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Effects of COVID-19 on the Environment

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I. INTRODUCTION

Covid 19 is also known as coronavirus disease which is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)[1,2,3].There are four structural proteinsare present in SARS-CoV-2: spike (S) surface glycoprotein; membrane (M) protein; nucleocapsid (N) protein; and envelope (E) protein. Genomic RNA is shown encased in the N protein. It is considered as a contagious disease which means that it can easily spread from one human to another with direct when two persons are standing or sitting close to each other and the droplets from infected humanscome in contact with normal humans either by coughing, sneezing and talking or indirect contact where an infected individual coughs or sneezes and those infected droplets travel from mouth and get settled on the things around or air and get in contact with a healthy individual [7]. Life span of SARS-CoV-2 on different medium is 3 hours (aerosols), 4 hours (copper), 24 hours (stainless steel), 2-3 days (cardboard), 3 days (plastic), 3 days (sewage).

Etiology

COVID 19 is caused by coronavirus which are found to be positive stranded RNA viruses under the visuality of electron microscopy. It was seen that the positive strands of RNA has a crown like appearance which is possible due to presence of spike type glycoproteins which are present on the envelope of virus [8]. There are several variants of COVID 19 which raised due to genomic mutations in the RNA of virus-Alpha, Beta, Gamma, Delta and Omicron.Alpha (B.1.1.7 lineage) was found in the UK; around December 2020 a new variant of SARS-CoV-2 was reported from the genome sequence of infected individuals who tested positive for SARS-CoV-2 [9,10].BETA (B.1.351 lineage) was found during the second wave of covid-19, a new variant was reported in South Africa in October 2020, (B.1.351 lineage) is also referred as Beta variant or GH501Y.V2 and this caused by mutations on spike proteins of genome of RNA strand of virus [11].Gamma (P.1 lineage) variant which is considered as the third variant of coronavirus and it is also known as Gamma variant or GR/501Y.V3 was first detected in Brazil in December 2020 and then in the US in January 2021 [12].Delta (B.1.617.2 lineage)is also reared as Delta variant which is the fourth variant of coronavirus and it was first identified in India in December 2020 but it was proved to be deadly in April 2021 which caused the second wave of virus that killed millions of people. This deadly variant has almost ten mutations in the spike protein which are (T19R, G142D*, 156del, 157del, R158G, L452R, T478K, D614G, P681R, D950N).Omicron (B.1.1.529lineage) is the fifth variant of corona virus which is further designated by WHO as omicron variant and it was first detectable in South Africa in November 2021 [13].There are around 30 mutations happened in the spike protein of the virus which are T91 in the envelope, P13L, E31del, R32del, S33del, R203K, G204R in the nucleocapsid protein, D3G, Q19E, A63T in the matrix, N211del/L212I, Y145del, Y144del, Y143del, G142D, T95I, V70del, H69del, A67V in the N-terminal domain of the spike, Y505H, N501Y, Q498R, G496S, Q493R, E484A, T478K, S477N, G446S, N440K, K417N, S375F, S373P, S371L, G339D in the receptor-binding domain of the spike, D796Y in the fusion peptide of the spike,

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L981F, N969K, Q954H in the heptad repeat 1 of the spike as well as multiple other mutations in the non-structural proteins and spike protein.[14].These mutations made theirs 2.8 times more infectious than delta variant and this variant also had 13-fold increase in the infectivity of virus [15].

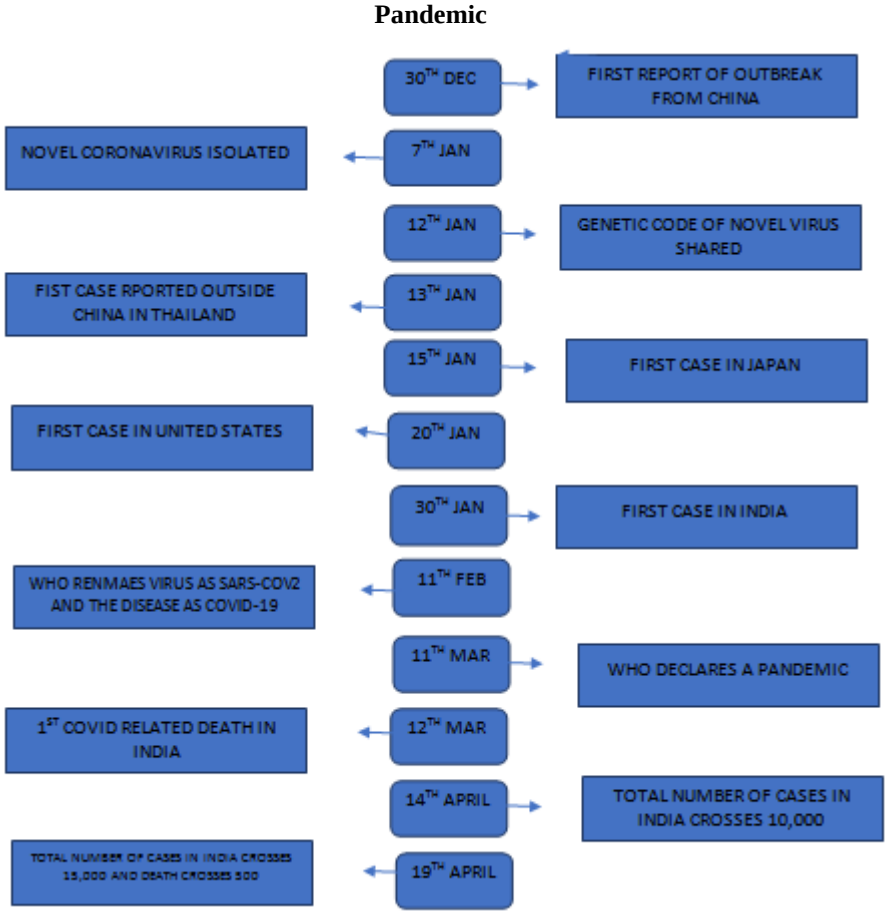

Figure 1 This Flow chart explains the journey of transmission of coronavirus across the world.

As it is displayed in picture number 3 that the first case of corona virus emerged in China, the disease spreads so rapidly because it is contagious and the cases related to it rises exponentially. The first case which was reported outside china was on January 11, 2020 in Thailand and in some up-coming months disease spread to almost all regions of the world except Antarctica. The first case of covid-19 in India was reported on January 30,2020 and by February 2020 it only rose upto three cases. On March 12,2020 first death was reported in India due to covid-19, by April 2020, covid-19 has been spread in all states of India except Sikkim. Globally there are almost 2,170,265 cases reported and 135,163 deaths have occured.[16,17].

Country	Number of infected persons	Number of recorded deaths
USA	31,530,214	564,091
India	16,263,695	186,920

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Brazil	14,122,795	381,475
France	5,325,495	101,513
Russian Federation	4,744,961	107,501
Spain	3,456,886	77,496
Italy	3,920,945	118,357
Turkey	4,501,382	37,329
Germany	3,245,253	81,158
Colombia	2,701,313	69,596
Argentina	2,769,552	60,083
Mexico	2,315,811	213,597
Poland	2,742,122	64,707
Iran	2,335,905	68,366
South Africa	1,571,348	53,995
Ukraine	2,004,630	41,700
Indonesia	1,626,812	44,172
Peru	1,726,806	58,261
Czechia	1,615,461	28,863
Netherland	1,435,772	17,002
Canada	1,147,463	23,763
Chile	1,148,320	25,532

Table 1- This table shows how many people died due to covid-19 in different countries between December 2019 till April 24, 2021.

EFFECTS OF COVID-19 ON THE ENVIRONMENT

Environment is defined as the surroundings in which an animal, plant and human lives. Environment can be easily affected by human activities like using excessive natural resources, natural oils, deforestation, polluting air and water.

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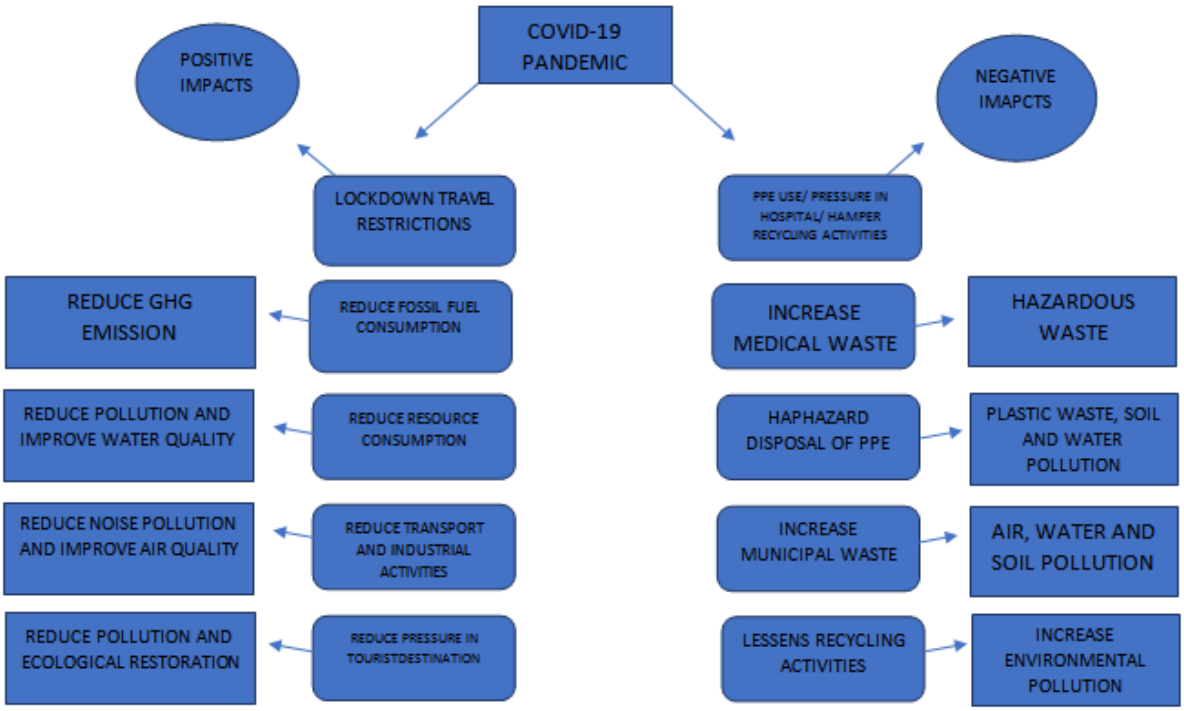

Figure 2- this flow chart displays what Covid-19 has done globally.

The above figure number 4 represents that the pandemic hit the world and what major changes it brought either positive or negative.

POSITIVE EFFECTS OF COVID-19 ON ENVIRONMENT

Reduction in water pollution- In the developing countries, the common way of water pollution is by dumping the water directly into rivers and ponds which comes from industries and that water has chemicals in it. The countries where this method id perform are India, and Bangladesh.[18,19,20,21].It was observed that during the lockdown period, water pollution has been decreased to a maximum extent because industries were closed as individuals were scared to step out from their residence.[22].For instance- it was observed that the river Yamuna and Ganga reached a significant level of purity because of the shutting down of industrial companies when there was lockdown in India.[23].The Grand Canal of Italy turned clear and many aquatic species reappear due to lockdown of Covid-19.[24]. In the beaches of Thailand, Bangladesh, Maldives and Indonesia water pollution is also reduced due to less people gathering and tourism. Food wastage has also been reduced in Tunisia which brings up a positive result in improving soil and water [25].

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These pictures of river Ganga and Yamuna shows one of the positive impact of Covid-19 which eventually helped them to get cleaned during lockdown.

Parameters	Before lockdown	After lockdown
DO (mg/L)	11.50	8.00
BOD (mg/L)	2.60	2.30
Total coliform (MPN/100 mL)	8400.00	2400.00
fecal coliform (MPN/100 mL)	3300.00	790.00

Table 2 - This table shows the level of water quality before and after lockdown.

Reduction in Noise pollution-Noise pollution is defined as then the level of sound crosses the limit of 80 -85 decibels which starts damaging the human ear and itis caused by human activities like driving vehicles, big machines and construction work.[26]. High levels of noise usually disturbs psychological health of individuals, hypertension, shortness of sleep along with cardiovascular disorders.[27]. If we see globally then it is reported that 360 million people are prone to hearing loss caused by noise pollution.[28]. However, it was seen that lockdown in cities has helped to reduce the noise levels by reducing economic activities and worldwide communication.[29]. It has been noticed that in Delhi, noise level is reduced drastically to 40-50% in the period of lockdown because of the reduction in movement of vehicles on the roads, reduction of underground metro

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trains, closing of industries.[30,31]. As per the records of Central Pollution Control Board (CPCB, 2020) of India, noise levels in residential areas are reduced in daytime from 55dB to 40dB and in the night time from 45dB to 30dB which results in positive environment and it was also highlighted people were able to hear the chirping of birds which has a range of 40-50 dB.[32,33]. Travel restrictions also helped in reducing noise pollution as the movement of vehicles and flights have reduced around the world. In the case of Germany, it was reported that car traffic has dropped by <50%, passenger air travel has reduced to 10% and running of trains has decreased by 25% then the usual rates.[34].

Reduction of Air Pollution and GHG emission- After the imposition of lockdown in almost the entire world, the emission of greenhouse gases has been reduced because companies closed down and less vehicle movement was seen on the roads. In New York, the level of air pollution has reduced by 50% under the effect of the virus.[35]. In China, it was reported that the emission of NO2 and CO has been reduced to 50% due to the shutdown of heavy industries.[36]. Global economic activities are also affected by the shutdown as the emissions of NO2 have been reduced to a certain level in countries like the US, Canada, China, India, Italy, Brazil etc.[37,38,39,40].The emission of NO2 is directly linked with the burning of fossil fuels and around 80% of NO2 comes from the exhaust of motor vehicles when they run.[41]. NO2 emission also leads to Acid rain when it interacts with H2O and O2 in the atmosphere and this acid rain is the reason for severe respiratory diseases from which humans suffer.[42]. A report brought by the European Environmental Agency (EEA) predicted that 30-60% of NO2 emission has been dropped in many European cities including Barcelona, Madrid, Milan, Rome and Paris and this becomes only possible because of a lockdown caused by COVID-19.[43]. Compared to previous years, the emission of NO2 declined by 25.5% in the US during the period of COIVID-19.[44]. In Canada the reduction of NO2 has been found to be to 1 ppb (parts per billion)from 4.5 ppb.[45]. In Sao Paulo, Brazil, around 54.2% of NO2 emission has been decreased.[46]. The major impact was seen in Delhi (capital of India) where almost 70% of NO2 emission is reduced along with PM2.5.[47]. During the nationwide lockdown of India, latest reports suggest that PM2.5 and PM10 emission is reduced between 40-50%.[48].

Furthermore, vehicles and aviation are also considered as the key contributors in the emission of GHGs with almost 72% and 11% to the environment.[49]. The measures which are taken globally also impacted the aviation sector of all the countries as international travelling was stopped and some domestic travellers were also restricted which caused the worldwide flights to be cancelled. The best example which can be seen here is China which reduces almost 50-90% of international and 70% of domestic flights as soon as the virus hits the country and due to this CO2 emission has been reduced by 17% in the environment.[50]. Around the world, almost 96% of air travel has been dropped which helped the environment to heal.[51].

Additionally, less consumption of fossil fuels means that there is less emission of GHGs which helps to reduce global climate change. As per the reports by International Energy Agency (IEA), oil demand has dropped globally by 435,000 barrels in the first three month of 2020.[52]. Coal consumption was also reduced globally because energy demands were reduced in the period of lockdown. In India, coal based power generation has reduced by 26% and total power generation has reduced by 19% due to COVID-19.[53]. China is at the top rank with coal consumption in the world but the lockdown dropped the consumption by 36%.[54,55].

CO2 emissions have been in an upward trend every year in late 2019. Conversely, since early 2020, red shading shows a significant decrease in carbon emissions during confinement (b). On April 7, 2020, the influence of the confinement on daily global CO2 emissions was less in contrast to the average level of emissions in 2019. Also, during January–April 2020, CO2 emissions fell as compared to 2019 levels.

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Figure 3- This figure is good in comparing the air quality difference where mountains became visible from the city after the impact of COVID-19 and after it.

- National Air Quality Index (NAQI)-After the lockdown, significant enhancement in the air quality was reported and it was compared with the pre-lockdown phase. 51% of reduction was observed in the NAQI on March 27,2020 of lockdown and it was then compared to data of March 21,2020. During the period of 1st lockdown which started from March 24,2020 and ended on April14,2020, there was a 43% reduction of NAQI which was reported and it was then compared to the level of NAQI from the first three weeks of March 2020. In different zones of Delhi which are Central, Eastern, Western, Southern and Northern the percentage of NAQI reduction was 54, 49, 43, 37 and 31. NAQI level declines abruptly due to change in concentration of existing pollutants which are PM10, PM2.5, NO2 and CO. However, slow and slight increase in NAQI was reported after the first two weeks of lockdown and this can be easily seen in the figure given below and this happens due to relaxation of necessary activities, increase in vehicular movement, power plant operations and industrial activities.[56].

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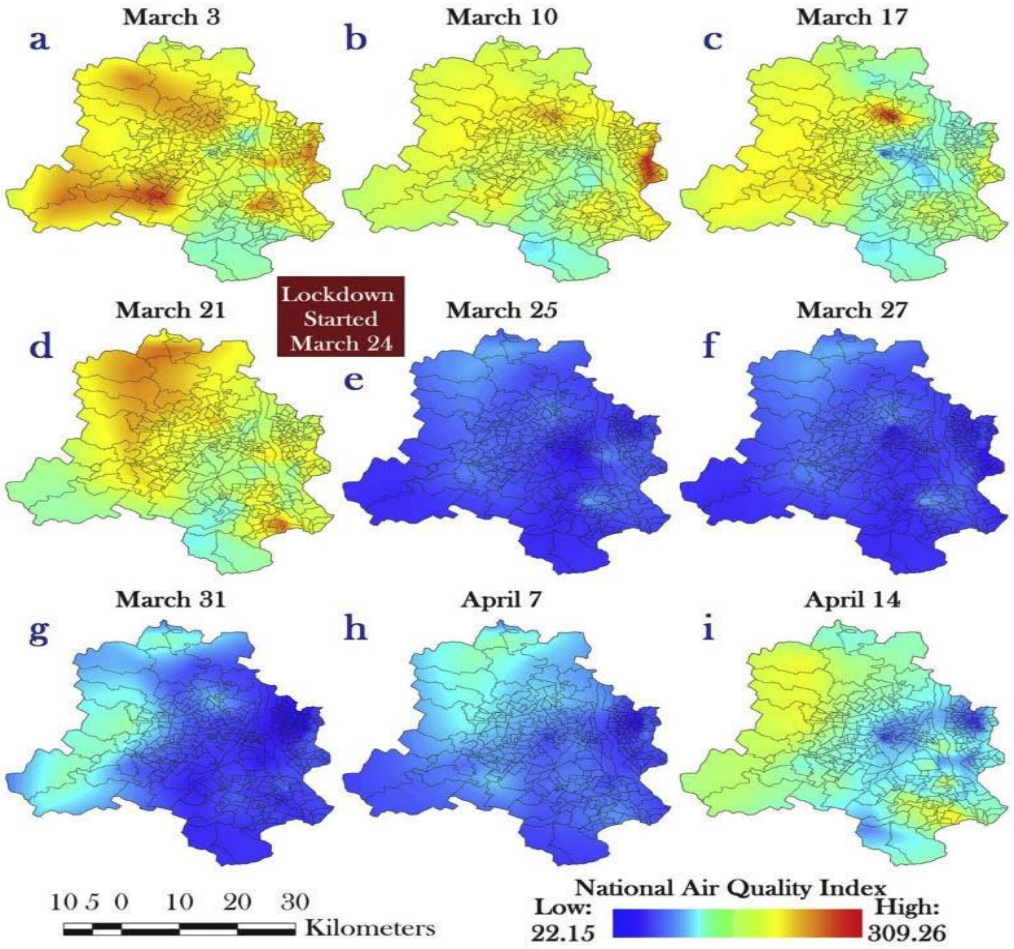

Figure 4 - This figure shows NAQI change at NCT Delhi from 3 March to 14 April 2020.

NEGATIVE EFFECTS OF COVID-19 ON ENVIRONMENT

 Bio-medical waste during COVID-19-The patients who suffered from COVID-19 have increased biomedical waste (BMW) all around the world. Almost 198 Common Bio-Medical Waste Treatment Facilities (CBMWTFs) and 225 captive incinerators of India are treating approximately 550 tons of biomedical waste which is produced per annum.[57,58]. However, in China during the epidemic the total biomedical waste produced in a single day was 240 tons which is quite huge as compared to terms of India.[59,60,61].Again, the city of India named Ahmedabad has the highest amount of waste in a single day which was 1000kgs during the first phase of lockdown.[62]. In Dhaka, around 206 m tonnes of medical waste was being produced due to COVID-19.[63]. Another cities like Manila, Kuala Lumpur, Hanoi, and Bangkok also brought up medical waste in the range of 154-280 m tonnes in terms of per day as compared to waste produced before pandemic.[64].

As the COVID-19 cases were rising there was a concern about the management of waste because treatment centres were already overburdened by medical waste and not taking proper care of it would lead to infections among sanitary workers. Another risk which was lying over there was related to mixing of COVID-19 waste with medical waste and food waste which came from the wards where COVID infected patients were staying. For the better protection of workers, three-layered masks were provided along with splash-proof aprons or gowns, gumboots, gloves and safety goggles.

 Use of Safety equipment and haphazard disposal- To protect from the virus everyone around the world tries to be wearing gloves and masks all the time either they sit close to each other or they are separated by a distance and this usage

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of safety equipment is the reason for the increase in healthcare waste. According to the recent reports. From the USA, the amount of trash has been increased due to an increment in PPE which is used at domestic level.[65]. After the covid-19 hits, the usage of plastic based PPE is increased globally along with its production.[66]. From February 2020, the production of masks in China has increased to 14.2 million every day which is much higher than before.[67]. Most of the people do not have proper knowledge regarding infectious waste management and they dump their gloves, face masks etcetera in open places and sometimes with household waste.[68]. This haphazard dumping is one of thereasons which causes environmental pollution because these masks and gloves cause clogging in waterways and worsens it.[69,70]. Face masks and protective equipment made of plastic were considered to be a source of micro plastic fibres in the environment.[71]. Chemicals like Polypropylene which is the main component of N-95 masks and Tyvek which is further used in making gloves, suits and medical face shields can cause release of dioxin and toxic elements when they are kept for a long time in the environment.[72]. Some experts and responsible authorities suggest the proper way of disposing and segregating organic waste and equipment made of plastic but they also warned that mixing them would increase the risk of side transmission.[73,74,75].

- Other effects on the environment- During the pandemic, huge amounts of disinfectants were applied on the roads, used in commercial areas and residential areas to exterminate COVID-19. All such disinfectants can sometimes kill non-targeted species which further creates ecological imbalance.[76]. Moreover, it was noticed that from the faeces of infected patients SARS-CoV-2 was detected in countries like India, Australia,Sweden, Netherlands and USA.[77,78,79]. Some additional measuresneed to be taken by the government and especially in countries like Bangladesh where municipal wastewater is directly drained into nearby aquatic bodies without even treating the water.[80,81]. China has taken steps to reduce the presence of SARS-CoV-2 in the water by adding chlorine to it but the excessive use of chlorine in water generates harmful by-product.[82].

- Impact on soil and water ecosystem - All the components of the ecosystem are intertwined to each other, with the emergence of COVID-19 everyone became more conscious about their health and they started washing their hands with soap more frequently which destroyed soil and water quality because of mass disinfection by local and government bodies. The production of bisphenol A (BPA) leaves a bad impact on the quality of soil and water of our ecosystem.[83]. Hand sanitisers are made up of around 70-75% of alcohol and during COVID-19 their usage has been increased a lot but when these alcohol based products are spilled in water then they become toxic to aquatic fauna along with pollution groundwater.[84]. Soaps are also used in large quantities during the waves of COVID-19 and they are known as oldest detergents, when these detergents are discharged into water bodies then they cause foam to build up.[85]. This foam creates a barrier which acts as an obstacle at the air-water interface and it was observed that 120 mg/L of soap can prevent the growth as well as development of algae.[86,87]. Soil quality is also destroyed by the detergents which get accumulated in the water of local bodies and rivers.[88,89].

II. CONCLUSION

In conclusion, this article comes to an end by saying that in the beginning we had discussed what is COVID-19 and how it gets spread to various parts of the world. This documents also shares the cause of the disease which is known as etiology and further on it explains what is pandemic and how COVID-19 hits the world. In addition to it, this document has shared positive and negative effects that happened to the environment after the COVID-19 strikes, the positive results lead to reduction in air and noise pollution, less usage of fossil fuels and improvement in air quality index. On the other hand, some negative effects which were listed and explained in this document are disruption of soil and water quality, increment in bio-medical waste, more demands for safety equipments leading to pollution and other environmental problems.

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