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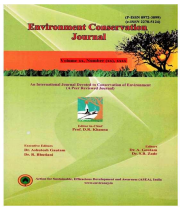

The dynamics of the first wave of COVID-19 on environment and wildlife– a boon or a bane?

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ABSTRACT

Even though COVID-19 has drastically weighed upon the humankind, still there is a "silver lining" to see in this dark time. Amidst of this pandemic, most of the human activities were restricted to break the chain of infection which resulted the remarkable change in nature. It has been reported that due to halt in air travel, reduction in the use of fossil fuels, way less functioning of vehicles, shutdown of industries has complied the change in air pollution levels and also change in river water quality. Reports also showed the reduction in particulate matter (PM 2.5 and PM 10), greenhouse gases emissions, massive improvement in the Air quality index (AQI), reduction in the NO_X and SO_X's level has clearly stipulated that nature has got it's time to "revive". Even the global carbon emission has reported to reduced reluctantly which is expected to be the biggest such drop since World War II. Despite conducting water-cleansing projects and spending a lot of money, the situation of the water bodies were far better now during first lockdown. Moreover, migration and breeding of the birds and animals have been reported to be restored to normal pattern due to depletion in man-animal conflict. Apart from the positive, negative impacts on the nature are also being experienced. Our review work is highlighting such impacts witnessed during the first wave of COVID-19, like, the significant improvement in air and water quality, reduction in environmental noise, therefore an in turn cleaner and quieter habitat for the wildlife to mate and also to quench their curiosities by their surprising excursions; but there are also some negative aspects as well, like reduction in recycling and the increase in waste, increased poaching and even lone shuttering of zoo animals.

Introduction

The pandemic induced lockdown, apart from wreaking havoc on human lives, has surely helped us to find a window to a brief time period with clear blue skies and chirping of the birds. The COVID-19 pandemic has brought about a significant upheaval around the world; wrecked economies, human misery, and altered attitudes have caused us to "rethink and re-act." Always in the race of development, there was no time to think what we are doing to our nature and environment but onset of coronavirus had put the world on a pause. There are lot of environmental issues which need to be addressed today and COVID-19 pandemic has set the stage for resolving these issues and coming out with the solutions for betterment of human beings. It has put a question mark on human activities that provokes environmental damage. In amidst of pandemic, most of the human activities were restricted to break the chain of infection and for this it was necessary to be indoors. Soon we noticed the remarkable change in nature be it the quality of air, water quality or biodiversity. Clear skies, fresh air and reduced pollution have made it clear that it's only human intervention that has created the mess

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in environment and overburdened our natural resources. Using less fuel, less industrial activities and less consumption had definitely relaxed the burden on our nature and natural resources and raised a quest for their rational use (Zambrano *et al.,* 2020). Lockdown had not only reduced the vulnerability to COVID-19 but also reduced the exposure time to air pollutants thereby preventing the loss of human lives. Reports showed the reduction in particulate matter ($PM_{2.5}$ and $PM_{10,}$), greenhouse gases emissions, Air quality index (AQI), NO_X and SO_X which has clearly indicated that nature has got it's time to "revive" (Muhammad *et al.,*2020). Despite conducting water-cleansing projects and spending a lot of money, the situations of the water bodies were far better during the first lockdown. Such an improvement in the environment will surely gifted a breath of fresh air to the wildlife, giving them their long lost freedom to breed and breathe in open and clean spaces, which were free from human interventions. Not only the streets were rendered empty, the national parks, zoos were also free from the human eye, which further helped in breeding at a much better and successful rate (Bar, 2021).Though, apart from such positives, some species also had to bear the wrath of humans in the form of illegal hunting due to the less availability of food resources due to the economic crunch and also the restrictions. Definitely there will be a thrust upon "Environmental and Wildlife" issues before and after this outbreak. Apart from the positive, negative impacts on nature are also being experienced.

Positive impact on environment and wildlife- impact on air quality

Air quality index (AQI)- A considerable fall of AQI to 30% was witnessed in almost all the parts of India. Following the closure, the air quality index (AQI) in all Indian states was currently in the two figures (indicating relatively acceptable air quality) (Lokhandwala and Gautam, 2020).The highest drop in AQI was seen in Delhi, where it was 49 percent. Across many areas the air quality index was found to be 20 as compared to 200 and even more in previous years. The air quality index (AQI) in India's North, South, East, Central, and Western regions fell by 44%, 33%, 29%, 15% and 32% , respectively. (Sharma *et al.,* 2020). A remarkable change was seen all over the world with respect to various air pollutants and air quality. Skies were comparatively clear and blue. NASA (National Aeronautics and Space Administration) and ESA (European Space Agency) collected data through Ozone Monitoring Instrument (on AURA satellite) and Tropospheric Monitoring Instrument (on Sentinel-5P satellite) respectively and reported 30% decrease in NO_2 levels showing an improvement in the air quality (ESA, 2020a). Countries such as China, Italy, United Kingdoms, and Germany had experienced about >40% decrease in CO_2 and NO_2 concentration. Particulate matter 2.5 and 10 as well as Nitrogen dioxide and carbon monoxide concentration in India were found to be decreased as 43%, 31%, 18% and 10% respectively during the time of lockdown in comparison to last year's (Kanniah *et al.,* 2020).

Nitrogen dioxide

In urban areas NO_x concentrations are high due to vehicular exhaust, power plants and industries. During the first wave of the pandemic, concentrations of NO_2 were decreased due to restricted human activities in densely populated areas. Remarkable drop of NO_2 concentration was observed in many countries of Europe such as Rome, Madrid and Paris when lockdown was imposed. It has been reported that overall air quality was better resulting in positive health benefits as seen in China. In China, NO_2 levels dropped approximately by 12.9 $\mu g/m^3$ as people were staying indoors (Chen *et al.,* 2020). Similar trends were noticed all over the globe. A decline of 56.2% in NO_2 levels was reported by NCAP (National Clean Air Program) as compared to previous year in India.

Sulphur dioxide

Sulphur dioxide emissions also declined in the period of lockdown according to CPCB (Central Pollution Control Board) who had done analysis of 115 Indian cities. Only 19 percent reduction in SO_2 levels was recorded in Delhi as 70 percent of SO_2 in Delhi comes from power plants in its vicinity. Also some industries were operating at that time in addition to biomass burning. Due to reduction in human activities, an overall decrement of 40% was recorded by Sentinel-5P satellite (ESA, 2020b).

Particulate matter 2.5 and 10

Reduction in particulate matter (PM2.5 and PM10) was also observed worldwide. Particulate matter

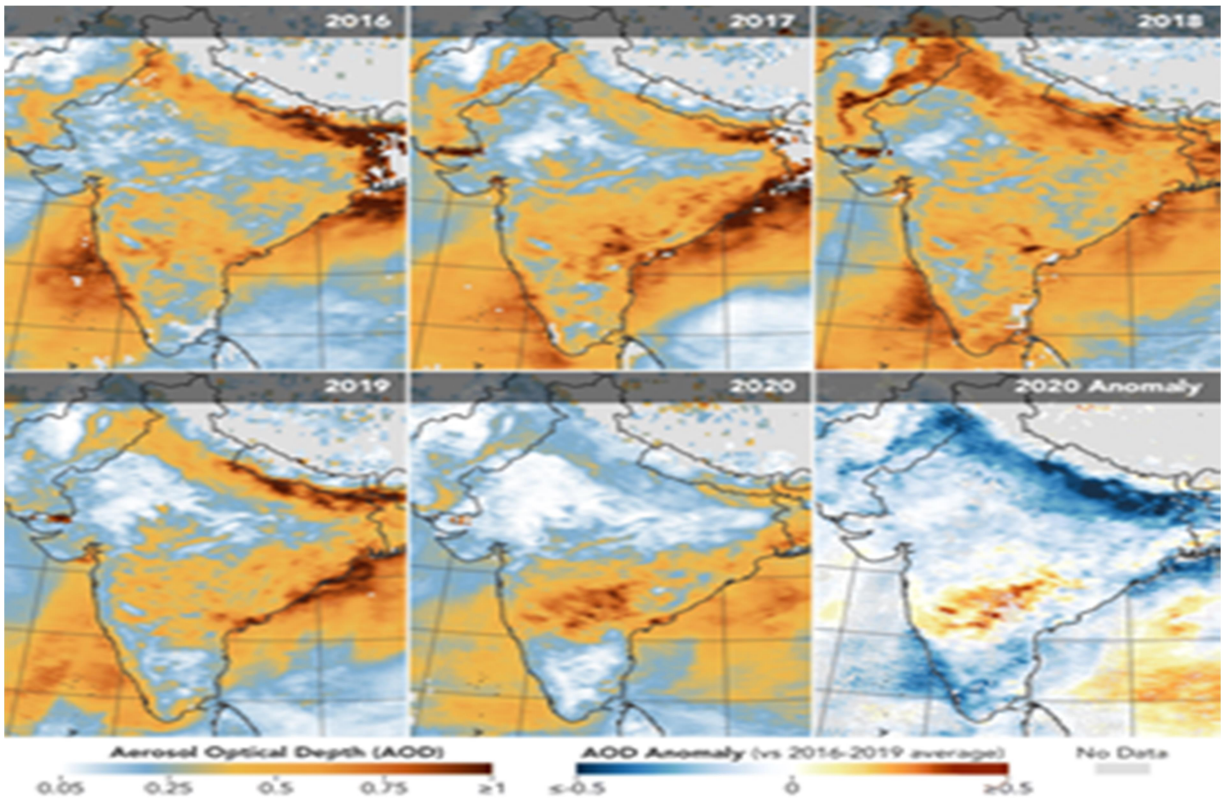

Figure 1: Aerosol optical thickness concentration sequence (month—Terra/Modis), India observed from 31st March to 5th April from 2016 to 2020. (NASA 2020)

2.5 dropped by 1.4 μg/m^3 in Wuhan, declined by 18.9 μg/m^3 across three sixty seven cities (Chen *et al.,* 2020). Similar trends were observed in many countries. In India, the maximum reduction was reported for PM2.5 and a decrease of 34% was reported during the lockdown (Sharma *et al.,* 2020). According to the database of NCAP, in comparison to 2019 a decrease of 35.7% for PM10 and 33.55% for PM2.5 was estimated in 10 Indian cities.

Carbon monoxide and aerosol optical depth

Carbon monoxide also reduced during the months of April and May 2020 in India but it was less than 0.03 mol m^{-2}. Due to vehicular activity restriction, a 30.35% drop was seen in carbon monoxide levels in Delhi (Mahato *et al.,*2020). Aerosol Optical Depth was observed to decrease during the months of March. AOD levels were above 0.75 in many regions of India as the first lockdown preceded it fell down to 0.3 on March 25, 2020 and then 0.2 around April 1st followed by 0.1 on 5th April, 2020. The reduction in AOD concentration was reflected in NASA Earth Observatory imagery of Aerosol optical density observations across India (Gautam, 2020).

Reduced GHG (Green House Gas) emissions

Greenhouse gas emissions reduced during the COVID-19 pandemic as social distancing was promoted and human activities were almost stopped. This was never observed since World War II as suggested by the climate experts (Global Carbon Project, 2020). Countries like the UK, United States of America and China were reported to show a decrease of 30.7%, 31.6% and 23.9% respectively in overall carbon emissions. According to a study, lockdown has resulted in 17% reduction in carbon emissions (Le Quéré *et al.,* 2020). India has also shown a dropdown of carbon emissions by 26%.

Impact on water quality

Due to less human intervention and restricted activities because of the COVID-19 outbreak, a clear effect can be seen on the water bodies. Be it oceans, seas, rivers, lakes, groundwater reservoirs or beaches everything looks cleaner. Due to

restriction in lockdown many anthropogenic activities had stopped and therefore the level of water pollution shrank down. Similar patterns were noticed across the World, such as the Grand Canal in Italy, which went clear when the COVID-19 debilitated the entire country, and numerous aquatic species emerged. Ganga and Yamuna, have shown significant decrease in the levels of contamination. As stated by the CPCB's statistics, in Ganga average water quality was recorded to be 27 points during the lockdown period. In Chennai, Perumbakkam lake was seen to be revived. Tourism, fairs, swimming, and textile washing near the ghats were all prohibited. The biochemical oxygen demand (BOD) and coliform levels in the rivers have been reduced. According to reports, the DO levels in the Ganga have risen above 8 ppm, while BOD levels have fallen below 3 ppm in Kanpur and Varanasi (Lokhandwala&Gautam, 2020), which in 2019 were about 6.5 ppm and 4 ppm, respectively. On April 4, 2019, a significant change of 79% in dissolved oxygen was noted in Nagwa Nala of Varanasi. It escalated from 3.8 milligrams/litre to 6.8 milligram/litre (Chakraborty *et al.,* 2021). A notable change can also be observed in the beaches of the world due to the lack of tourists. Beaches in Acapulco, Mexico, Barcelona, Spain, and Salinas, Ecuador, for example, now appear cleaner and have crystal blue water.

Noise pollution reduction

Noise pollution has decreased significantly in most places across the world as the usage of public and private transportation, commercial and industrial activity has plummeted. Delhi's noise pollution was considerably reduced due to empty roads, no honking, closed industries, no commercial events (Times of India, 2020a). Normally the decibel noise level in residential areas is about 55dB in day time and 45 dB at night. During lockdown, these noise levels were expected to reduce to about 30 dB and 40 dB respectively (CPCB).

Impacts on aves

The significant decrease in human activity, implying to decreased air and noise pollution, gave birds the freedom of vocalization, thus helping them out in clearer mating calls and in turn their overall population (Bhat *et al.,*2020). For example, an increase in population of Ruffle feather headed Dalmatian in Divjaka National Park was observed during the first wave induced lockdown. The huge contributors of such positive gifts were overall less human disturbance and less pollution, under such conditions, the birds preferred to expand their flying ranges or to stay within their historical geographical boundaries. As it is clearly known that, changing environmental conditions synchronise and modify bird circannual cycles in a complicated way (Gwinner, 1996). Therefore, birds were found migrating due to extremely less busy migratory ways in larger numbers, for example, pink flamingos were spotted in Navi Mumbai and in Albania due to such surprising migrations.

Impact on fishes

The emergence of the first COVID-19 lockdown resulted in overall less waterways transportation and a steep decrease in the pollutants dumped into the water bodies. Because of a break in industrial activities, waterways were rendered clearer and quieter, allowing fishes to communicate with ease. Thus, it also helped in the recovery of the food chain. A remarkable reduction in the levels of macro and meso-plastic pollution was also reported. Therefore, all of these factors resulted in an increase in the spike of fish biomass. 16 spiny seahorses, an endangered species of seahorse native to the United Kingdoms, were found because of the possible repair of seagrass, which gave them a place to hide (BBC, 2020a). Bronze featherback, a threatened species of fish, was also found in River Gomti as a result of the reduction in disturbances. Barely one of these is spotted once in six month.

The slowing of the worldwide commercial fishing activity has more likely supported species' recovery in the Mediterranean, breeding between March and May, 2020 and the Atlantic, breeding between April and June, 2020. In the shark market of Indonesia, due to the imposed lockdown, a decrease of demand by 70% also helped the revival of shark population (Forbes, 2020).

Impact on amphibians

The empty driveways, streets, vegetative areas around the springs/lakes etc. helped the amphibians to find counterparts of their species during the early warm, damp evenings of spring. These creatures could sense the correct circumstances. Therefore, were noticed to excurse out. After returning to the pool, the adults participated in a number of mating activities before laying eggs in the water for hatching. The increased mating and eggs were

found, for example, of American toads; spotted, four-toed and blue-spotted salamanders; spring peepers, and wood frogs, etc. Usually during pre-Covid times, such activity was at times interrupted by human interventions. Frogs have always co-existed with humans, but due to human idleness they were being noticed more. Like, the Indian bullfrog spotted in Narsighpur in Madhya Pradesh, which changes color drastically during mating season in monsoons.

Impact on reptiles-

Replenishing Gharial population in Yamuna

Gharials, an endangered species of reptiles has suffered a 98 percent decline since the 1940s. Destruction of their riverine habitat caused by dams' construction, sand mining, irrigation canals, pollution, agriculture, excessive hunting had resulted in such an exponential decrease in the past. As stated by TOI, in 2011, the gharials ventured in the Yamuna for breeding for the first time. Due to the limited human activity and improvement in Yamuna River's water quality because of the close to null industry and transport interference during the lockdown, baby gharials of the Chambal River returned to the river body after almost a decade. Their number in June-July 2020 was recorded to be around three thousand (Times of India, 2020c).

Increase in egg laying of Turtles

During the pre-Covid time, it can be clearly noticed that humans have wrecked many turtle spawning grounds. Fishing gear, change in climate, pollution, and extreme weather all pose as hazardous to the turtles. But since due to the restricted activity and restrictions due to COVID-19, many residents, visitors, and even wildlife traffickers were deterred from approaching turtle nests and hatchlings. Bumper hatching of rare Olive Ridley turtles was noticed on the beaches of Odisha, Bay of Bengal, and Goa. Generally, only 1 in these 1,000 eggs hatch due to such interferences, but during the lockdown, nearly 20 million and above Olive Ridley hatchlings hatched in Odisha, with half of the 0.4 million nesting making their way to the water. Leatherback sea turtle hatchlings were faring better than they have in years. For example.-Since November 2020, 11 leatherback sea turtle (*Dermochelys coriacea*) nestings were discovered on a Thai beach, the most in the past 20 years (The Hindu, 2020). The 76 Leatherback Sea Turtle nests were found on Juno Beach, Florida, The Guardian (2020). Loggerheads, Greens and Leatherbacks nests were also found in refreshed numbers.

Snakes have always co-existed with humans but due to the induced standstill, they were observed more. Also as snake being alleged as one of the sources of the Coronavirus, it has in some way benefitted the snake population as their consumption, illegal trafficking has stopped in many countries like China etc. There have been few instances of alligators and crocodiles venturing into human settlements or beaches due to less human activity. For example alligators were seen during Spring Break at Barefoot Landing in Myrtle Beach. In India, seven-feet-long crocodile was caught from the Kelanpur village of Vadodara.

Impact on Mammals-

Pangolins Protected

Even after banning hunting and commercial trade of pangolins, their population was seen to be steadily declining as a result of their habitat damage and inadequate penalty for eating them. To correct it, China's top legislature voted to outright prohibit the illicit wildlife hunting trade and to eradicate the harmful practice of consuming wild animals, amid the start of the pandemic in February 2020 (Global times, 2020).

More of Hopping Dolphins

Due to a decrease in waterways activity and less industrial waste dumping, monitored by a system of hydrophones installed on the ocean bed, a freedom to hop around was unlocked by many marine species. Because sound travels significantly longer in the ocean, several dolphin and whale species have evolved extremely sophisticated communication systems, which being free of the industrial noises were noted to be more capable of better communication. The Bosphorus, which runs through Istanbul, Turkey, is one of the busiest international shipping lanes; dolphins were seen swimming and leaping in the seas, now that there was a break in traffic and fishermen were stranded at home due to the lockdown. As stated by the National news of UAE, a pod of 2000 dolphins also surfaced off the shore of Fujairah, UAE, in the Middle East. Ganges Dolphins were back to Ganges shores after a good 30 years. Dolphins were also spotted in the waterways of Mumbai, India. A lot of articles had appeared stating that the water

quality of Kolkata's Hooghly River had improved as a result of the present lockdown scenario opening ways to many home species (Bar, 2021).

Collective freedom

Many mammals around the world got intrigued by the deserted cities therefore were found coming out on roads etc. for example sea cows (Sirenia) were found at The Hat Chao Mai National Park, Thailand; cougars in Santiago; Kashmiri goats in Wales; boars in Catalonia. In India too, many such sightings were observed like Nilgai/antelopes in Noida; elephant in Dehradun; bison in Karnataka; leopard in Patna; small Indian civet in Meppayur; one-horned rhino in Guwahati (BBC, 2020b). It was observed that Malaysia's endangered otter population has been dwindling for many years. During the COVID-19 lockdown, however, otters were seen in the normally busy Putrajaya Lake and many other interior Malaysian lakes.

The greater solitude enjoyed by zoo creatures seemed to have some unanticipated advantages. After 10 years of natural mating efforts, Ying Ying, one of Ocean Park's resident pandas, got pregnant (abc news, 2020). Since, natural mating has a greater likelihood of resulting in pregnancy than artificial insemination; it resulted into a successful impregnation. It occurred when the park had been restricted for tourists since late January, 2020 owing to COVID-19 pandemic. Due to the scare of the virus, tourism in all aspects had stopped, therefore giving a heave of sigh to animals that were physically manipulated and were forced to work despite their injuries, like elephants, etc. in India and Thailand.

Overall positive impact- global wildlife trade being at the centre of the stage

The COVID-19 outbreak was suspected to have started at a Chinese market trading wild creatures, shining a focus on the worldwide wildlife trading. The Wildlife Conservation Society, located in New York, pushed governments to outlaw live animal marketplaces and wildlife trading, as well as to put a halt to illicit wildlife trafficking and poaching. Following the initial breakout in Wuhan, China imposed a ban on the rearing and intake of live animals, which is due to become an official law later. To stop any potential pandemics, nations throughout the world are increasingly calling for the prohibition of "wet markets", which peddle living and dead animals for human use (Roe *et al.,* 2020).

Negative impact on environment and wildlife

An increase in the concentration of ozone at the ground level- a negative impact-

Increase of about 17% ozone (O_3) levels was recorded (Sharma *et al.,* 2020). Ozone was even found in high concentrations in clean areas. When compared to the preceding two years, the influence of COVID-19 on ozone was noticed in European cities such as Nice, Rome, Valencia, and Turin, as well as Wuhan (China). According to the NCAP tracker, an increase of 24.8% in ozone was observed in Mumbai. Other cities like Aurangabad, Nagpur and Pune had high ozone concentration. Reason for the increased ozone concentration as given by the Centre for Science and Environment (CSE) is that high NO_x levels mop the ozone out but the reduced level of nitrogen dioxide was not available to react with ozone and the ozone levels were thus increased. Also high temperatures increased the formation of hydrocarbons from biogenic sources such as trees resulting in high ozone concentration over urban areas. So the improved condition has a disguised effect on air quality and thus human health in the form of increased ozone levels.

Increase in solid waste and reduction in recycling

There is an increase in biodegradable waste, hazardous waste, packaging waste and reduction in other recyclables and inert waste due to the increased use of disinfectants and other sanitary chemicals. To avoid the risk of spreading of the coronavirus, many countries like USA and Italy have even suspended the "recycling" programs and centers that perform such recycling actions. Waste management has also been limited in European countries. Some sectors, on the other hand, have embraced the chance to repeal throwaway bag prohibitions. Single used packaging is widely encouraged due to the risk of Coronavirus. Household organic and inorganic garbage was also found to be expanding as a resultant to the situation created by the virus.

Expansion of biomedical waste

There was a high rise in the "medical waste" due to the outbreak. Hospitals generated tons of medical waste per day which was far more than before. With the discarded Personal protective equipment

(PPE) kits, masks, gloves risk for sanitization workers has also increased. During the pandemic, Wuhan (China) produced around 240 metric tonnes of biomedical waste each day, up from 50 tonnes earlier (Sangkham, 2020). There has been an upsurge in trash from personal protection equipment like masks and gloves in other nations such as the United States (Zambrano *et al.,* 2020). The weight of biomedical waste in Delhi has grown in tandem with the growth of COVID-19 infections. Previously in 2020, around 6 tons of medical waste was incinerated but after the outbreak this number has raised up to 13 tons.

Impact of pandemic on single use plastic

Panic buying, online delivery, increase in medical bags including face shield, vinyl gloves had resulted in increment of single use plastic. Based on the spread of the pandemic, it is expected that plastic waste in the form of plastic medical bottles, trays, gloves, syringe, sterile liquid containers all were found to be increasing (Silva *et al.,* 2021).

Detrimental consequences on wildlife

Clearly as a result of the shattering economic impact on the human population and a decrease in food availability, illegal poaching for food or for selling expensive parts like rhino's ivory (as seen in Africa) etc. were seen in practice. Poaching of endangered animals and wild cats, including jaguars, had been documented throughout Africa down to Colombia, reason being the visitors kept away and many park officers being laid off. An example being-six black rhinos were reported to be slain in March, 2020 in Botswana, and were removed by the government personnel from the Okavango Delta. Bushmeat harvest and illegal wildlife trade were also noted to be increasing alarmingly in Africa (Manenti *et al.,* 2020). Such intrusions and infliction of harm on wildlife can be kept in check using drones with thermal-imaging technology, thus providing a practical solution to the problem. At zoos, the animals faced their own challenges while the world stayed shut. The intelligent and social animals like gorillas, chimpanzees, monkeys, otters, meerkats etc. still showed up close to their grills, amidst the shuttered zoos, in expectation of catching a pair of eyes. Also there had been instances where animals in national parks or zoos of third world countries were facing less care and food due to the diversion of government funds to fight the coronavirus pandemic. The city dwelling animals like monkeys found at temples were found to be starving because of the significantly decreased footfall as their main source of food was that provided by the devotees visiting such sacred places, as seen in Coimbatore, where the residents had to come together to feed them (Times of India, 2020b); but such coming forward of residents or activists cannot be seen in every such instance. Therefore, during the locked up phase, such animals were not able to obtain food and were compelled to change their behaviour (Zellmer *et al.,* 2020). There had been reports of China prescribing use of an injection shot containing bear bile 'Tan Re Quing' to treat COVID-19 (National Geographic, 2020). Such approaches can also harm India's biodiversity of bears in the North-Eastern region.

As a coin has two sides to it, a pause in tourism apart from relieving the giants from the physical manipulations, also led to a massive fall in income for the elephant owners therefore, affecting the animals in terms of food and veterinary care needed (India Today, 2020). Though in India the government through various programs do tend to help elephant caretakers in economic crises to some extent, but that too isn't reported to be going to every single needy caretaker; while many other countries like Thailand don't even have such incentives (Lo *et al.,* 2021).

Conclusion

The noticeable improvements in nature had made us realize and sensitize that our own actions have an impact on the environment. Post pandemic environmental issues are going to come back in a much worse form as everybody will be just focused on building the economy and dealing with Corona virus on the other hand, the glimpse of which we are already seeing now. Thus, COVID-19 pandemic have no effect on the environment permanently. But it made us learn how we can reduce the degradation of the environment by changing social, economic and behavior patterns and help to promote sustainability of environment and wildlife. The huge positives seen during the first wave, in respect to environment and wildlife have got almost obliterated due to the comeback of human interventions, industries, and transports. Overall,

the crisis may have no permanent environmental effects as economic activities has resumed now. What we've learned about the environmental benefits and risks of sharp drops in global economic activity, on the other hand, will help us better understand the mechanics of environmental sustainability, societal consumption patterns, and how we can reduce environmental degradation in a post-crisis world. We as a human race cannot recreate the situation again because of our economy and needs, but also think about the betterment of the environment, for us and especially for the wildlife, as they are the ones facing it head-on while we have sheltered ourselves to face the indirect effects now and also in the future. To conclude, the sign of recovery should not be ignored; our lifestyles, developments and economic concerns have to reflect our concern for nature and least impact on the environment. So the need of the hour is to make balance between nature and human beings for today and tomorrow.

Conflict of interest

The authors declare that they have no conflict of interest.

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