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Effect of Covid-19 pandemic on the Environment and Potential Strategies of Sustainability : A Global Review

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ABSTRACT:

Coronavirus (COVID-19) is an infectious disease caused by severe acute coronavirus syndrome coronavirus-2(SARS-CoV-2). The global outbreak of coronavirus disease-2019 has affected every part of human lives including the environment. The various containment measures taken by the government globally and the world health organization (WHO) to control the spread of the virus and slowdown of the economic activities has had significant impact on the environment, thus opening the global community to various opportunities and threats.The present study intends to explore the positive and negative environmental impact of COVID-19 pandemic using the available scientific literature. It focusses on air quality, water demand, water quality, climate change, afforestation and deforestation, wild life resurgence, littering, reduced traffic congestion, noise reduction as well as human activities. The study provides a critical analysis of how the COVID-19 containment measures had an direct and indirect impact on the environment. The study also outlines the various possible ways to achieve the long-term environmental benefits. Further, it is expected that proper implementation of proposed strategies may help in sustainability of global environment.

KEY WORDS: COVID-19, Pandemic, Environment, Containment measures, Strategies, Sustainability.

Introduction:

Coronavirus disease (Covid-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2). it was first identified in the city of Wuhan, China in December 2019 and later spread to various countries with many cases being reported worldwide. By the end of March 2020, the disease spread across 114 countries by 118,000 cases and 4291 deaths (Sarkodie and Owusu, 2020; WHO, 2020). The geographic distribution of Covid-19 cases indicating the number of confirmed cases and deaths in different parts of the world are illustrated in Figure –1.

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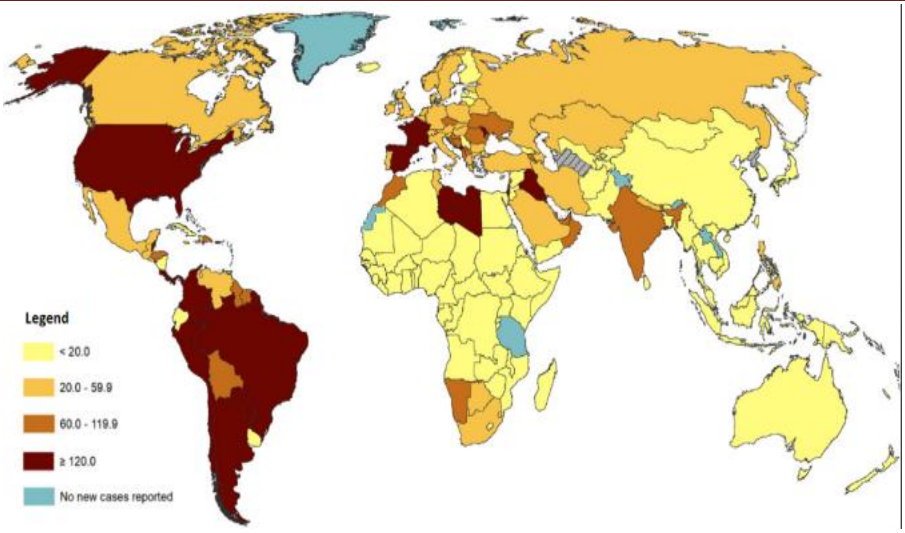

Fig-1: Geographic distribution of reported Covid-19 positive cases in different parts of the world

India has one of the highest Covid-19 infection rates in the world with over 2.5 million confirmed cases and the death toll on the rise (Gupta et al, 2020; world meter, 2020). State-wise distribution of positive cases depicted on an Indian geographical map are shown in Figure-2.

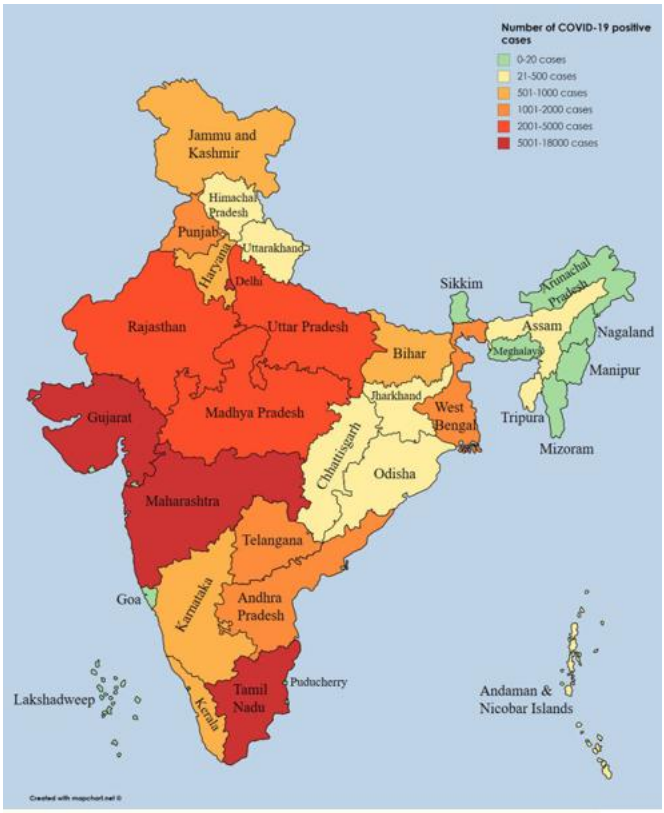

Fig-2: State- wise distribution of positive Covid-19 cases displayed on an Indian geographical map

By the end of March 2022, about 500 million individuals were confirmed to have been infected by the virus and more than 6 million people succumbing globally as indicated by Johns Hopkins coronavirus resource center. It has plagued the earth for the past 2 years with far reaching consequences. The WHO declared Covid-19 as a public health emergency of international concern (WHO, 2020a). The outbreak of Covid-19 in several countries is found to be similar to the previous outbreaks of SARS and Middle east respiratory syndrome (MERS) which merged in China and Saudia Arabia in 2003 and 2012 respectively (Smith, 2006; Mackay and Arden, 2015; Peeri et al, 2020), but the death rate is high compared to them (Wang et al, 2020). The Coronavirus is responsible for both SARS as well as Covid-19 disease that affect the respiratory tract and cause major disease outbreaks globally. Genomic analysis revealed that SARS-CoV-2 is associated phylogenetically with SARS viruses and bats could be the primary source of infection (Chakraborty and Maity, 2020). Although the intermediate source of origin and transfer to humans is not clearly known, the human to human transmission capability of the virus has been established (Hui et al, 2020). The transmission mainly occurred through person to person via direct contact or droplets produced by coughing, sneezing, talking or speaking and accidentally inhaling the droplets in a closed proximity of an affected person (Islam et al, 2020; Li et al,2020; Wang et al, 2020). Coronavirus is also spread due to contact of the surface which is contaminated by the infected individual. The contaminated surfaces include the entry way chimes, lift catches and steps, vegetables, organic products etc which may interact with the people. The disease may also spread through faecal oral contamination (Verma and Prakash, 2020).

The common symptoms of covid infection include fever, body pain andtiredness, chills, dry cough, sore throat, nasal blockage, difficulty in breathing, fatigue, nausea, vomiting and diarrhoea (Huang et al, 2020; Wang et al ,2020; Verma and Prakash ,2020). Severe cases lead to cardiac injury, respiratory failure, acute respiratory distress syndrome and sometimes even death. (Holschue, 2020; Wang et al ,2020). Further,the older people along with the other underlying medical problems are at high risk of mortality (Chen, 2020).

The Covid- 19 pandemic led to far-reaching consequences on the physical and mental health of individuals as well as on the global economy. It affected both young and the old. Young people were less susceptible to severe forms of the illness suffering milder symptoms with low morbidity and better prognosis when compared to adults (Ludvigsson, 2020; Gotzinger et al, 2020). Many people experienced stress (Ellis et al, 2020; Ozamiz –Etxebarria et al, 2020) precipitating loneliness, anxiety and depression (Cao et al, 2020; Chen et al, 2020; Zhou et al ,2020). Thus the Covid -19 pandemic not only caused havoc disrupting the routine normal life of the people but also claimed about five million lives worldwide. As immunization for the Covid-19 is not available, this prompted the government and WHO to formulate various measures to contain the transmission as well as the impact of the disease on the human populations. The various measures that were adopted include wearing masks, shutdowns, restrictions, lockdowns, curfews, curbing human gatherings and maintaining social distances, travel bans etc. With these measures, people experienced closure of educational and training institutions, hotels and

restaurants, malls, cinemas, gyms sports, recreation centers or picnic spots and places of worship.These measures were found to be more effective in containing the spread of covid-19 pandemic but led to a significant impact on various aspects of an individuals life; their worries and emotion pertaining to their academic attainments, work, physical health, social and recreational activities. Thus Covid-19 pandemic disrupted everyday human activities and industrial products throughout the globe with social and economic facets of human life brought to a drastic halt. National and International experts suggested the use of non-pharmaceutical measures like wearing hand gloves, face masks, washing hands frequently with soap, frequent use of antiseptic solution and maintaining social distance (Hui et al, 2020; Sajed and Amgain,2020; WHO, 2020b).

The infection has spread quickly and posed enormous health, economic, ecological and social difficulties to the whole human population. The Covid-19 pandemic triggered political and financial emergency in the world. On the whole, the Covid-19 pandemic has caused huge global socio-economic disruption which either directly or indirectly affected the environment such as improvement of air and water quality with low carbon emissions, low pollution levels, enhanced ozone layer, reduction of noise and restoration of ecology (Chakraborty andMaity, 2020;Somani et al, 2020; Saadat et al, 2020). However, the use of personal protective equipment (PPE) i.e. face mask, hand gloves, gowns, goggles, face shield etc with their haphazard disposal creates the environmental burden (Fadare and Okoffo, 2020; Nghiem etal, 2020; Singh et al, 2020). Keeping in view all the above facts, the present study intends to explore the environmental consequences (both positive and negative) of the Covid-19 pandemic and propose possible strategies as future guidelines for the sustainability of the environment.

Methodology:

The study was performed based on the review of the published literature, case studies and information from reports & official websites of different government and non-government organizations. The scientific literature was collected through electronic means from the database of Springer, Pub Med, Science Direct, Tailor and Francis, ISI web of knowledge, Google scholar, Research Gate etc.

Environmental effects of Covid-19:

Covid-19 evolved as a significant threat to the public health and humanity throughout the globe.The global disruption caused due to Covid-19 pandemic has brought several effects on the climate and environment. Due to movement restriction and slowdown of social and economic activities, the air quality has improved in many cities with low carbon emissions, low pollution level, enhanced ozone layer with significant reduction of green house gases. A notable reduction in water pollution as well as noise pollution was also recorded in many parts of the world. Despite the reduction in pollution, the increased use of PPE such as face mask, hand gloves etc with their haphazard disposal and generation of huge amount of hospital waste caused a significant effect on the environment. Thus the Covid-19 pandemic has brought both positive and negative effects on the environment. The positive and negative effects of Covid-19 are illustrated in Figure-3.

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Fig-3: Positive and Negative effects of Covid-19

Positive and Negative effects of Covid-19 on the Environment:

Air Quality:

The Covid-19 pandemic led to a significant reduction of Co_2 emissions that had once contaminated the air undermining its quality before the breakdown of the pandemic. The decrease in the human activities due to lockdowns, curfews and movement restrictions has reduced the emission of green house gases that was responsible for affecting the air quality negatively in the major towns and cities (Stratoulias and Nuthammachot, 2020).Use of automobiles and traffic congestion in cities and towns results in increased emissions thus polluting the air undermining the health of the environment, the wildlife as well as the people exposing them to serious health conditions. However, decreased emissions during the Covid-19 pandemic due to stay at home order and movement restrictions have improved the air quality attracting the wildlife to the cities. The areas that were characterized by poor air quality have improved significantly due to the movement restrictions and other Covid-19 protocols that compelled the factories and companies to close their operations. The close down of industries, transportation and companies has brought a sudden drop of green house gases emission. Compared to last year, the level of air pollution was reduced to nearly 50% due to various measures taken to control the virus (Henriques, 2020). It was estimated that about 50% reduction of No_2 and Co occurred due to the complete shutdown of industries in China(Caine, 2020). Reduction of No_2 emission was also observed in many countries such as Canada, US, China, Italy, India, Brazil etc., due to the recent shutdown (Biswal et al, 2020; Ghosh, 2020;Somani et al, 2020; Saadat et al, 2020).No_2 which is emitted mainly from the motor vehicle exhausts causes acid rain with the interaction of O_2 and H_2O and several respiratory diseases suffered by humans (USEPA, 2016). As per the prediction of European Environmental Agency due to Covid-19 lockdown, the No_2emission dropped from 30 to 60% in most of the European cities including

Barcelona, Madrid Milan, Rome as well as Paris (EEA, 2020). It was also reported that the levels of No_2 and $PM_{2.5}$reduced by 70% in Delhi (Thiessen, 2020). On the whole, about 46% and 50% reduction of $PM_{2.5}$ and PM_{10} respectively was reported in India during the lockdown (IEP,2020).

The motor vehicles and aviation are the key contributors of emissions contributing almost 72% and 11% of the transport sectors and GHGS emission respectively (Henriques, 2020). Due to Covid-19, many countries restricted international travellers from entry and departure. As a result of decreased passengers and restrictions, many commercial air craft companies cancelled the world wide flights, that ultimately led to deduction of nearly 17% of national Co_2 emissions (Zogopoulos, 2020). Furthermore, 96% of air travel drop was reported globally compared to previous year due to Covid-19 pandemic (Wallace, 2020) which has ultimate effects on the environment. Thus, it was projected that the Covid-19 pandemic could cut 1,600 metric tons of Co_2 equivalent to above 4% of the global total before the onset of Covid-19 pandemic (Evans, 2020).Further, the study conducted by Centre for Research on Energy and Clean Air revealed significant improvement in the air quality following Covid-19 containment and several safety rules. Travel bans and quarantines are the most effective measures that have helped to contain and prevent the transmission of pandemic that claimed many lives in the whole world (Pisot et al, 2020]. These measures also resulted in 25% reduction in carbon emissions, such a significant change improved the air quality in a densely populated country (Zhang et al, 2021). A reduction in coal consumption, oil refining as well as air traffic has since significantly improved the air quality worldwide. However, the resumption of normalcy in many parts of the world including major towns and cities is likely to reverse the advancements made in air quality realization, although some of the governments are likely to formulate certain policies and regulations that could help in sustaining the reduction of the emissions.

Water demand:

Water demand increased following the hygiene practices during the Covid-19 pandemic that required the people to wash their hands regularly with soap and water at least for 20 seconds. This resulted in a demand for adequate clean water for domestic use and sanitation to increase straining the environmental resource as it was a very critical part of the pandemic's spread. Ludtke et al, (2021) reported significant increase of water demand in residential homes due to stay at home orders. The Covid-19 pandemic saw many companies and businesses either suspending or closing their operations thus rendering most jobless with a few working from home. This led to an increased demand for water in residential homes resulting in shortage of water due to increased use. With this, the families not only incurred hiked water bills but also faced financial constraints due to the restrictions caused by Covid-19 pandemic. Further, due to the closure of companies and industries, the standby water present in the pipes saw the growth of the mold as well as other microbial organisms which undermined the quality of the pipe water (kim et al, 2021). This forced the companies and industries to close as the growth of the mold and other microbial organisms affected the water quality and safety causing health issues to their employees and customers. Thus, the increased demand for water in the residential homes has left the water supply and various regulatory agencies with numerous lessons that could help them improve water supply for the future crisis.

Further, the developing countries who were facing water shortages and having very little access to clean water experienced increased shortages and strain trying to uphold the hygiene practices of regularly washing hand with soap and running water. This resulted in severe depletion of water sources which were once supplied with ample amount needed for survival and livestock. The competition for the scarce available water towards sanitation and hygiene negatively affected the environment with the wild life and other living beings denied water for their survival. The increased demand for water resulted in depletion of the environmental resource thus exposing the other living beings to drought and famine due to the inaccessible water. Thus the competition for water between the humanbeings and wildlife characterized the Covid-19 pandemic, an aspect which undermined their well being.

Water quality: Water pollution is a very common phenomena of a developing country such as India and Bangladesh, wherein the domestic and industrial wastes are directly dumped into the rivers without any treatment (Islam and Azam, 2015; Islam and Huda, 2016;Budrud-Doza et al ,2020; Yunus et al, 2020). During the Covid-19 pandemic lockdown period, the major industrial sources of pollution have been completely stopped that helped to reduce the pollution load (Yunus et al ,2020). Major rivers like Ganga & Yamuna reached a significant level of purity during the lockdown period in India. Further, the physicochemical parameters like P^H (7.4-7.8) DO (9.4-10.6mg/L), BOD (0.6-1.2 mg/L)and total Coliform concentration(40-90) MPN/100ml of Ganga river was found to be within the water quality standards. The Concentration of P^H, electrical conductivity (EC), DO, BOD and COD were reduced almost to 1-10%, 33-66%,45-90% and 33-82% respectively in different monitoring stations during the lockdown period when compared to pre lockdown period (Arif et al,2020). The number of tourists and water activities were also reduced in many places due to imposing a ban of public gathering (Cripps ,2020; Zambrano-Monserrate et al ,2020). Thus, the water quality significantly got improved for various reasons during the pandemic period. The clean atmosphere due to reduced air pollution has seen improvement in the rainwater quality thus promoting and protecting the well being of the wildlife and human beings. Chu et al, (2020) reported that previously due to increased air pollution, the contaminants saturated the atmosphere thus making it poisonous which has mixed with the rainwater to form the acidic rain that has threatened the survival of the living beings and corroded buildings causing fats corrosion. The movement restrictions, decreased transport activities, introduction of virtual events and work from home significantly reduced the emissions into the atmosphere thus enhancing the quality of air as well as rainwater. Further previously oil spillage and contamination of water in deep seas also contributed to poor quality of water threatening the survival of the aquatic animals (Georgian et al ,2020). Reduced movement activities due to travel bans, lockdowns, quarantines and closure of business have helped reduced the water contamination during the pandemic period. Further reduced use of pesticides, fertilizers and other agricultural chemicals due to their shortage following disruption of supply chains have also improved the water quality due to the elimination of the contamination. The industry and factory operations releasing waste water and contaminating chemicals had stopped during the Covid-19 pandemic thus helping to safeguard and improve the underground water quality and other related sources such as lakes, rivers etc. The indirect contributions of the Covid-19 pandemic to improving global water quality cannot be underestimated.

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Climate change: Over the past few decades, the tourism sector has witnessed enormous growth due to the technological advancements and transport networks that contributed significantly to global gross domestic product (GDP) (Lenzen et al ,2018). It has been estimated that the tourism industry is responsible for about 8% of the global GHG's emission as reported by Lenzen et al,(2018). The places of natural beauty such as Islands, Beaches,National parks,Deserts, Mountains, Mangroves etc are attracting the tourists and making a huge harsh. However, to facilitate and accomodate them, number of hotels, restaurants, bars and markets are built which consume lot of energy and other natural resources (Pereira et al, 2017). But, due to the outbreak of Covid-19 pandemic and local restrictionswith associated containment measures, the number of tourists got reduced in various tourist spots globally (Zambrano – Monserrate et al, 2020), thus indirectly helping address the climate change, which has remained a significant challenge to the world. The increased water, air as well as land transport have been associated with increased emissions of Co_2 in the atmosphere undermining the efforts to combat climate change. The outbreak of Covid-19 has opened the world to various enormous opportunities such as virtual events & remote working arrangements that have significantly reduced the need for the said transport (Barouki et al, 2021). The world is likely to realize the benefits of reducing these emissions, if virtual events and working from home arrangements are sustained, as these will minimize the unnecessary transportation to the work place. it is reported that Co_2 has been known to deplete the ozone layer thus exposing the world to extreme temperatures (Marazziti et al, 2021). The increase in the global temperatures commonly referred to as global warming has contributed to the climate change undermining the human as well as wildlife survival. However due to Covid-19 pandemic, the introduction of quarantines, virtual events and working from home arrangements have improved significantly the efforts to combat the climate change thus, making it imperative for the international community to continue realizing the associated benefits. The Covid-19 pandemic also led to reduced human activities responsible for the climate change. The suspension of industrial operations significantly led to reduced emissions from various factories that were previously responsible for the air pollution and depletion of ozone layer which inferred with the global temperatures.

The increased transportation of raw materials as well as finished goods from the factories resulted in increased emission before the pandemic. However, the movement restrictions, curfews, lockdowns and travel bans have significantly reduced these activities making the environment to replenish and to clear the excess carbon and other green house gases in the atmosphere which are responsible for climate change and global warming as reported by Gosssling et al, (2020). The containment measures adopted by various governments to control the outbreak of Covid-19 pandemic have indirectly had positive impact on the climate change helping address some of the associated benefits. The government should formulate the policies and legislation to sustain the positive achievements made during the Covid-19 pandemic.

Afforestation and deforestation: The impact of Covid-19 pandemic resulting in increased deforestation, an activity that has environmental implications affecting the wellbeing of the wildlife as well as human beings. The Covid-19 pandemic negatively affected the global economics forcing the businesses to suspend or shutdown their operations completely. As a

result, many people were rendered jobless, still they need to provide for their families especially during the difficult time characterized by food shortages and disrupted supply chains. In most countries, the governments reallocated their resources to combat the Covid-19 pandemic, but in turn neglected their efforts to protect the forest cover and illegal deforestation. (Mohan et al, 2021). Many people embarked on cutting down the trees for their survival with the tropical region & forests being mostly affected. During the Covid–19 pandemic, the forest cover was significantly reduced, an activity that caused adverse implications on the climate change and environmental conservation. The increased deforestation and destruction of the forest cover threatened the survival and wellbeing of wildlife due to their habitat destruction (Rahman et al, 2021). Due to illegal deforestation undermining the survival of diverse wildlife and ecosystems, the scientists are projecting the changes in rainfall patterns and an increase in global warming.

Wildlife Resurgence: Due to Covid-19 pandemic, there were reduced fishing activities. According to Hu et al, (2021), the fish biomass increased steadily following the movement restrictions and travel. bans that suspended the fishing activities resulting in fast growth of the number of fish thus negatively affecting their process in the market . The increased number of fishesin the seas has seen them transfer and distribute phosphorus in the water resulting in nutrients and other minerals getting transferred between the shores and the deep seas. Further, the reduced fishing activities allowed the fish to invade the places that were once uninhabited before the Covid-19 pandemic affecting the ecosystem that once balanced itself with the human activities. The suspension of fishing activities also allowed the growth of undermined and endangered fish species (Coll et al, 2021). The Covid-19 pandemic thus protected the survival and well-being of the fish allowing them to move freely in the oceans, seas and lakes without any human interference. Reduced human activities in the seashores and lakes has seen increased growth of water lilies as well as other aquatic vegetation thus making it difficult for the people to use those areas. Mantur, (2020) reported that increased human activities in the seas and lakes scared the aquatic animals away from the shores and habitats. However,the suspension of human activities during the pandemic period has seen the resurgence of aquatic wildlife. This aspect however is likely to cause conflict between humans and aquatic wildlife once the people resume their activities again on the seashores and lakes. Increased vegetation cover in the lakes and seashores during the Covid-19 period resulted in the disappearance of the once beautiful beaches that the people enjoyed and were inhabited by aquatic wildlife that threaten the human health and life. Thus the changes in the aquatic environment and in itsP^H due to reduced human activities and increased sea life activities indirectly attributed to movement restrictions in lakes andseas to contain the spread of Covid-19 pandemic

Littering: Due to the outbreak of Covid-19, generation of medical waste increased globally posing a major threat to public health and environment. For sample collection, diagnosis and treatment of suspected Covid-19 patients and disinfection purpose, lots of infectious or hazardous and medical wastes were generated from various hospitals globally (Somani et al, 2020; Zambrano-Monserrate et al,2020). Use of face masks, hand gloves and other safety equipment increased the amount of health care waste. The production and use of plastic based PPE also increased worldwide(Singh et al, 2020). However, due to lack of knowledge about the

waste management, many people dumped these wastes (i.e. hand gloves, face mask etc) in open places and also with household wastes (Rahman et al ,2020). The haphazard dumping of these wastes causes clogging in the water and also worsens the environmental pollution (Singh et al, 2020; Zambrano-Monserrate et al, 2020). The face mask as well as other plastic based protective equipment are the potential sources of microplastic fibers in the environment (Fadare and Okoffo , 2020) . Polypropylene is generally used tomake N-95 masks and Tyvek for making protective suits, gloves as well as face shields which persists for a longer duration releasing dioxin and other toxic elements in the environment (Singh et al, 2020). Further mixing of household organic wastes and hazardous medical waste (plastic based protective equipment) increases the risk of exposure to virus of waste workers and disease transmission (Ma et al, 2020;Somani et al, 2020; Singh et al, 2020). Increase in generation of both organic and inorganic municipal waste has direct and indirect effects on the environment such as air, water and soil pollution (Islam et al, 2016). Further, SARS-CoV-2 virus was detected infaeces of Covid-19 patient and also from the municipal waste water in many countries including Australia, India, Netherlands, Sweden and USA (Ahmed et al, 2020; Nighiem et al, 2020; Mallapaty, 2020) .Huge amount of disinfectants was also sprayed onto roads, commercial and residential areas to eradicate the SARS-CoV-2 virus. However, such extensive use of disinfectants can kill the non-targeted beneficial species that may create an ecological imbalance (Islam and Bhuiyan, 2016). The increase of hazardous waste and their proper management became a significant challenge to the waste management authorities during the Covid-19 pandemic.

The spread of Covid-19 pandemic had lot of implications for the appearance of the environment. Reduced human activities have seen the environmental efforts to uphold cleanliness being upheld, for instance, before the Covid-19 pandemic, increased trading activities in the markets and public places were characterized by increased littering and piling of solid waste that undermined the environmental and population health (Okuku et al, 2021). But the lockdowns, movement restriction, curfews and stay at home orders during the Covid-19 pandemic have compelled the people to abstain from the city centers. This has made easy for the authorities responsible for cleaning cities and towns worldwide for getting ample time to clean and manage solid waste effectively, practices that have led to improved appearance and aesthetic of public places which were once crowded or congested, dirty and undermined the global image of the major cities and towns. One cannot underestimate the Covid-19 pandemic's environmental benefits as it was a period characterized by cleanliness and improved appearance of the once crowded and congested places with reformed waste and disposal practices. However despite these improvements, the new practices emerged to contain the spread of Covid-19 pandemic have threatened the safety and well being of the environment. The increased use of disposable face masks, hand gloves and personal protective equipment (PPE's) have been prevalent in the pandemic, shielding its users from contracting the virus (Yousefi et al ,2021; Torkashvand et al, 2021). Further, poor disposal practices of the users face masks, hand gloves and PPE's conversely exposed the people and the domestic animals to further health risks undermining the environmental well being. Increased littering during Covid-19 pandemic has undermined and degraded the environmental conservation.

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Reduced traffic congestion: Before the onset of Covid-19 pandemic, increased use of automobiles characterized by traffic congestion was the day's order in many cities and towns globally. Major cities and towns all over the world enjoyed infrastructural developments that have seen the transport and communication being improved significantly to meet the changing needs of the people. The technological developments also improved the ease of movement, reduced traffic congestion and also promoted the smooth movement of people and the automobiles. However, the densely populated towns and cities still have the issues with traffic congestion as reported by Du et al, (2021). This aspect has inconvenienced the people and also negatively affected the environment. The lockdowns, curfews and movement restriction directives due to Covid-19 pandemic not only reduced the traffic and congestion in the major cities and towns but also strained the environment and its resources. Further, the directives during the Covid-19 pandemic not only allowed the essential services such as medical services, transportation of food and delivery of other necessary items saw these services improved, thanks to the reduction of congestion and traffic jams, which had previously undermined the health of the population with increased pollution emission from the motorists.

Traffic congestion though undermined the public health but that of the environment undermined the existence and survival of the ecosystems. Further, increased population in certain areas has scared the wildlife threatening their survival and existence (Li et al, 2021). The ban on the international movements due to Covid-19 pandemic significantly reduced traffic congestion in major cities with tourists attractions allowing the local communities to enjoy their biodiversity peacefully. The closure of international borders during Covid-19 pandemic also saw reduced oil and fossil fuel transportation following disruption in supply chains (Mahajan and Tomar, 2021) which ultimately reduced the automobile emission that once undermined the health of the people and the environment. The Covid-19 pandemic thus negatively affected the people's lives disrupting their routine activities and operations, but opened them to numerous opportunities from improved environmental health, wellbeing and conducive surroundings. The Covid-19 pandemic saved the people in major cities and towns globally from experiencing traffic and providing an opportunity to relax at home following the stay at home orders.

Noise reduction: Noise pollution is caused due to elevated levels of sound generated from various human activities such as use of machines, vehicles, construction work etc. that leads to adverse effectsin human as well as other living organisms (Goines and Hagler, 2007; Zambrano – Monserrate et al, 2020). Noise pollution negatively affects the physiological health of the humans along with cardiovascular disorders, hypertension and shortness ofsleep (Kerns et al, (2018). it has been reported hat around 360 million people are prone to hearing loss due to noise pollution globally (Sims, 2020). Further, anthropogenic noise pollution cause adverse effects on wildlife through the changing balance in predator and prey detection and also avoidance. Unwanted noise also cause negative effect on the invertebrates which controls the environmental processes that are vital for balancing the ecosystem (Solan et al, 2016). Thus, the noise pollution has undermined the environments well being over the decades i.e., the wellbeing of the living things with humans being affected the most. But, when the Covid-19 pandemic struck, there was sudden reduction in the noise levels with people enjoying peace and calmness. Peace of mind is

essential for an individual to have good mental health and psychological wellbeing. The quarantine and lockdown measures compelled the people to stay at home and reduced economic activities and communications worldwide ultimately reduced the noise level in most cities and towns (Zambrano-Monserrate et al, 2020).

The emergence of the Covid-19 pandemic thus played a crucial role in reducing the noise pollution that once disturbed the cities, communities and the individuals. The increased industrial operations in the major cities and towns in the past were routine. They were always accompanied by increased noise pollution (Gevu et al, 2021). The individuals and the communities were benefitted significantly from the Covid-19 pandemic as it brought their activities to a standstill. Different operations such as mining, water drilling, manufacturing and several other events significantly increase the noise pollution adversely affecting the environment and the health of the people (Rumeand Islam, 2020).

The Covid-19 pandemic compelled the governments all over the world to take radical measures that will assist in containing the spread of the corona disease. The measures indirectly reduced the noise pollution in the areas which were previously characterized by increased noise. The measures improved the environmental health as well as social wellbeing of the people (Nandan et al, 2021). The suspension of noisy activities of the various factories has seen the surrounding communities living in peace with minimal noise and conducive environments, free from noise pollution that once undermined the environmental health and discouraged the people from living in certain areas (Ryan et al, 2021). Major towns and cities are characterized by increased noise due to factories, increased traffic congestion, increased use of automobiles and several human activities that undermine the noise reduction efforts. However, as a result of Covid-19 pandemic, the neighbourhoods close to recreation centers and clubs had an opportunity to live in calm and quiet environments due to the suspension of large crowds, partying and indirectly noise production. Thus, noise is a destructor that undermines the social and psychological well being of a person. The Covid-19 pandemic undoubtedly has seen the people living in quiet environments that promote and protect their health.

Human Activities: The Covid-19 pandemic has had both positive and negative impacts on human activities that in turn have affected the environment. The spread of Covid-19 pandemic made it mandatory for the governments globally to institute the measures to contain the transmission of the disease compelling the businesses, organizations and the individuals to suspend their activities and operations to confirm to the directives. These measures resulted in the suspension of human activities with positive environmental impacts. As reported by Vandyck et al, (2018), large scale farming activities affected the air quality thus exposing the environment to sprays, fertilizers, chemicals and agricultural pesticides that undermined the quality ofair and the environment negatively affecting the health of the environment as well as the population. The suspension of these activities due to Covid-19 pandemic significantly improved the environmental health thereby protecting the peoples health as advocated by Churkina et al, (2017). Reduced outdoor activities especially outdoor games have reduced the strain on ecological resources, allowed more time for the growth of various plant species and enhanced the

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conservation efforts. The pandemic positively affected the ecological conservation due to reduced outdoor activities that once threatened the environment through exposure of its huge threats and pollutants.

The Covid-19 pandemic also led to increased human activities in few areas which had environmental implications. The closure of the companies followed by the suspension of their operations rendered most people jobless with the majority of them resorting to farming on their lands to keep themselves busy. Agriculture business increased tremendously during the Covid-19 pandemic with the demand for hiking fresh vegetables (Sridhar et al, 2022). This activity saw many people overusing their small lands to cultivate and grow vegetables using the farm chemicals to enhance growth and to meet their product demand in the market. Increased use of the farm chemicals in the form of sprays, pesticides and fertilizers spilling has negatively affected the environment undermining environmental well being (Kaur et al, 2019). The beauty of the environment has improved with the beautification of the compounds of the residential houses as majority of the people were compelled to work from home to follow the stay at home orders. The Covid-19 pandemic simultaneously reduced and increased the human activities having on indirect effect on the environment in terms of water quality, air quality and conservation efforts to uphold the sustainable use of environmental resources.

Potential Strategies of Environmental Sustainability:

The environmental consequences are short lived. Hence, a proper strategy should be made for long-term benefits and sustainable environmental management. The Covid-19pandemic has elicited a global response and to make us all united to fight and win against the virus. United effort of all the countries should be imperative to protect this universe (Somani et al, 2020). Hence few possible strategies were proposed for global environmental sustainability (Figure- 4).

Fig-4: Possible strategies for global environmental sustainability

1. **Sustainable Industrialization:** Though industrialization is essential for economic growth, but for sustainable industrialization, it is important to shift to less energy intensive industries, use of cleaner fuels and technologies as well as strong energy efficient policies as advocated by Pan (2016). The industries should be constructed in such specific areas where the waste from one industry can be used as a raw material of the other industry (Hysa et al, 2020). Further, the industrial zones should be shut down in a circular way after a certain period to reduce the emissions from the industries without hampering the national economy. Proper distance and hygienic environment should be maintained to reduce the spread of the infectious communicable diseases.
2. **Use of green and public transport:** In order to reduce the industrial emissions,it is necessary to encourage the people to use public transport rather than their private vehicles. People should be encouraged to use bicycles for a short distance. Furthermore,public bike sharing system should be made available for the people which is not only environment friendly but also is beneficial for health.
3. **Use of Renewable energy:** Renewable energy lowers the demand of fossil fuels like coal, oil and natural gas and plays an important role in reducing the GHGs emission (Ellabban et al, 2014; CCAC, 2019). The global energy demand is reduced due to the Covid-19 pandemic resulting in the reduction of emission and increased ambient air quality in majority of the areas (Somani et al, 2020; Zambrano-Monserrate et al,2020). However,to maintain the daily needs and global economic growth, it is not possible to cut off the energy demand as in the pandemic situation. Hence,it is imperative to use the renewable energy sources like solar, wind, geothermal heat, hydropower, and biomass to meet the energy demand and reduce the GHGs emission (Ellabban et al ,2014).
4. **Waste water treatment and Reuse:** The industrial as well as municipal waste water should be treated properly before discharge into the water bodies to control the consequences of water pollution. Besides, reuse of treated waste water in toilet flushing and road cleaning can reduce the burden of excess water withdrawal.
5. **Waste recycling and Reuse:** In order to reduce the burden of wastes and environmental pollution, the industrial as well as the municipal wastes should be recycled and reused. Hence,circular economy should be implemented in the production process to minimize the use of raw material and waste generation (Hysa et al, 2020). Further, the hazardous and infectious medical waste should be managed properly by following the WHO guidelines (WHO, 2020C). Majority of the people have a lack of knowledge regarding waste segregation and its disposal issues as reported by Rahman et al, (2020), Hence, the government should implement awareness campaign regarding the proper waste segregation, handling and disposal methods through different mass media.
6. **Ecological restoration and Ecotourism:** For the ecological restoration, the tourist spots should be shutdown periodically after a certain period. Further, the ecotourism practice should be strengthened to promote the sustainable livelihoods, cultural preservation as well as biodiversity conservation (Islam and Bhuiyan, 2018).
7. **Behavioral Change in daily life:** To reduce the carbon emission globally, it is necessary to change our behavior in daily life and make optimum consumption of resources such as avoiding processed food and taking locally grown food, making compost from food

waste, switch off or unplug the electronic devices when not in use and use of a bicycle instead of a car for shorter distances.

8. **International Co-operation:** To meet the sustainable environmental goals and protection of global environmental resources like the global climate and biological diversity, combined international effort is essential (ICIMOD, 2020). Hence, some responsible international authority such as united nation environment programme (UN environment) should take an effective role to prepare the time-oriented policies, arrange international conventions, conference and co-ordination of global leaders for proper implementation.

Conclusion: Directly or indirectly, the Covid-19 pandemic has opened the world to opportunities and threats that have affected the human life and global economy ultimately affecting the environment and the climate. The Covid-19 pandemic has disrupted the routine activities that once used to be considered as normal making it imperative for the international community to adopt new normal to survive. The pandemic reminds us as to how we have neglected the environmental components and enforced human induced climate change. The Covid-19 pandemic prompted the governments and the world health organization to formulate measures to prevent the transmission and to enhance the containment of the disease. Interestingly, the Covid-19 containment and various preventive measures had indirect environmental effects.Though some effects have worsened and threatened the conservation efforts, while most containment measures have significantly improved the management of the environmental problems. Further, several possible strategies wee proposed globally to sustain the Covid-19 response and containment measures that had positive implications on the environment, as they can enhance the efforts to address the environmental challenges that undermine sustainable development. The global response of Covid-19 pandemic also taught us to work unitedly to combat against the threat to mankind. Though,the effects of Covid-19 on the environment are short-term, united and proposed time –oriented effort can strengthen the environmental sustainability and save the environment from the effects of global climate change.

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