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REVIEW PAPER

Various impacts of COVID-19 on environmental pollution

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ABSTRACT

BACKGROUND AND OBJECTIVES: The COVID-19 pandemic has created a global health crisis that had a deep impact on the world and our everyday lives. The deadly virus i.e. SARS-CoV-2 has rapidly spread around the world, posing enormous health, social, economic, and environmental challenges to the entire human population. Countries around the world have implemented complete or partial lockdown measures to mitigate the spread of the coronavirus. Corona lockdown has profound social implications and it has sparked fears of impending economic trouble and recession.
METHODS: However, this lockdown has also shown some positive effects on the natural environment due to the reduction of pollutant loading from vehicle emission, industries, and other sources. Based on a review of recent research in the relevant area, this paper assesses the effect of COVID-19 pandemic on air and water quality as well as on environmental noise.
FINDINGS: A substantial reduction in the level of noxious NO_2, particulate matter, and carbon emissions have been observed during the lockdown period, the lockdown also led to an appreciable drop in BOD (biological oxygen demand) and a significant increase in DO (dissolved oxygen) of different river water globally. In addition to this, the anthropogenic noise level has fallen by about one-third due to the COVID-19 lockdown.
CONCLUSION: This study reveals that there is a substantial possibility for healing the environment from the detrimental effects of anthropogenic activities through partial or temporary lockdown measures.

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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes coronavirus disease, namely COVID-19, as implied in its name, 'CO' stands for 'corona,' 'VI' for 'virus,' and 'D' for disease, and 19 is used for the year of its existence. The first case of COVID-19 was detected in Wuhan city, Central Hubei Province of China in December 2019 (Ashour *et al*., 2020; Lu *et al*., 2020; Shi *et al*., 2020; Xu *et al*., 2020). In subsequent months, it spread rapidly to the rest of China, which has later become a global public health problem (Cascella *et al*., 2020; Chen *et al*., 2020a; Gilbert *et al*., 2020; Sohrabi *et al*., 2020). This name SARS-CoV-2 was taken because the virus is genetically related to the coronavirus responsible for the 2002-2004 SARS outbreaks. Which was first identified in Foshan, Guangdong, China, on November 16, 2002 (Tang *et al*., 2020; Cheng *et al*., 2007; Wen *et al*., 2020; Xu *et al*., 2004). Over 8,000 people from 29 different countries were infected, and at least 774 died worldwide. The more influence of the outbreak lasted about 8 months; however, several SARS cases were reported until May 2004 (Pasley 2020; WHO, 2004). In 2020, SARS-CoV-2 struck the world through widespread human transmission creating fears of a new afflicts. Generally, most SARS-CoV-2 infected patients have mild symptoms including common cold or flu, dry cough, and trouble breathing (Bchetnia *et al*., 2020; Grant *et al*., 2020; Huang *et al*., 2020a; Larsen *et al*., 2020). However, some patients could also have severe complications such as hemoptysis, lymphopenia and acute respiratory distress syndrome (Chen *et al*., 2020; Peeri *et al*., 2020; Wang *et al*., 2020). Further, the temperature, relative humidity, and wind speed have also affected SARS-CoV-2 transmission. Optimal humidity, temperature, and wind speed are variables that can determine the survival and transmission of the SARS virus. These climate variables can be a direct cause of biological interactions between SARS-CoV-2 and humans. Changes in weather are very significantly correlated with changes in mortality rates due to pneumonia (Tosepu *et al*., 2020). As per WHO, over 6 million cases of COVID-19 have been reported in 200 countries and territories resulting in more than 350K deaths till the end of May 2020 (Fig. 1). Among the total coronavirus tests conducted so far in the world, USA is at the top of the list (Fig. 2). The number of coronavirus cases is changing rapidly and detailed up-to-date information about COVID-19 is available on the WHO website. At present, the whole world is struggling to contain the virus because of the unavailability of any specific and effective pharmacological treatment. Hence, social distancing is the only option to combat novel coronavirus. Consequently, in order to confine further transmission of the fatal virus in the community, most of the afflicted countries have decided to undergo complete lockdown. Due to lockdown all air and rail travel, bus, truck, and private transportation are restricted, several types of industries are not functioning or significantly reduced the operations, even entire educational institutions, religious places, sports stadiums, and recreational activities are also closed. This worldwide lockdown is menacing the world economy. According to the International Monetary Fund (Global Financial Stability Report, 2020), the global economy is expected to fall by over 3% in 2020, which is the worst recession since

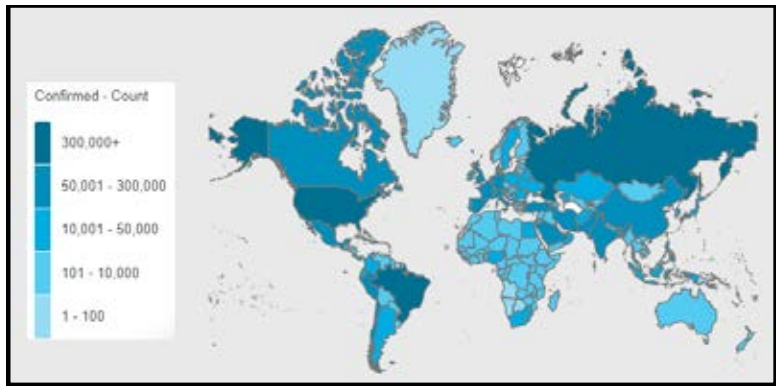

Fig. 1: Distribution of COVID-19 in different countries (WHO, 2020)

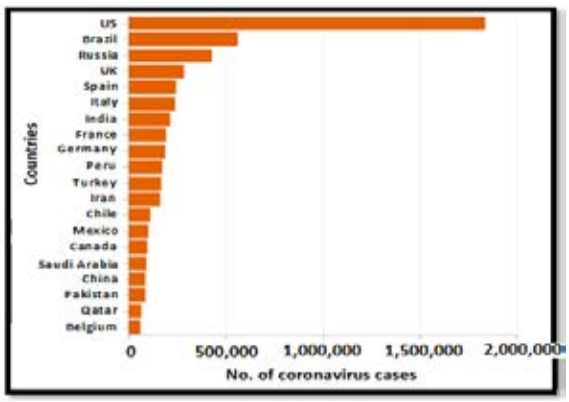

Fig. 2: Top countries affected by COVID-19 (WHO, 2020)

the Great Depression of the 1930s. This has been an extremely painful time for communities across the world. But there is news in the midst of all this, which gives some relief that our nature is recovering gradually. Before the beginning of the COVID-19 pandemic, the air around us had been very harmful to breathe in due to the higher concentration of noxious or greenhouse gases that had been emitted over the centuries. The increased concentration of greenhouse gases in the atmosphere causes an increase in the earth's temperature, which results in the rising sea levels by melting of glaciers (Khan *et al*., 2017; Maurer *et al*., 2019; Manisalidis *et al*., 2020). Environmental deterioration was happening rapidly due to various anthropogenic activities. But after the COVID-19 lockdown start, there have been dramatic transformations in the environment. Due to the standstill of transportation, different industrial process, and anthropogenic emission, their adverse effects on the environment has reduced considerably. And in this way, the environment is being greatly improved. This paper gives a brief sketch of the different potential effects of COVID-19 pandemic on environmental pollution, such as noise level, air, and water quality.

IMPACT OF COVID-19 ON ENVIRONMENT

Effect on air quality

Air quality is one of the world's largest health and environmental problems at the present time, due to this nearly 7 million peoples die globally every year. Air pollution affects all regions of the world, and around 91% of the world's population lives in places where air quality levels higher than WHO limits (Neisiani *et al*., 2016; Torres *et al*., 2020). According to WHO, 9 out of 10 people breathe in such air containing high levels of pollutants. State of Global Air Report (2019) exhibits that air pollution contributes to about 8% of total deaths in the world and also the fifth leading risk reason for mortality worldwide. It is the reason for more deaths than many well-known risk factors such as high LDL, malnutrition, and alcohol use. Even every year, many people die due to air pollution-related diseases than road traffic accidents and malaria (Polk, 2019). Most of the mortality is due to exposure to fine particulate matter with a diameter of 2.5 microns or less, (< PM2.5), which may cause respiratory problems, asthma, lung cancer, and nonfatal heart attacks (Brauer, 2010). Majorly, South Asia, Southeast Asia, and Western Asia are the highest affected regions in terms of the higher concentration of fine particulate matter (PM2.5) worldwide. Even most of the cities within these regions also placed at the top of the world polluted city ranking. All the top 30 cities are within Asia, where 21 of the 30 most polluted cities in the world are located in India, and Ghaziabad emerged as the most polluted during 2019, Table 1 (World Air Quality Report, 2019). Due to the pandemic effect on industry and travel, many countries experienced a drop in air pollution recently. The minimal activities of factories, industrial sites, construction sector, and transportation bought a sudden decline in carbon, nitrogen dioxide, and particulate matter emissions. Consequently, Air Quality Index (AQI) levels have regularly fallen, which led to improving air quality, therefore, the skies are suddenly piercing blue even the birdsong seems louder than before. A considerable reduction in AQI was observed worldwide during the lockdown. The major improvement was observed in South-East

Table 1: Most Polluted cities in 2019 (World Air Quality Report, 2019)

Rank	City	PM2.5 (μg/m^3)
1	Ghaziabad, India	110.2
2	Hotan, China	110.1
3	Gujranwala, Pakistan	105.3
4	Faisalabad, Pakistan	104.6
5	Delhi, India	98.6
6	Noida, India	97.7
7	Gurugram, India	93.1
8	Raiwind, Pakistan	92.2
9	Greater Noida, India	91.3
10	Bandhwari, India	90.5

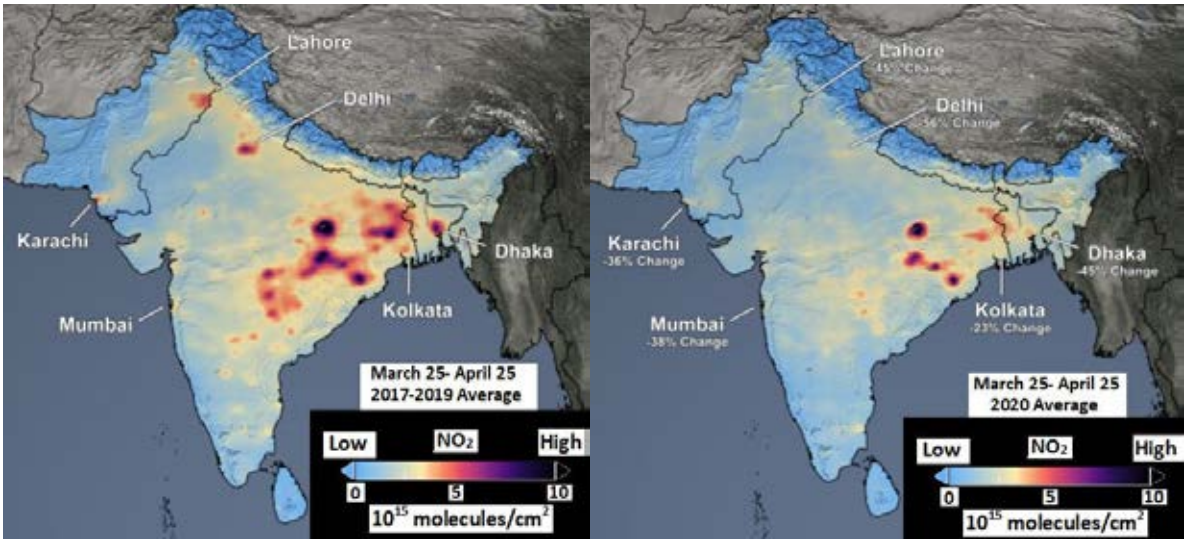

Fig. 3: Reduction in NO_2 Air Pollution over South Asia with Efforts to Control the Spread of COVID-19. (Can *et al*., 2020)

Asia and South Asian countries including major parts of Indian regions, where NO_2 concentration was drastically reduced during the shutdown of various industries and a travel ban issued (Lal *et al*., 2020). Fig. 3 displays that a significant reduction of NO_2 levels around 30-60% has been recorded in most of South Asia during the shutdown. For example, NO_2 levels reduced by around 45% in Lahore, Pakistan, and Dhaka, Bangladesh, while almost 55% in Delhi, India. The strong NO_2 levels that remain in eastern India are associated with electricity generation by thermal power plants (Can *et al*., 2020).

Recently a study also showed there is a significant improvement in the air quality of Delhi during the lockdown phase. Around 54%, 49%, 31%, 43%, and 37%, reductions in AQI were recorded in central, eastern, northern, southern, and western regions of Delhi, respectively (Mahato *et al*., 2020). Another study of COVID-19 impact on air quality has also been performed in several regions in Indonesia before and during the pandemic. In a nutshell, the results revealed that there are remarkable differences of CO, HCHO, and NO density before and during public activities restrictions in Jakarta, West Java, East Java, and South Sulawesi (Caraka *et al*., 2020). The Centre for Research on Energy and Clean Air reported that methods to reduce the spread of the COVID-19, such as social distancing, stoppage of factories, and travel bans, resulted in almost 25% fall of carbon emission in China (Myllyvirta, 2020). Fig. 4 depicts the concentrations of noxious gas i.e. NO_2, detected by NASA, and ESA pollution monitoring satellites. A dramatic drop of NO_2 was observed across China from January 2020 before the restriction and February 2020 during the restriction (NASA, 2020). Similar reductions in air pollution have also been observed over the major metropolitan areas of the Northeast United States by NASA satellite, recently. The study revealed a 30% drop in the concentration of NO_2 over the Northeast U.S. for March 2020 compared to 2015 and 2019 (Schindler *et al*., 2020). These recent improvements in air quality have come due to widespread lockdowns.

Effect on water quality

Many researchers have reported the substantial drop in air pollution in response to the restrictions imposed by the pandemic. However, the impact on hydrosphere like rivers, seas, and oceans is not much studied yet. Since air quality also affects water quality, hence it is expected to see improvements in water properties too. Clean water has a positive impact on human health and environment, and the COVID-19 lockdown has also contributed to minimize pollution and improve water quality. Recently, the European Space Agency has taken the images of famous canals of Venice by the Copernicus Sentinel-2 mission, which depicted the

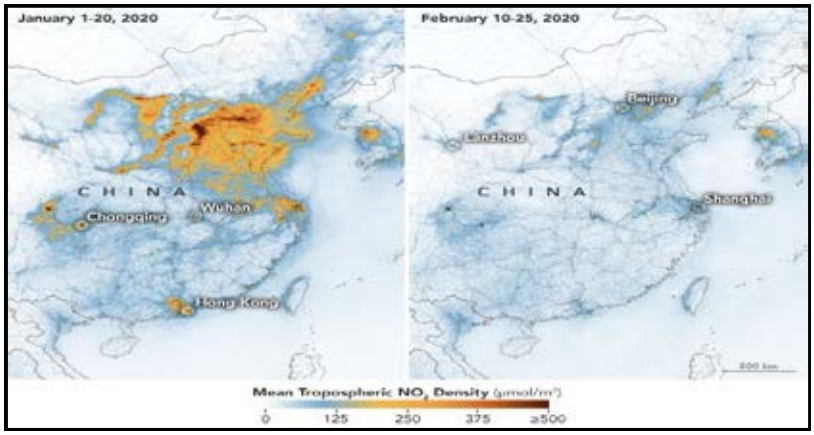

Fig. 4: NO_2 levels of China before and after the pandemic effect (NASA, 2020)

difference in the pollution level and the boat traffic during the lockdown due to the COVID-19 across the region (Brando *et al*., 2020). In waterways of Venice, the water became so clear with better water flow allowing aquatic life to be visible from the surface, this incredible improvement occurred because boat traffic was drastically reduced in the canals during restriction. One another study conducted by satellite images to analyze the water transparency of Venice's lagoon during the lockdown (Braga *et al*., 2020). This investigation also revealed that the turbidity of Venice's canals substantially decreased by the reduction of boat traffic and tourism. The lesser turbidity levels of the water increase the intensity of light and may also have positive impacts on aquatic ecosystems in the area. The unprecedented water transparency of the canals is certainly a positive environmental consequence of the pandemic lockdown. In India, water bodies are in a miserable condition, most rivers and lakes have transformed into sewer canals, which are getting difficult to be treated now. More than 1.3bn liters of sewage and industrial effluent enter rivers and other water bodies every day in India (Rajaram and Das, 2008; Iqbal *et al*., 2019). Ganga which is the largest river in India flows for a length of 2,500-kilometer has been an important part of India's history, religious beliefs, as well as a source of livelihood for millions since time immemorial. But today the holy river Ganga is considered to be the sixth-most polluted river in the world (Trivedi, 2010; Paul, 2017). Over the hundreds of industries release their waste directly into the river, as per the Central Pollution Control Board (CPCB); more than 50% of wastewater treatment plants do not follow the discharge norms (Ministry of Environment, Forest and Climate Change, India 2020). However, the water quality of the Ganga River considerably improved due to enforcement of the nationwide shutdown. According to the real-time water quality monitoring data of CPCB, there are 36 monitoring units of the Ganga, out of which 27 have become safe for bathing and propagation of aquatic organisms. To assess the health of the river different parameters including dissolved oxygen (DO), biological oxygen demand (BOD), total coliform levels, and pH were analyzed by CPCB, recently. The study demonstrated that the river water contained > 6 mg/L of DO, < 2 mg/L of BOD, and 5000/100 ml of total coliform levels, while, the pH of river water was found between 6.5 to 8.5 (Real-Time Water Quality Monitoring of River Ganga, 2020). This observation clearly shows that water quality has significantly optimal for bathing and wildlife. Meanwhile, another study on Ganga water carried out by the Mahamana Malviya Research Centre for Ganga, River Development and Water Resource Management at Banaras Hindu University also showed that river pollution during the lockdown period has decreased by 25% to 30% than before the lockdown (Kumar and Roy, 2020). Recently, Yunus *et al*., (2020) also estimated the surface water quality in terms of suspended particulate matter (SPM) of the Vembanad Lake, the longest lake in India. The SPM was evaluated by the turbidity algorithm showed that the SPM concentration during the lockdown phase decreased by 15.9% compared

with the pre-lockdown phase. While compared with preceding years, the reduction in SPM for April 2020 was recorded up to 34%.

Effect on environmental noise

Environmental noise is an accumulation of noise pollution defined as excessive or unwanted noise resulting from modern industrialized urban life and congestion due to overpopulation. Environmental noise in recent times has been well recognized as one of the major apprehension that affects the quality of life worldwide (Srivastava, 2012). Noise pollution can cause a number of short and long-term health problems, such as sleep disturbance, hearing impairment, high blood pressure, heart failure, etc. It has also a huge environmental impact that can alter the natural conditions of the ecosystem and can seriously affect wildlife (Pal and Bhattacharya, 2012; Sadeghi and Panahi, 2016; Monserrate and Ruano, 2019). Since to curb the spread of SARS-CoV-2, most anthropogenic activities that usually take place have now discontinued for longer than usual, and this has resulted in a rapid and substantial change in noise level worldwide. Seismologists of Royal Observatory of Belgium has reported that inland anthropogenic noise level has fallen by about one-third due to the COVID-19 lockdown. This has opened a new possibility to detect minor seismic noises and monitor volcanic activity (Gibney, 2020). Noise pollution generated by stone quarries is also one of the major troubles which can adversely affect environmental quality. There are a number of operations, which lead to high noise levels in the quarrying industry for instance crushing, blasting, drilling, heavy machinery, and transportation. Recently, during the COVID-19 lockdown, the noise level is significantly dropped to < 65dBA in the stone quarrying area of eastern India, which was above 85dBA in the pre lockdown period (Mandal and Pal, 2020). Regarding oceanic activities, oceans are more tranquil than before; the level of anthropogenic noise in the ocean can inflict irreversible damage to marine life, habitat displacement, reduced reproduction, and even leading to death. As global trade has significantly slowed down due to the coronavirus pandemic, therefore maritime transport has also drastically dropped. Recently, a study showed a reduction of noise 4 to 5 decibels in underwater near the port in the busy Strait of Georgia during the shutdown. The researcher says, it's a small but remarkable reduction and may even larger decreases in the near future (Thomson and Barclay, 2020). The reduction in acoustic levels in the ocean due to COVID-19 may be a positive mark for whales and other sea mammals.

Effect on lifestyle

Food waste is one of the biggest problems facing mankind today (Karin *et al*., 2018; Massow *et al*., 2019; Huang *et al*., 2020; Gandhi *et al*., 2020). The leftover food puts a redundant burden on the environment by wasting precious resources, such as water and agricultural land. Food waste that ends up in landfills also generates a higher amount of methane, which is a more powerful greenhouse gas than even carbon dioxide (Clune *et al*., 2017; Poore and Nemecek, 2018; Moult *et al*., 2018). The excess amounts of methane and carbon dioxide absorb infrared radiation and heat up the earth's atmosphere, resulting in global warming and climate change. COVID-19 has obligate people to stay at home and cook, which also a beneficial impact on the environment because it requires lesser resources than an online food ordering system or food eating outside, processing, packaging, and transporting of food. In addition to this after the experienced the view of empty shelves in supermarkets during the pandemic, the people may also aware to waste less food. Nowadays people are more conscious of healthy eating to increase immunity, hence people may move away from processed foods, and opt to eat more organic, vegetarian, and vegan foods or grow a garden. Researchers expect that shifting to plant-based diets would reduce the individual's average carbon footprint by 900 kg of carbon dioxide/year. A vegetarian diet may decrease CO_2 emissions more than 1200 kg of CO_2/year, and for vegans, it may reduce up to 1500 kg of CO_2/year (Scarborough *et al*., 2014; Rosi *et al*., 2017; Lacour *et al*., 2018). Recently a study also revealed that dietary patterns, such as, vegetarian, or vegan significantly favorable for both individual health and the environment (Wilson *et al*., 2013; Smith 2014; Aleksandrowicz *et al*., 2016). As gym, restaurants, and movie theaters shuttered or limited, most people have to found recreation by walking outside in parks and in nature. This experience could contribute to enrich nature and increase the human understanding of anthropogenic activities on

the environment. Expectantly, it will transform into an impetus to protect and care for the environment. Furthermore, cultural sites can be peace hubs that help maintain reconciliation processes, which in turn can enrich environments that bring communities together within the framework to learn, understand, and live peacefully together (Sumaryana *et al*., 2020; Toharudin *et al*., 2020). These favorable effects are especially important in the pandemic time when the mental and emotional effects of social isolation are slowly becoming clearer.

Effect on medical waste

Medical waste is a subset of wastes generated at health care facilities, which includes various types of waste obtained from clinics, nursing homes, hospitals, medical research centers, and medical shops, etc., (Windfeld and Brooks, 2015). Medical waste is considered one of the biggest challenges faced by healthcare providers, around 10% of the waste produced in health care facilities is contagious and improper disposal of such waste exposes human beings and the environment to serious health risks (Manzoor and Sharma, 2019). As the COVID-19 pandemic is increasing exponentially, resulting in a huge growth in medical waste in particular plastic waste. Different types of masks are made of polypropylene, a kind of plastic, which is not going to break down easily, and its safe disposal is becoming a major concern nowadays. It is estimated that one single positive COVID-19 cases generate 10 times higher medical waste than the average patient. Due to pandemic in Hubei Province, People's Republic of China, infectious medical waste increased by 600% from 40 tons per day to 240 tons per day (Jiangtao and Zheng, 2020). The US has also seen a growth in medical waste from discarded personal protective equipment as well as in other items, such as surgical masks, respirators, goggles, or face shields (ResearchAndMarkets.com, 2020). The world these days is affected by the fear of coronavirus hence face masks and hand gloves have become an essential component of everyday life to protect from infection. However, the large amount of waste being created as the single-use items tossed aside has also the potential to become an ecological disaster. This huge amount of medical waste generated by COVID-19 in 2020 will seriously affect sustainable medical waste management practices in the near future, globally.

CONCLUSIONS

Based on the above discussion, it is concluded that during the COVID-19 control period, anthropogenic activities have been lowered greatly, causing significant reductions in industrial operations, constructions, and other activities which further leads to improving noise level, air, and water quality. However, these positive impacts on the environment are ephemeral and the pollution level is likely to worsen again after the ends of the pandemic. But the common people and governments can learn lessons from the lockdown that pollution can be reduced to a great extent only by taking some steps. When the whole world is anxious about the suitable policies for decelerating pollution, this emergency lockdown shows the perfect way to heal the environment and ecosystem. It needs to be researched, but broadly not averse to saying that pollution can be controlled. For this, the participation of common people, experts, and NGOs with the administration will be important.

AUTHOR CONTRIBUTIONS

N. Kumar conceptualized, writes, and edited the manuscript. R. Tyagi supervised and review the manuscript.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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