report in early July 2020 stating that 121 million more people could be pushed to the brink of starvation in 2020, with 12,000 people potentially dying per day due to COVID-related hunger and the emergence of new hunger hotspots across the globe. As Oxfam’s Interim Executive Director Chema Vera said, “COVID-19 is the last straw for millions of people already struggling with the impacts of conflict, climate change, inequality and a broken food system that has impoverished millions of food producers and workers. Meanwhile, those at the top are continuing to make a profit: eight of the biggest food and drink companies paid out over \$18 billion to shareholders since January even as the pandemic was spreading across the globe—ten times more than the UN says is needed to stop people going hungry” (Oxfam, 2020a, 2020b) Box 1.4.

Information on dividend payments of eight of the world’s biggest food and beverage companies up to the beginning of July 2020 have been collected by Oxfam with numbers being rounded to the nearest million: Coca-Cola (\$3522 m), Danone (\$1348 m), General Mills (\$594 m), Kellogg (\$391 m), Mondelez (\$408 m), Nestlé (\$8248 m for entire year), PepsiCo (\$2749 m), and Unilever (estimated \$1180 m).

The pandemic has unveiled profound humanitarian concerns never witnessed before and it is complex to determine precisely how the pre-existing social inequalities have intensified. Nevertheless, as new vulnerabilities continue to emerge, the global community will find planetary health and environmental justice too critical to ignore.

1.7 Recommendations

“The patient Earth is sick. Global environmental disruptions can have serious consequences for human health. It’s time for doctors to give a world diagnosis and advice on treatment,” wrote Per Fugelli, a Norwegian physician in 1993, way before the field of planetary health was recognized by the global community (Casassus, 2017). This “treatment” necessitates radical redefinition of the models of development adopted by governments, which, till now, have promoted production and consumption at any cost (Casassus and Per Fugelli, 2020). Four of the planetary boundaries have now been crossed as a result of human activity; these include climate change, loss of biosphere integrity, land-system change, and altered biogeochemical cycles (phosphorus and nitrogen; SRC, 2015). Climate change and biosphere integrity are core planetary boundaries and significantly altering either of these two core boundaries, could drive the Earth System into a new state of destruction (Rockström et al., 2009; Steffen et al., 2015). Concerns for planetary health especially due to climate change and biosphere integrity especially remain. The Intergovernmental Panel on Climate Change has time and again sought to warn on the dire impacts of climate change in terms of extreme events, ocean acidification, and socioeconomic implications (IPCC, 2014, 2018).

The growing body of literature which examines the causes and consequences of COVID-19 on the environment also explores solutions to address the challenges that confront human and planetary health. Recommendations are presented below with implications for governments, policymakers, and advocates to be creative in designing strategies for preparedness in embracing of health, socioeconomic vulnerabilities, sustainable production, and waste management. Further, evolving multistakeholder and cross-sectoral conversations remain key to understanding the links between fragile biodiversity and increased human risk to zoonotic diseases. As COVID-19 serves as a wake-up call to urgently tackle mounting planetary and human health crises, recommendations are presented below for global governments, policymakers, researchers, program managers, business, and academia among others to urgently address these issues.

1. Factoring climate change in planetary health is essential which would need engaging with adaptation and socioeconomic implications along with multiscale temporal and spatial approaches. For future preparedness to pandemics with zoonotic origins, there is an urgent need to monitor and report indicators at various scales at the regional, national and subnational levels. Two focal metrics of species diversity and human risk of exposure to zoonotic diseases must be monitored and taken into account (Ostfeld, 2017).
2. A systems-level approach from companies and governments on a global scale is required to be adopted in policymaking to address the issue of planetary health and environmental protection. Along with planetary scale issues through climate action and addressing biodiversity loss, safe handling, and sustainable management of the plastic and biomedical waste are vital elements of defining new models for development.
3. Balancing the COVID-19 response with wider health needs to prevent the already stretched healthcare system from being overwhelmed, government bodies should focus on leveraging existing health intervention capacities for outbreak response. For example, WHO delivered PCR testing supplies to test for COVID-19 (these testing kits including new cartridges for the GeneXpert equipment are widely used in the world for testing tuberculosis as well).
4. More relevant research needs to be conducted so that it provides enough evidence. This evidence can then be used to create the awareness needed to develop and promote new planetary health technologies.
5. COVID-19 and the growing awareness of zoonotic diseases should be a part of mainstream narratives and conversations with more engagement of policymakers and pressure groups such as opposition parties, nongovernmental organizations, media and even youth. Multistakeholder conversations need to be informed by science on planetary health and the growing risk of zoonotic infections.
6. Each local or municipal authority needs to develop risk-based contingency plans to manage future outbreaks of zoonotic diseases along with ensuring that essential waste management services. These services should be uninterrupted and add no extra health risks on top of pandemics. There is a need for informed long-term planning so that future health, environmental, and socioeconomic risks are addressed well in advance.
7. Businesses should invest more in sustainable innovation, using environmentally friendly products and renewable resources. For example, glove manufacturers are shifting their focus toward greener manufacturing

- technologies by employing renewable resources such as solar and wind power (GVR, 2020). Through use of renewable technologies businesses must strive to reduce costs by using less water and synthetic fuels. This approach, if widely adopted, is expected to spur further product demand over forecasted periods, while also protecting the environment.
8. Linked to the previous point, using bio-based materials to produce PPEs, will offset some of the negative environmental impact due to the current usage of PPE. New PPE producers are already collaborating with biological experts to develop PPE made from bio-based materials in an effort to promote sustainability. For example, Japan-based Bioworks Co. Ltd. has designed a washable and reusable antibacterial face mask made of biomass-based yarn also termed as poly lactic acid (AMR., 2020).

1.8 COVID-19 calls for reflection—conclusion

Planetary health approaches are needed to deal with the multiscale issues related to environmental quality and human well-being. Today, three-quarters of the land-based environment and about 66% of the marine resources have been significantly altered by human exploitation (IPBES, 2019a). More than a third of the world's land surface and nearly 75% of freshwater resources are now used for plant or livestock production (IPBES, 2019a). The expanding human footprint resulting in habitat loss and fragmentation disrupt critical animal behaviors and risk extinction of one million species of flora and fauna, many of which are predicted to be forced into extinction within just decades (IPBES, 2019). Biodiversity loss is associated with the emergence of zoonotic infectious diseases (Civitello et al., 2015). Ecosystems in disturbed or depleted state can affect emergence of zoonotic pathogens in part due to a reduced "dilution effect" on principal disease reservoir species (Ostfeld, 2017; Ostfeld and Keesing, 2000; LoGiudice et al., 2003; Khalil et al., 2016). Dilution effect indicates that the species vary in susceptibility, which are infected by a pathogen and the higher diversity often leads to lower infection in hosts as nonhost species dilutes the infection.

Advancing land-use frontiers to biodiversity rich areas not only have negative implications for planetary health but also increase frequency of ecotones (areas where there is increased interactions between humans and wildlife) which result in the onset of zoonotic infectious diseases (Rohr et al., 2019). Climate change would only exacerbate the outbreaks of infectious diseases due to human and wildlife contact due to shifting wildlife migration along with habitat destruction due to wildfires and climate extremes (Jenkins et al., 2020).

The foreseen danger that lies ahead, is the lack of measures adopted by governments in addressing this unsurmountable issue as they are forced to divert their attention and employ existing time and resources to overcome the pandemic without regarding the larger picture of long-term environmental and humanitarian consequences. The rise in magnitude of the production of self-care products will be further compounded with the production and dissemination of vaccines as governments race to control and end the acute phase of the pandemic by 2021. Without a strategic mechanism to address the anticipated biomedical waste accumulation, there will be growing pressure on the existing quality of treatment and disposal.

The policies for the management of medical waste, in general and, in particular, for those from the management of patients with COVID-19, have been suggested by the UN considering factors such as: generation and minimization, separation, identification and classification, handling and storage, packaging and labeling, internal and external transportation, treatment, waste disposal, including emissions, occupational health and safety, public and environmental health, awareness, and education and research. These factors are contained in the Technical Guidelines on the environmental management of biomedical and sanitary waste of the United Nations Basel Convention on the Control of Transboundary Movements of Hazardous Wastes (UN, 2020b).

In light of the building global waste crisis and the vast realm of impending environmental consequences, human rights concerns have become another undeniable reality that the world has to confront. The impacts of COVID-19 have revealed that it is those at the margins, who are already in a state of vulnerability are pushed to new extremes. According to the study carried out by United Nations Economic Commission for Latin America and the Caribbean and UNDP, the main consequence of COVID-19 pandemic will be a "profound social inequality, distribution of long-term resources and equal opportunities in different dimensions," the latter two presenting themselves as great challenges to face. Adopting a strong humanitarian and planetary consciousness and proactively embracing the five pillars of sustainable development is the fundamental need of the hour (Neidhöfer, 2020).

The COVID-19 pandemic is a wake-up call to the fact that, if governments continue business as usual, devastation of the Earth's landscape for "development" will persist at the cost of the planet's natural resources and threaten the very survival of all species. Such a model of development, which serves governments' insatiable appetite for "development" putting profit over the cost of life, must be radically redefined. Active and visionary leadership from

world governments is urgently needed to redefine approaches to development, which will be a stark departure from the environmental desecration the world has witnessed in recent decades. As countries scale up responses to COVID-19, an opportunity exists to align with the proposed redefined values of development, which embrace a safer planet and a promise of improved health for all.

Positive, sustainable environmental impacts demand long-term changes in production and consumption norms. These changes will be necessary in both rich and poor countries and will demand making radical shifts in political focus. The role of public opinion in compelling such a change will be key. As people become more aware of their dependence on the environment, governments must focus on effective science–policy interface or changes in policy, which is informed by science. A strengthening of international scientific partnerships and collective action is needed for all governments to deal with the challenge of redefining models of development to improve the lives of all species and protect our planet (Colglazier, 2020; POP Movement, 2020). The current disruptions due to COVID-19 are likely pale in comparison to the upheavals in store, if governments do not act aggressively to limit warming to less than 1.5°C above preindustrial levels and adopt cleaner and healthier models of development. As governments think about the world post-COVID-19 and prepare for what comes next, they must closely examine how their actions to protect our planet can be part of the new world. It is clear, as the world grapples with many unknowns, the one thing that is known is that the health of the planet and those that inhabit it are inextricably linked.

BOX 1.1

Forecasting demand of mask

To estimate the number of mask for general public requirements for example the Center for Health Security using a calculation forecasted demand, “10% of the US population of 330 million are essentially household and will not need masks. Of the remaining

300 million, the assumption is 75% will adhere to guidance and wear 1 mask per 5 days on average.” Almost 45,000,000 masks/day, 1,372,500,000 per month until the vaccine arrives and this is for the US population only.

BOX 1.2

Some of the key players in the global PPE market

Some of the key players operating in the global personal protective equipment market are the 3M Company, Ansell Limited, Honeywell International Inc., etc. [Box 2] Sioen Industries NV, Kimberly-Clark

Corporation, E I DuPont de Nemours and Co., MSA Safety Inc., Lakeland Industries, Alpha Pro Tech, Ltd., Radians Inc., Delta Plus Group, Uvex Safety, Avon Rubber, and Metric AG.

BOX 1.3

Change in demand and supply trend of PPE; India

For example, developing countries like India struggled in arranging protective equipment (PPE) kits in the month of March when the lockdown was announced when India had not begun manufacturing PPE kit, and was dependent on other countries like Singapore, Korea, and China for the PPE kits. For India alone, the requirement changed

from approximately 4 lakhs to 10 lakhs and more, and has now achieved an almost unrealistic goal of producing 2.06 lakh PPE kits daily within 2 months after the coronavirus outbreak. The latest demand estimated by Empowered Group-3 of the Government of India is a total requirement of 2.01 crore till the month of June.

BOX 1.4

Dividend payments information of biggest food and beverage companies; July 2020

Information on dividend payments of eight of the world's biggest food and beverage companies up to the beginning of July 2020 have been collected by Oxfam with numbers being rounded to the nearest million: Coca-Cola (\$3522 m), Danone (\$1348 m), General Mills (\$594 m), Kellogg (\$391 m), Mondelez (\$408 m), Nestlé (\$8248 m for entire year), PepsiCo (\$2749 m), and Unilever (estimated \$1180 m).

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