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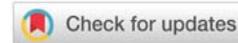
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Research Article

Minimizing human race creating an unknown climate leading to pandemics–Need of the time

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We are on a planet that orbits the Sun which emits a huge amount of energy. The climate we experience is a result of an energy gradient across Earth and an imbalance in energy across the world due to axial tilt of Earth rotation.

As 2021 is ending, it leaves a trail of climate disasters. From floods in Europe to heatwaves in Canada, hurricanes across the US, droughts in Africa and deluges in Asia. The climate has changed from being a stable friend to an entity none can recognize. The greenhouse effect is necessary for life on Earth, increasing the amount of greenhouse gases increases the amount of energy going into the climate system and thereby affects weather because that energy input drives these phenomena.

Human activities lead to a thermodynamic effect (the warmer the atmosphere gets, the more water vapor it can hold and therefore windstorms have more intensity of precipitation) & climate changes. Indian scientists have found that due to thermodynamic implications the wet spells have become more intense with a greater risk of extreme precipitation and the dry spells have grown protracted. Therefore, during the monsoon, precipitation has become more extreme with flooding hazards. And there have been severe heat during the dry spells alongside leading to the late onset of the monsoon becoming a growing risk.

The recently concluded COP26 conference held in Glasgow from 31 October to 12 November 2021 has highlighted the urgency to address the problem of climate change and rapidly rising global temperatures. The scientists have proposed that we work towards being carbon neutral to balance our carbon emissions; that means to soak up the man-made carbon emissions, by planting more trees, adopting eco-friendly, sustainable practices & being mindful of our carbon emission through carbon sequestration.

Decades of abject misuse of natural resources, and population explosion in the last few decades have exposed all countries to an array of natural disasters, like forest fires, land use change, volcanic eruptions, storms, earthquakes, droughts, floods, rising sea levels, and pandemics.

The worst pandemics have ravaged humanity throughout its existence. The history of pandemics runs over 2000 years starting from Antonine plague (165 AD), Plague of Justinian (541-542), The black deaths (1346-1353), The Cholera pandemics (1852-1860) & (1910-1911), Flu Pandemics of 1889-1890, 1918, 1956-1958 and 1968, HIV/AIDS Pandemic peaking in 2005-2012, and the most recent Pandemic of SARS-CoV-2 virus since December 2019.

The push for humans to survive the pandemic has become



the primary concern in the world. The history of all these pandemics have documented the spread of the diseases, suffering, how they were managed, disabilities, thousands of deaths, economic losses, details of the decimation of armies, devastated cities, and kingdoms. Even after 2 years of The Covid-19 pandemic, the outcome is impossible to predict. Though all countries have learned from the history of pandemics how to determine our best courses of management and recovery over time, the Covid 19 pandemic, has made people all over the world more aware of the best practices during a pandemic, from careful handwashing to social distancing, protecting the environment, most importantly human values of empathy and co-existence.

Various environmental factors influence the outbreak and spread of an epidemic. So do the pandemics in turn, damage our environment. The documentation on the cyclic effect of the environment on pandemics or the vice versa was lacking until The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change held in its first session from 28 March to 7 April 1995 in Berlin, Germany, at the invitation of the Government of Germany. Following Covid 19 Pandemic beginning in December 2019, which forced countries across the world to declare mandatory stay-at-home measures, closing schools, businesses, and public places, documentation of these diametric effects has begun.

For the first time in the history of the world, more people live in towns and cities than in rural areas. Towns and cities are responsible for producing over three-quarters of the world's carbon emissions that cause the climate to change. Additionally, urban areas are disproportionately located along coasts and rivers, highly exposed to climate-induced disasters such as floods and sea level rise. With over one in three urban residents living in slums and one in four earning less than 2 US \$ a day, cities are inhabited with vast numbers of people who lack the capacity to withstand the impacts of a changing climate.

While Pandemics per se and consequent government actions to mitigate the sufferings and deaths may see Temporary improvement in air and water pollution due to lock down and homestay or working from home. But more long-term negative ecological impacts are faced due to generating massive medical wastes and dead bodies that are difficult to manage given the poor medical waste management capacities in most of the developing countries due to limited investments for the last few decades. Other requirements of frequent handwashing or use of Sanitisers, Cough and Toilet etiquettes increase demand on water requirements. Most importantly, due to increased screen time up to 8-10 hours a day for work, education have increased mental health problems like anxiety, depression, and suicidal efforts and deaths. What we observe externally is also happening to us internally. The fire of rage, anger, resentment, denial, and indolence is pervading through our being and playing havoc with our mental & physical wellbeing because of climate change effects.

This article is a review of the association between Climate, Environment and Pandemics and epidemics globally with specific reference to India and course of action required.

Materials & methods: Covid 19 Worldometer reports, National Government reports on Pandemic and mitigation efforts, Press reports on climate disasters, Meteorological reports.

Introduction

Causes of climate change

We are on a planet that orbits Sun which emits a huge amount of energy. Earth's rotation is tilted on an axis. As Earth orbits the sun, different parts of the planet get differing sunlight. The seasons are a result of the tilt of Earth's axis that affects the solar input, creating an imbalance in energy across the world. The weather and climate we experience is a result of that energy gradient across Earth [1,2].

Climate change is reshaping the dynamics that make our weather

In first week of November 2021 my 3-year-old grandson, from Saint Jose, USA reminded me that Venus is the hottest planet; Mars is very cold, and Earth is just right among planets, learning from his attending a nursery since a month. He was explained that it was the greenhouse that effect makes all the difference. Venus has a very strong greenhouse effect which makes it so hot. Mars has a very weak greenhouse effect resulting in temperatures below the freezing point of water. Earth has a greenhouse effect which keeps our temperature slightly above water's freezing point. The greenhouse effect is necessary for life on Earth increasing the amount of greenhouse gases increases the amount of energy going into the climate system and thereby affects weather because that energy input drives these phenomena.

Human activities and climate change

Global warming and climate change refer to an increase in average global temperatures. Natural events and human activities are believed to be the main contributors to such an increase in average global temperatures (Singh & Singh 2012) Indian scientists have found that due to thermodynamic implications the wet spells have become more intense with a greater risk of extreme precipitation and the dry spells have grown protracted. So, during the monsoon in India, precipitation has become more extreme with flooding hazards and severe heat during the dry spells alongside leading to the late onset of the monsoon becoming a growing risk. The pattern of land utilization in many sea-front cities over the last few decades, we see low lying areas have been subject to permanent structures, being areas where water accumulates there is excess precipitation. Water needs spaces to flow away to and we are now considering amounts of water which are unprecedented in history. our urban development must take this profound change into account. Our water systems and ecosystems, agriculture, infrastructure and economic growth and Health including epidemics & Pandemics are already being impacted by this. As 2021 is ending, it leaves a trail of climate disasters. From floods in Europe to heatwaves in Canada, hurricanes across the US, droughts in Africa and deluges in Asia. The climate has changed from being a stable friend to an entity none can recognize.

Humans are clearly influencing the weather, that impacts Earth's climate system. These impacts are resulting in a new number & intensity of extreme weather events which impact us. Humans are adaptable, they manage to live everywhere from the Saharan desert to Antarctica & in-between. We can expect greater intensification of these extreme conditions since our activities will cause more warming, more intensification of extreme weather. India's per capita GDP is about 30% lower today than it would have been without global warming. Global warming is driving up global economic inequality, with changes in the weather producing a substantial drag on growth in warmer countries and exposing to the risks of epidemics and Pandemics.

Over the past 150 years, the amount of carbon dioxide, methane and other gases in the atmosphere have increased, because of the burning of fossil fuels. These molecules in the atmosphere, make it more difficult for our planet to cool Earth's temperature rises.

One of the places where the temperature really rises is the oceans - they take up a lot of heat and consequently, they expand, leading to sea level rise. Ocean holds many of the answers like mangroves, seagrasses, and salt marshes that absorb carbon, and ocean-based solutions like clean shipping and offshore wind energy. As the planet warms, ice on land also melts, and the water, from ice caps, glaciers, etc., will run off into the oceans, causing further sea level rise. A warmer atmosphere holds more water vapor. Due to warming of the atmosphere, the amount of moisture in the air has been rising and we're getting extreme rain events increasing in intensity.

Two main ingredients drive extreme rain - the amount of moisture in the air and how rapidly the winds bring that moisture together. Global warming is impacting both these factors particularly in the tropics. When the temperature is

neither too hot, nor too cold, humidity isn't high, and rain is slight. Global warming is reducing such mild days, hence tropical parts of India have the rhythm of the monsoon dictating temperature and rainfall Figure 1.

A recent press report (press cutting above, TOI Bengaluru 18 December 2021), indicates the effect of unprecedented rains in one of safe and moderate climate state in India.

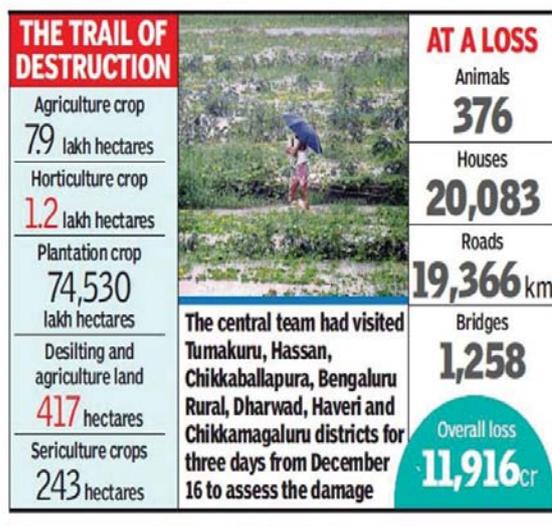
Due to the pattern of land use in many sea-front cities over the last few decades, we see low-lying areas where water accumulates there is excess precipitation have been subject to permanent structures. Water needs spaces to flow away to and we are now considering amounts of water that are unprecedented in history. Our water systems and ecosystems, agriculture, infrastructure and economic growth and Health including epidemics & Pandemics are already being impacted by this.

Do we need to choose between reducing emissions, promoting climate-smart agriculture, increasing financing for vulnerable countries, or something else or all doable among them?

History of pandemics

Humans throughout their existence have been ravaged periodically from the middle of the late 1880s due to Pandemics. History can be traced to Starting from the Spanish Flu in 1889-1890 the deadliest pandemic reported in Russia, that spread rapidly throughout St. Petersburg and reached Europe and the rest of the world, even though air travel didn't exist in that era [3]. AIDS Pandemic beginning in early 1981- claiming over 35 million lives till day. HIV, a virus first identified in humans in West Africa in the early 1920s, that spread across by the late 20th century. In 2020 approximately 37.7 million people across the globe with HIV and of these, 36 million are adults and 1.7

Disastrous Rains in Karnataka in 2021



- Flood and landslides have damaged crops in 10.23 lakh hectares.
- ₹853cr input subsidy deposited into 13.3L farmers' accounts
- During the northeast monsoon, simultaneous cyclonic circulation and low pressures over the Bay of Bengal and Arabian sea resulted in untimely incessant heavy rain over the state, especially in south-interior parts, Malnad and coastal regions.
- From October 1 to November 30, 2021 the state received 322mm rain as against the normal 173mm, recording 87% excess which is the highest since 1960. As many as 23 out of 31 districts recorded more rain.
- The norm of assistance is Rs 6,800 for raised agriculture crops, Rs 13,500 for irrigated crops and Rs 18,000 for perennial crops per hectare.

Figure 1: Disastrous rains in Karnataka in 2021.

million children aged 0–14 years and 53% are women and girls. An estimated 1.5 million individuals worldwide acquired HIV in 2020 91.3 m adults over 15 years and 0.16 million children under 14 years) marking a 31% decline in new HIV infections since 2010 [4]. Swine flu pandemic (H1N1) beginning 2009 caused by a new strain originating in Mexico spread to the rest of the world, infecting over 1.4 billion people across the globe killing around 5.5 Lakh persons. Covid 19 Pandemic since December 2019 has affected as many as 2.6 billion people by 25 November and killed 5.1 million [5].

India recorded 756 instances of natural disasters such as landslides, storms, earthquakes, floods, and droughts since 1900 as per a report of State Bank of India. Of these 402 events occurred during 1900–2000 in 100 years and 354 during 2001–2021 in the last 2 decades, impacting a total of 100 crore people and a death toll of 83,000. Cities across the world today are on the frontlines of the battle against environmental change. Decades of abject misuse of natural resources, and population explosion in the last few decades have exposed us to an array of natural disasters, like forest fires, volcanic eruptions, storms and earthquakes, droughts, and floods to rising sea levels. What we observe externally is also happening to us internally. The fire of rage, anger, resentment, denial, and indolence is pervading through our being and playing havoc with our mental and physical wellbeing. Recently Delhi declared a public health emergency on account of its air pollution.

The latest Key Health parameters indicate that in 2021 11,690,904 Communicable disease deaths of which 445,560 Seasonal flu deaths, 6,845,257 Deaths of children under 5 this year and, 38,428,889 Abortions and 278,355 mothers dies during birthing. 43,201,003 HIV/AIDS infected people and 1,513,909 Deaths caused by HIV/AIDS, 7,396,286 Deaths caused by cancer this year. 965,728 Suicides and 1,215,682 Road traffic accident fatalities. Similarly, the environmental statistics mention 4,683,656 Forest loss this year (hectares), 6,305,468 Land lost to soil erosion this year (ha), 32,725,034,726 CO₂ emissions this year (tons), 10,807,345 Desertification this year (hectares), 8,819,135 Toxic chemicals released in Tons in the environment this year [4].

India made the headlines at the end of the climate summit in Glasgow for its insistence on watering down a global commitment to phase out coal, but we can take pride for a still emerging economy; a 50-year deadline to achieve net-zero emissions and some bold 10-year targets, including 500 GW of renewable energy capacity and 50% of energy needs from renewables by 2030. As a rapidly growing economy with a low level of per capita energy consumption, India needs a lot of energy. India is the world's third-largest energy consuming country, but 80% of demand is still being met by coal, oil, and solid biomass. As of 2020 is estimated that Indian energy demand is about 1000 metro tons, of 44% comes from Coal, 25% from Oils, 13% from traditional Biogas, 6% from natural gases, 3% from modern renewable sources and 9% from other sources, on a per capita basis, India's energy use and emissions are less than half the world average. At present, renewable energy contributes to less than 10% of India's total energy

requirement and it is estimated that by 2030 total energy requirement will be two-fold and renewable energy will not increase by the same proportion (World Energy Outlook Special Report <https://www.iea.org/reports/india-energy-outlook-2021>). So, both renewable and non-renewable energy needs to be scaled up even as their shares change. Estimates suggest that the cost of India's climate transition will be around \$100 billion a year. GOI's annual budgetary spending across the board is around \$500 billion. There is no way it can afford to foot the bill. India's private sector has only a handful of large firms which can access finance at the cost that will make climate-friendly projects viable. India insisting for a 'phasing down' rather than 'phasing out' of coal, was an admirable decision as even that will cost at least 21 million livelihoods, many of which are in the relatively deprived parts of eastern India, depending on the coal economy. Govt. of India needs a transition plan but given the constraints on productive jobs as well as budgetary constraints, it seems unlikely that coal can be wound down quickly. Careful political negotiation will be required [5].

For the first time in the history of the world, more people live in towns and cities than in rural areas. Towns and cities are responsible for producing over three-quarters of the world's carbon emissions that cause the climate to change. Cities are the major contributors to climate change. According to UN Habitat, cities account for less than 2% of the Earth's surface but consume 78% of the world's energy and produce more than 60% of greenhouse gas emissions (UN 2021). Additionally, urban areas are disproportionately located along coasts and rivers, highly exposed to climate-induced disasters such as floods and sea level rise. With over one in three urban residents living in slums and one in four earning less than 2 US \$ a day, cities are also inhabited by vast numbers of people who lack the capacity to withstand the impacts of a changing climate. It is therefore shocking that the Glasgow Climate Pact that results from the 26th Conference of Parties makes no explicit mention of the critical role of urban areas in finding solutions to the climate problem. Once again, the challenges of cities have taken a backseat in global negotiations on climate change [1].

Environmental factors and outbreaks, epidemics, and pandemics association

Impact of pandemics on environment: Pandemics per se and consequent government actions to mitigate the sufferings and deaths saw Temporary improvement in air and water pollution due to lock down and homestay or working from home. Use of Fuel has come down and so are road traffic accidents. Other requirements of frequent handwashing or use of Sanitisers, Cough and Toilet etiquettes increase demand on water requirements.

But more long term negative ecological impacts are faced due to i) generating massive medical wastes and dead bodies that are difficult to manage given the poor medical waste management capacities in most of the developing countries due to limited investments for the last few decades. ii) Most importantly, due to increased screen time up to 8–10 hours a day in the workplace, education have increased mental health

problems like anxiety, depression, and suicidal efforts and deaths. iii) social impact of early marriages, sexual abuse, and miscarriage have also been reported. iv) Economic impacts include work loss, lower productivity/salary packages/ lower house rentals/ Lower tourism and hospitality sector losses.

What we observe externally is also happening to us internally. The fire of rage, anger, resentment, denial, and indolence is pervading through our being and playing havoc with our mental and physical wellbeing because of climate change effects.

Impact of environment on pandemics: Multiple environmental factors influence the outbreaks, epidemic or pandemics and their spread. The epidemics and Pandemics in turn, can damage our environment due to generation of huge medical waste. The magnitude of the disease incidence and its spread are defined by two measurable factors: a) Reproduction rate (RR), The speed by which a disease spreads and b) Critical Susceptible population/community. Let us understand the three words commonly used in the context of environmental effect on disease occurrence.

Outbreaks: Occurrence of illnesses of similar nature (a cluster of cases occurring over a brief period) more than normal expectations among a specific group of people or in a geographical locality is called an outbreak. If translated into vector-borne diseases it may mean 1) If the disease is endemic, no of cases more than double of the similar period in the last year like Malaria, Leptospirosis in Mumbai after rains, 2) If the disease is not endemic even one or few cases may be called as an outbreak (Measles, Polio, NNT).

Epidemics: Epidemic is generally described as any problem that has grown out of control. An epidemic is defined as “an outbreak of a disease that is widespread in geographic area and affects the large population in a district or state. e.g., epidemics of Cholera, Typhoid, Diphtheria Figure 2.

Covid 19 pandemic

COVID-19 was declared as a global health emergency – a pandemic on 13 March 2020 by WHO due to the spread of the corona virus across multiple countries. As of 20th December 2021, it has affected 2.75 billion people taking a 5.37 million death toll and spread to 222 countries and territories [5]. The global outbreak of coronavirus disease 2019 (COVID-19) is affecting every part of human lives, including the physical

world. The measures taken to control the spread of the virus and the slowdown of economic activities have significant effects on the environment. Major ecological impacts of epidemics or pandemics will be of three types:

Short term

- i) **Temporary Benefits:** Temporary improvement in air and water pollution due to lock down or restrict population movements to minimize the spread of the infection. This action led to the cessation of all economic and production activities and vehicular movements.
- ii) **Temporary Challenges:** Ergonomic challenges due to Work from Home (WFH). for long hours with no proper worktables or furnitures. b) Impact of long hours of screen-time leading to fatigue, redness, dryness in the eyes, headache, and behavioral issues, Figures 3,4.

Ambient temperature and humidity

Humidity: Initial international observations had put forth a hypothesis that temperature, relative humidity, and absolute humidity, affected transmission of COVID-19. Temperatures below -3°C and above 18°C were ascribed to slow the spread of the COVID-19. However, Indian observations showed that the patterns of COVID-19 were not consistent with the hypothesis. Many states like Maharashtra, Delhi, Kerala and Tamil Nadu in India with high temperate and high humidity like with an average AH, between 8 and 11 g/m³ during March and April and sometimes more than 15 g / m³ in May, did report a higher number of cases compared to better climate states like Karnataka

Temperature: A “heatwave” is declared in India when the maximum temperature is more than 40°C , and at least 4.5 notches above normal similarly a “severe heatwave” is declared if departure is more than 6.5°C from normal temperature by the Indian Meteriologic Department. Parts of Delhi, Punjab Haryana and Uttar Pradesh experienced one of the worst spikes in temperatures in early 2021 as the monsoon was delayed. Delhi recorded a temperature in the excess of over 43°C . Contrary to a study in China suggesting that the relationship between mean temperature and COVID-19 confirmed cases was linear in the range of $<3^{\circ}\text{C}$ and became flat at above 3°C upto 18°C [6], the transmission of a pandemic in North India particularly in Delhi during April –July 2020 and 2021 did not come down.



Figure 2: The word Pandemic relates to the spread of a disease over an entire country or several countries of the world.

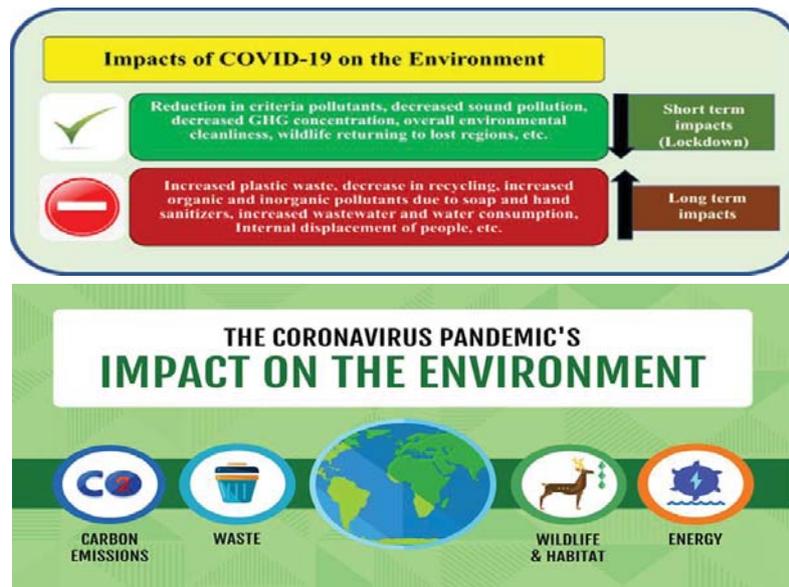


Figure 3: Impact of COVID-19 on the Environment.

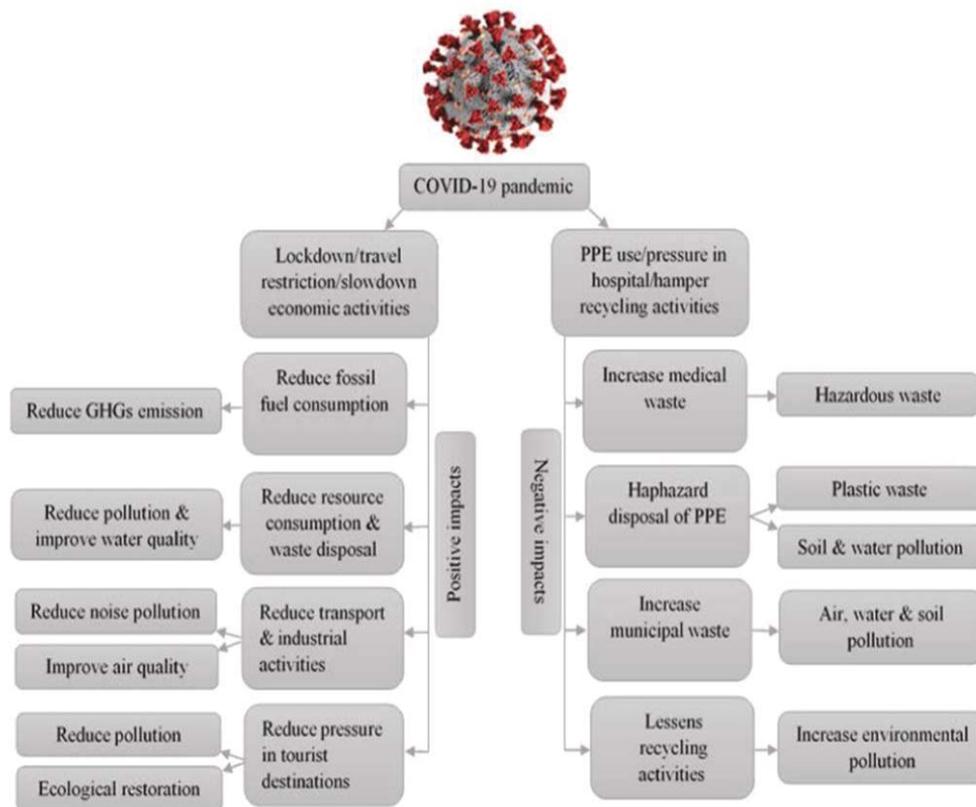


Figure 4: Environmental effects of COVID-19 pandemic & potential sustainable strategies. Source: Tanjena Rume, et.al. Published online 2020 Sep 17 [8].

Health & economic impact: Cities are at the frontline of combating epidemics (World Bank 2021). More subtle impacts like the deteriorating health of urban residents due to changing disease patterns, an increase in violence due to extreme heat, and overall reduced wellbeing of city dwellers is documented, those will impact the economic productivity of urban areas that currently account for over 80% of the world's GDP.

Impact on fossil fuel consumption

With a nationwide lockdown between March to May 2020 and 2021 domestic fuel, demand plummeted, with the lowest level in April at 48.7%. that improved to a level of contraction by just 8.6 percent in June 2020. Following the aggressive spread of the virus in 2021, it again came down in August 2021

to a 20.6% contraction. Jet fuel saw a sharpest contraction by 46.6% in the eight months to August 2021, improving from its lowest in April by 91.4% y-o-y, due to a total ban on flights. However, flights for the essentials such as medicines cargo movement was continued. Petrol and Diesel demand fell by an average of 16.1% and 25% respectively per day with a high of 64.5% and 55.5%. However, the LPG, demand had increased by 4.3% in the year due to increased home cooking because the hotel industry was also hit by the pandemic.

Impact on accidents

India recorded a marginally low (1.2 lakh) cases of “deaths due to negligence relating to road accidents” in 2020, with 328 persons losing their lives every day on an average, despite the COVID-19 lockdown. The figures stood at 1.36 lakh in 2019 and 1.35 lakh in 2018, In 2020 there were 41,196 cases of “hit and run”, as against 47,504 such cases in 2019 and 47,028 in 2018, On average, there were 112 cases of “hit and run” reported across the country every day in the past year, 52 cases of deaths due to negligence related to rail accidents were recorded across the country in 2020 [6].

A recent study in Bengaluru city reported 1177, 412 and 841 accidents respectively in 2 tertiary hospitals in 76 days each for pre lockdown (1/1/20 to 16/3/20), during (March 25th to May 31st, 2020 -1st lockdown and July 14th to July 22nd, 2020 -2nd lockdown) and after lockdowns (from July 23rd to October 6th, 2020) Figure 5.

Impact on crimes: Year 2020, marked by months of a national lockdown due to the Covid 19 pandemic saw fewer traditional crimes such as those committed against women and children, among others, it witnessed a big spike in civil conflicts.

Riots (Civil conflicts): Communal riots registered an increase of 96% in 2020 and 2021 over the previous year. Delhi Police alone registered the highest i.e., 520 cases of communal riots in the year and Uttar Pradesh (UP) did not record a single

case of communal violence in 2020. Caste riots saw an increase of close to 50%, agrarian riots 38% and riots during ‘andolan/morcha’ increased by 33%.

Traditional crimes: The number of cases registered for crimes against women, children and senior citizens, theft, burglary, robbery and dacoity, among others, dropped about 2 lakhs. Murders registered a marginal increase of 1% even as offenses falling under the category of “violent crimes” decreased by 0.5%. More than 10,093 cases of crimes against women were registered in the capital in 2020.

Environment related offences: Cases under the ‘environment-related offenses’ increased by 78.1% in the country in 2020.

Cyber crime: The rate of cybercrime (incidents per lakh population) also increased from 3.3% in 2019 to 3.7% in 2020.

Offences against state: The year also saw a significant drop in cases related to Offences against the State, with a drop of 27% over 2019. UP, however, was the only major state to record an increase in this category, mostly due to the large number of ‘Damage to Public Property’ cases registered by the state, many of them during the anti- CAA (Citizenship (Amendment) Act, 2019) protests. Offences against the State’ include cases related to sedition and waging war against the nation, those falling under provisions of the Unlawful Activities Prevention Act (UAPA) 1967, Official Secrets Act 1923 and Damage to Public Property Act 1954 [6].

Long term negative ecological impacts

No long-term positive impact is reported from any country. Negative impacts include a) Increased demand for water and soap for frequent hand washing or side effects of sanitizers to be used. b) worsening of physical environments such as shoreline pollution or increased smoke due to the unhygienic disposal of sanitary consumables and dead bodies rising out of millions of masks, face shields, personal protective equipment (PPEs), surgical gloves. c) human struggle for getting a hospital

A JUMP IN NUMBERS

OFFENCES	2019	2020	% increase
Communal riots	438	857	96%
Caste riots	492	736	50%
Agrarian riots	1,579	2,188	38%
Andolan/Morcha riots	1,442	1,905	33%
Promoting Enmity Between Groups	1,058	1,804	70%
TOTAL RIOTS (including other causes)	45,985	51,606	12%

Offences Against The State decreased by 27%, but UP only major state where they increased

Figure 5: Comparison of offences in 2019 and 2020.

bed for severe cases, mental stress due to their inability to meet the kith and kin sick in the hospital and not even being able to bid adieu when they died were cremated by the government system.

Personal hygiene practices

The importance of personal hygiene practices in public health is well accepted and documented. Minimizing inter-personal contacts, touching infected surfaces and repeated handwashing with soap were advocated to limit the community spread of Covid 19 [6].

a) **Cough etiquette:** An average Indian lacks the habit of covering mouth and nose while coughing or sneezing and even the habit of speaking gently, which increases the transmission.

b) **Toilet etiquette:** Despite the Indian government and most of the State governments claiming that 699 districts and 599,963 villages had “declared themselves as free from open (ODF) defecation by December 2019 the fact that at least 10–20 % of people rural households are not comfortable using the toilets yet. Since most of the household have only one toilet and was used by an average of 4 persons in quick succession in the morning hours coupled with poor flushing practices or inadequate water supply for cleaning the squatting plate or commode posed additional risk of fecal-oral transmission.

Population density: Explosive transmission of Covid 19 in Dharavi Slum, Mumbai, Tablighi Jamaat meeting in Delhi, and 107 JK Tyres factory employees in Metgalli in Mysuru, are some examples of the influence of density of population role in the transmission of the disease.

Working from home: Domestic data from IT companies estimated that 96% of organizations had rolled out working from home from a low 19% just two weeks before lockdown. Approximately 2 million people worked from home, and more than half of them complained of working long hours without ergonomic chairs and tables. At home, people worked in a “forward head position” putting pressure on the discs and joints of the spine, as well as causing muscle imbalance in the neck. A real estate advisory survey of 1,600 technology professionals found that 30% of them reported deterioration in productivity and work performance while working from home [6].

Most of the people working from home changed how they worked. They stopped walking down the hall for a meeting, or across the street for a cup of coffee, or even walk to the car for the commute instead, sat in the same position for too long, which strained the body each day. Humans are social animals and crave physical connections, as many remained in the virtual mode many days, the fatigue was setting in.

Health care waste

Waste segregation and separate treatment of waste streams

play important roles in reducing the environmental hygiene, human and animal health, and social impacts of waste and waste management. The global warming potential of Municipal Solid Waste (MSW) and Solid Medical Waste (SMW) are estimated to vary from -0.64 to 520 kg CO₂ equiv/tonne and -52.1 to 3730 kg CO₂ equiv/tonne, respectively, depending upon the sterilization and disposal processes. Similarly, MSW and SMW disposal costs varied from 90 to \$242/tonne and 12 to \$1530 /tonne, respectively [7].

Any waste generated from healthcare facilities, research centers, and laboratories relating to medical procedures is considered healthcare waste. Approximately 75–90% of healthcare solid waste is just like households waste and therefore ‘non-hazardous. This waste is generated from the administrative sections like the kitchen and housekeeping functions of the facilities. Only about 10–25% of waste is ‘hazardous waste’, posing serious environmental and health risks. In Covid 19 pandemic the generation of a huge quantity of plastics/micro-plastics increased enormously [7,8] and the quantity of Urban Solid Waste (USW) generated changed its composition. As Covid 19 virus can survive up to three days, institutions thought of segregating and storing the waste in a yellow bag to reduce the spreading of the infection, resulting in storage space shortage and availability of manpower.

Chemical waste: Normally chemical waste accounts for about 3% of waste originating from healthcare activities, but due to millions of RTPCR tests and other tests this type of waste had increased 10–25folds since April 2020. Laboratory reagents, X-ray film developing reagents, expired/unused disinfectants, solvents, and waste containing batteries, broken thermometers, blood-pressure gauges, etc. are considered chemical healthcare waste.

Since the outbreak of Covid-19, the quantity of plastic wastes generated worldwide is estimated at 1.6 million tonnes/day. Similarly, approximately 3.4 billion single-use facemasks or face shields are discarded daily.

Radio-active waste: The outbreak of the COVID-19 pandemic has led to compromised containment of radioactive waste, a by-product of various nuclear technologies like radio-diagnosis by CT scanning or X-rays, radiotherapy, and reagents for developing Xray plates and research.

Sharps waste: COVID-19 pandemic has increased sharp waste composed of used or unused hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glasses by many folds.

Pharmaceutical waste: The amount of pharmaceutical waste comprising of contaminated pharmaceutical products, used biological products for therapy and transdermal patches, and expired or contaminated pharmaceuticals including vaccines, has also increased substantially during the COVID-19 pandemic due to the increased number of hospital admissions and vaccinations [9].



A study in Iran has indicated that the epidemic Covid-19 led to 102.2% increased waste generation in both private and public hospitals. The ratio of infectious waste in the studied hospitals increased by 9% in medical waste composition and 121% compared with before the COVID-19 pandemic [10]. They had used high-pressure steam sterilization (121°C, 110 min), high-temperature pyrolysis (540–830°C), high-temperature incineration (800–1200°C), incineration (> 1100°C), double-chamber incineration (primary chamber at 750–980°C temperature, while the secondary chamber was designed. Since the outbreak of COVID-19, the sudden surge of waste flows swamped the current waste management facilities.

In the USA, the estimated COVID-19 waste generation was 530 million tonnes per year. In Canada, COVID-19-related plastic waste generation from PPE is expected to be 63,000 tonnes per year. SMW generation rate varied from 350% in Spain to 600% in Wuhan, China, depending on the severity of the pandemic [7] Figure 6.

Masks menace

According to the Waste Free Oceans organization, masks take 450 years to decompose. Globally, every month, 129–210 billion disposable masks and 65 billion disposable gloves are used and about 200 billion masks are disposed of every month. I estimate that if every Indian used one single-use mask/ day for a year, we would generate 16.5 million tonnes of waste Figure 7.

Plastics (Gloves & PPE Kits) protected service providers, but incineration increased smoke, increased littering by indiscriminate disposal and washed-up coastlines littering the seabeds:

Millions of discarded single-use plastics (masks, gloves, aprons, and bottles of sanitizers) have been added to the terrestrial environment and could cause a surge in plastics washing up the ocean coastlines and littering the seabed, though these plastic products have played significant roles

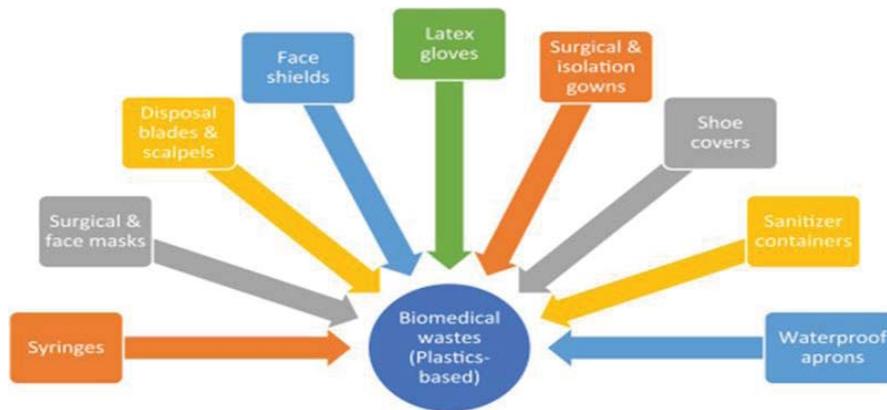


Figure 6: Various types of biomedical wastes (plastic based).

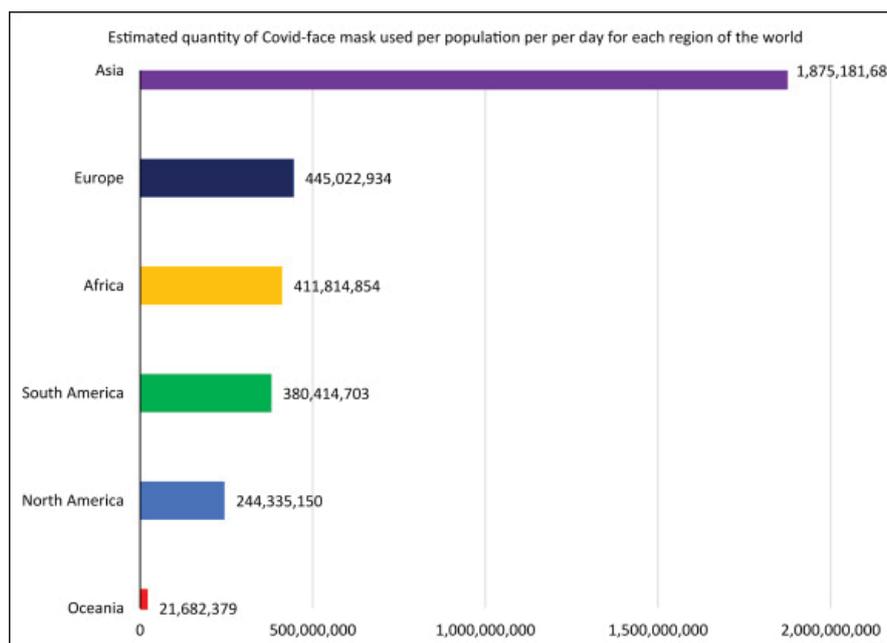


Figure 7: Estimated daily single-use facemasks (face shields) discarded by each continent [8].

in protecting people during the COVID-19 pandemic. The widespread use of personal protective gear has created a massive disruption in the supply chain and waste disposal system [11].

PPE kits: Personal Protective Equipment (PPE) has emerged as a significant lifesaver for Corona warriors and frontline workers shielding them from the Covid-19 pandemic for the last 2 years. Despite physical discomfort may health care provided working in hospital wards, ICUs used them without fail. India did not make PPEs till February 2020 but used to import the coveralls. The need of the hour made domestic manufacturing a necessity, and in a span of three months India went from making zero to 4.5 lakh PPE kits a day. Total waste generated from June–December 2020 was 28,747.91 tonnes, a monthly generation increased from 3025 MT to a maximum of 5600MT in October 2020. The calculation of the exact amount of BMW is challenging, although a study has suggested the increment in BMW generation to be as high as six-fold in comparison to the pre-pandemic situation [10]. Though countrywide data is not readily available, one can estimate it to be at least 30 folds, amounting roughly to 100 to 200 MT per day. Around the central incineration units in each state, smoke has increased 10 times what was emanated earlier it is reported. The guidelines recommend the use of color-coded bins for onsite segregation and the usage of double-layered bags in the COVID-19 isolation areas continue and additional and temporary bins for disposable PPEs, gloves and masks and separate containers for reusable materials (e.g., N95 mask for cleaning and sterilization have been advocated.

The amount of plastic wastes generated worldwide since the outbreak is estimated at 1.6 million tonnes/day [8] If in China (1.4 billion population), India (1.3 billion population), United States (331 million inhabitants), Brazil (212 million people), Nigeria (206 million population) and United Kingdom (67 million population), if all their citizens wear and discard a facemask or face shield per day, it would result in the generation of at least 702, 386, 219, 140, 75, and 45 million of contaminated masks respectively per day. Once the masks are discarded into the environment and are not properly managed, they could degrade into smaller-sized particles which invariably exacerbates the already plastic pollution problems.

COVID-19 pandemic can worsen the global plastic waste problem due to the rapid increase in plastic wastes is happening at a time when some recycling programs in many countries are being suspended because of concerns about the virus spreading [11,12].

Disposal of the dead bodies: All countries are overwhelmed with COVID-19 deaths. With over 5.2 million deaths worldwide and nearly half a million of them in India by the end of November 2021, safe disposing of these bodies created an ecological challenge apart from upholding the issue of Dignity in Death, family's frustration.

Covid 19 dead bodies are generally considered infectious until disposal and if handled improperly during the autopsy. As SARS-CoV-2 virus virulence and duration of survival in the

dead body is not yet entirely understood, more precautions are advised during the handling of dead bodies [12]. Incidence of mishandling the bodies, burial graves being shallow and use of electronic crematorium much against the religious sentiments have been reported. The states taking over the responsibility of the dead bodies also added additional biomedical waste of beds, linens, and the PPE used by service providers, relatives requesting attendance at last rites. At an average of 10 PPEs per dead person, the volume swells into millions of PPEs, Lakhs of beds and linen. The residents of the locality of disposal opposed burial fearing the additional risk of contracting the virus.

Ecological consequences of frequent handwashing: Washing hands often with soap and water for at least 20 seconds requires four liters of water if the tap is on while scrubbing and about 2 liters of water if the tap is shut off. Thus around 20 to 40 liters of additional water are needed for every person per day. This is going to add to the water crisis and burden on ecology in the coming years [6].

Impact of sanitizers: In India, the revenue from the Hand Sanitizer segment amounts to US\$ 566.49m in 2021 and is expected to grow annually by 10.37%. Indian urbanites with disposable income and health conscious are opting for sanitizers as the standard of living is improving. Only 24% bought from reputed brands mainly in cities and towns. New entrants and local brands now dominate India's sanitizer market that swelled more than fourfold after the novel coronavirus outbreak [6].

Impact on mental health: Mental health has been emerging as one of the most important concerns since the beginning of the pandemic. There are two studies indicatives of mental health implications. Regular teaching classes, tuitions, games, recreational activities, dance, music, and chess lessons and watching movies have all gone online, leading to children and adults glued to mobiles or laptops or tablets, for many as 8-10 hours. With no outdoor activities during the pandemic, several children and young adults with excessive screen time are complaining of fatigue, redness, dryness in the eyes, headache, and behavioral issues. The social environment of interacting with peers in person has gone down creating a feeling of loneliness and in some cases driving to suicidal attempts.

- 1) The 7th Fold's 'Employee Well-Being Survey, 2020' was conducted in July and August 2020 with 509 respondents across metro cities in India and diverse sectors. The survey found that employees below the salary of Rs. 5 lakhs per annum were more vulnerable and reported personal finances (55%) and career prospects (53%) as their biggest sources of stress. 35% of employees with an annual salary of Rs. 21 – 30 lakhs per annum reported burnout and poorest mental well-being scores. The self-employed category was slightly better placed when it came to overall well-being as compared to others. 45% of employees working for an employer complained of anxiety or depression against 30% of those who were self-employed. 44% of employees working full-time from home reported feelings of anxiety. Boredom was least reported by those who worked full-time from their workplace (26%). 28% of work-from-home employees

reported burnout with 48% feeling stressed due to task deadlines, and 35% of employees working from home were worried about self/ family's mental health. Mental health of the unemployed was the worst hit as 47% of them reported anxiety with 61% of them feeling stressed and 42% feeling anger. 60% of the unemployed showed stress regarding the uncertainty of the future and 61% for career growth. The blended model of working from home and workplace showed higher benefits than those employees who were full-time working from either home or workplace [13].

- 2) In another online survey using a snowball sampling technique was undertaken with the help of a semi-structured questionnaire involving 278 responses collected across various states of India & abroad from 17 March 2020 at 10AM IST -23 May 2020 at 20 PM IST. The online tool was filled by the participants one by one as they were auto-directed. The mean age of the participants was 22.19 +8.83 years, 70.9% were female and 29.1% were males. The lowest and highest-level educational qualifications were 10th- (<31%) and graduation & above (> 69%).

The majority of respondents were Indians (87.8%) representing Maharashtra, Kerala, Haryana, Punjab, Uttarakhand, Tamil Nadu, and Andhra Pradesh. Other countries' proportion was 12.2% that included UAE (7.6%), Australia (1.4%), US (1.4%) and Kuwait, Russia, New Zealand, Canada & Oman (1.8%). Near half (46.7%), respondents were healthcare workers, 5% teachers, 3.6% were Défense personnel's and 44.6% were of various other professions. Out of total respondents, 52.2% were students, private employees & s Govt. Servants 38.8%, self-employed 4.7% and unemployed 4.3%. More than 80% of participants were urbanites. Single respondents were above 60% with 5% suffering from existing mental /physical illness. Nearly 45% were earning < 2.5 Lakh/ annum with 70% having own house [14].

- 3) A third study ahead of the World Mental Health Day on October 10, 2021, LinkedIn conducted across 3,881 professionals between July 31 to September 14, 2021, and nearly 55% of the respondents reported that to be feeling stressed at work is almost a luxury. Given the worsening scenario of the aspect of mental health over the period of last eighteen months, respondents point out that 'balancing work with personal needs' (34%), 'not making enough money (32%), and 'slow career advancement (25%) are the biggest factors affecting the mental health. Interestingly, under such circumstances, 1 in 3 professionals (36%) focus on the positive aspect of at least not being laid off, while 30% cite the opportunity to control expenses in a recovering, yet competitive marketplace [14-17].

Conclusion

Entire world witnessed that the pandemic situation had a temporary positive effect as the restriction of people's

movements due to lockdown, improved air quality in different cities. There was a definite reduction in GHGs emissions, minimized water pollution and noise, and reduced the pressure on the tourist destinations, which restored the ecological system.

Many negative consequences of COVID-19, due to increase of medical waste, haphazardous use and disposal of disinfectants, PPEs, masks, and gloves, dead bodies, and burden of untreated wastes are continuously endangering the environment.

As the Omicron variant of Covid 19 is threatening the world, the situation might worsen. We need to outline possible ways to achieve long-term environmental benefits.

The lesson from the COVID-19 pandemic is that Ecosystem degradation like deforestation, land use change and agricultural intensification compound the problem by undermining water and other resources essential for reducing disease transmission and mitigating the impact of emerging infectious diseases.

Ecosystem degradation undermines water security, limiting the availability of adequate water for a good hand and food hygiene, sanitation, and disease treatment.

Disease risk cannot be dissociated from ecosystem conservation and natural resource security. Environmental destruction will make pandemics more likely and less manageable.

Maintaining intact and fully functioning ecosystems and their associated environmental and health benefits is key to preventing the emergence of new pandemics.

Ecosystems naturally restrain the transfer of diseases from animals to humans.

Societies globally need to protect and restore damaged ecosystems in line with the goals of the 2021-2030 UN Decade on Ecosystem Restoration by keeping the values of nature and human rights at the very forefront of environmental and economic policy-making.

Way forwards

- Minimize permanent structures by monitoring the pattern of land utilization in low lying areas where water accumulates as it helps excess precipitation and heavy rains. Water needs spaces to flow away, urban development must take this change into account.
- Solutions like mangroves, seagrasses, and salt marshes that absorb carbon, but also ocean-based solutions like clean shipping and offshore wind energy.
- Encourage use of re-usable masks, gloves, Personal Protective Equipment (PPE) to minimize the medical waste
- Develop medical waste management capacities in Municipal corporations investing in modern mechanical equipment, to tackle long-term negative ecological



impacts due to generating massive medical wastes and dead bodies that are difficult to manage.

- Multipronged approach of minimizing Fossil fuel use, by encouraging electrical vehicles for public and personal transport, improving Road and Vehicles conditions, monitoring polluting industries around cities.
- City specific Comprehensive climate action plans need to be produced through genuine consultation with a wide cross-section of urban residents. Apart from developing the plans, it is important that those running cities have the know-how to execute them.
- A key component of equipping cities to deal with climate change is the provision of finance, therefore our national and state governments must enable cities to generate their streams of finance for tackling climate change.

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