Environmental Impact of Coronavirus disease (COVID-19) Pandemic around the World with a Special Focus on Thailand and India: A rapid review

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Abstract

COVID-19, scientifically called Novel Coronavirus SARS - CoV-2 which was first identified in Wuhan, Hubei Province, China, has infected above 118,000 persons in more than 114 countries worldwide on 11 March 2020, and so the World Health Organization announced coronavirus disease (COVID-19) as a pandemic. The study aims to review the positive as well as negative environmental impact of the COVID-19 pandemic around the World, with a special focus on Thailand, and India. The study reviews documents and collects relevant data, related to COVID-19 and the environment in the world, particularly Thailand and India, from the beginning of the outbreak in January 2020 till February 2021 from various kinds of electronic documents available on various publication sites, the daily internet media, social media, news, and opinions, during 2020-2021 by typing keywords as "Environmental impact of COVID-19". It is found that coronavirus disease has impacted the World, Thailand, and India's environment both positively and negatively through several indicators including improvement in air quality, clean beaches, reduction in surface temperature and environmental noise, freedom of movement to wildlife, birds, animals, regeneration of biodiversity, and water bodies. Even though the pandemic has caused many environmental benefits, it caused an alarming situation in the amount of generated disposable packaging, plastic, medical waste, and the management of its disposal. It can be concluded that human behavior and activities, indeed impacted the environment, so the solution to the environmental crisis depends on changing human behavior and activities that cause the deterioration of the environment.

Keywords: COVID-19, Positive environmental impact, Negative environmental impact, SARS-CoV-2, Pandemic

Introduction

Recently, there was an outbreak of a new contagious disease, first detected in December 2019 in Wuhan city of China, and in a few months, it affected more than 200 countries globally (Wu, Chen, & Chan, 2020). The new disease is called COVID-19, caused by the coronavirus scientifically abbreviated as SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2), that also caused large-scale epidemics in the past decades, as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (Gabutti, Anchera, Sandri, Savio, & Stefanati, 2020). The pandemic had caused 104,393,853 confirmed infection cases, with 2,262,795 death cases by February 3, 2021 (Aroonsrimarakot, Laiphrakpam, Chathiphot, Saengsai, & Prasri, 2022). COVID-19 was first detected in late 2019, when an anonymous person from the Huanan seafood market in Wuhan city, Hubei province in China was found to be virus-infected, where it infected many others. On January 20, China then declared the outbreak an emergency. On Feb 11, 2020, WHO called the disease COVID-19, and then on March 11 declared the outbreak a pandemic. On April 20, 2020, Global COVID-19 infected cases crossed 2.48 million confirmed cases, 170,494 death cases, and WHO warned about 'worst days' ahead (World Health Organization, 2020). Laiphrakpam, Aroonsrimorakot, & Paisantanakij (2022)

have presented the socio-economic impact of COVID-19 in a recently published article. In India, the first case was confirmed on January 30, 2020, with a student from Kerala, who had returned home from Wuhan University (Andrews et al., 2020). In Thailand, the first case was detected on January 13, 2020, with a Chinese woman, who came from Wuhan city, China, followed by the 2nd and 3rd cases on January 17 and 22 with 74 and 68 years old Chinese tourists from Wuhan, while the 4th case was the first Thai infected case (Smith, 2021). In the first wave of infections in Thailand, there was a steep rise in total confirmed cases (599) on March 22, with 188 new positive cases related to a boxing stadium and drinking avenue and so an immediate nationwide lockdown was passed. Due to rising active cases in April, a night curfew was imposed from April 3, 2020, until May 16, 2020, and due to these strict measures of lockdown, the figure of COVID-19 new cases gradually declined and was kept under control (Dechsupa, Assawakosri, Phakham, & Honsawek, 2020). To prohibit the spreading of the disease, all countries of the world have suspended all educational, airline, and business activities. So, in India nationwide lockdown was imposed on March 24, following an increase of 103 new cases for 21 days, and consequently, all shops, business centers, factories, workshops, offices, markets and places of worship, interstate buses, metros, construction activity, airlines operations were closed. Lockdown has restricted all industrial production, restriction of movement, travel, or transportation and all these have resulted in lowering of emission of pollutants of all kinds.

Method and objectives

The study has been carried out at Mahidol University, Thailand by state-of-the-art rapid literature review from the beginning of the outbreak in January 2020 till February 2021. The authors searched various scholarly publication sites, and day-to-day news, available on the internet, TV, news, and social media related to the environmental impact of the COVID-19 pandemic, both positive and negative in the world, with a special focus on Thailand and India. These two countries are focused on because one of the co-authors has originated from India while the other is from Thailand. The study is presented by organizing into parts such as Introduction, Environmental impact of COVID-19, and Conclusion. It is presented with the following objectives:

1. What are the positive impacts of COVID-19 on the environment of the World, Thailand, and India?
2. What are the negative impacts of COVID-19 on the environment of the World, Thailand, and India?

Positive environmental impact of COVID-19

Improvement of air quality

There is a growing concern about air pollution all over the world, especially in developing countries like Thailand and India. Many studies have reported the global environmental impact of COVID-19 in terms of improvement of air quality due to the reduction of pollution of particulate matter and other gases. Enforcement of lockdown measures, including restricted mobility, travel, and transportation has led to an improvement in air quality during that period. For example, a research study has reported a reduction of 29% NO_2, 11% O_3, and 9% $PM_{2.5}$ from February to March 2020 all around the world (Venter et al., 2020). Similarly, another study at Almaty, Kazakhstan found a reduction of 21% in $PM_{2.5}$, 49% in CO, and 35% in NO_2 along with an increase of 15% in O_3 level effective on March 19, 2020 (Kerimray et al., 2020). The result of Global AQI data from 2019 to 2020 has found significant improvement as NO_2, CO, and Particulate matter: $PM_{2.5}$ decreased while O_3 increased substantially (Wetchayon, 2020). For instance, a high quantity reduction of particulate

matter was observed in Wuhan (63%), Lima (61%), and Berlin (61%), while Ozone levels increased remarkably in affected cities as in Milan of Italy (86%) and Wuhan of China (36%) (Habibi, Awal, Fares, & Ghahremannejad, 2020). Similarly, (Muhammad, Long, & Salman, 2020) studied the pollution and other environmental impacts in some of the most affected countries of the world such as China, Italy, Spain, and the USA, etc. by compiling the environmental data of NASA and ESA. The result found a 30% reduction of CO_2 in China and 50% in the USA. Further assessing air quality data of global COVID-19 hotspot cities, 12 in number, resulting in significant air quality improvement in the concentration of $PM_{2.5}$, PM_{10}, and NO_2 by 20-34%, 24-47%, and 32-64%, respectively, due to restriction on all industrial activities during the time of lockdown across the globe (Kumari & Toshniwal, 2020). However, these improvements were considered for a short time as the environmental condition will be the same as before once the lockdown measure was discontinued in New Normal. In all these studies, the ozone level was found to be remarkably increased due to the reduction of greenhouse gas emissions. In the case of Thailand, there was an improvement in air quality in Bangkok, with a reduction of air pollutants in percentages, namely PM_{10}, $PM_{2.5}$, and NO_2. (2.9, 21.8, and 33.7 respectively) (Stratoulias & Nuthammachot, 2020). This reduction was due to social distancing measures, restriction of large gatherings, and closure of various recreation centers, educational institutes, businesses, and other public places after the Government declared the State of Emergency on March 26, 2020, which decreased the number of road vehicles on the road and industrial operations. During the lockdown period, Bangkok's NO_2 level decreased by 20% and 9.5 % in Thailand as a whole (Oo, Arunrat, Kongsurakan, Sereenonchai, & Wang, 2021). However, the positive environmental impact, resulting in a reduction in PM_{10} or NO_2 is not uniform all over Thailand. For instance, in Chiang Mai, North of Thailand PM_{10} has been increasing due to persistent agricultural waste, and forest burning, along with the continuous operation of industry and other power plants (Arunrat, Pumijumnong, & Sereenonchai, 2018). Environmental air pollution is a serious matter because it shortens the average lifespan of the global population by at least three years. In India too, the presence of particulate matter is the major cause of death of the population in many cities and its major contributors consist of the operation of industrial and residential energy, operation of vehicles for travel, and other forms of transportation. New Delhi has been listed as one of the world's top polluted cities based on the environment performance index and $PM_{2.5}$ concentration is recorded to be very high in Delhi as it has 7.3 million vehicles in 2015, a population of 25.8 million, 7.6 % of India's urban population, with the presence of 84 micrograms per cubic meter and the average lifespan of people in India is reduced by 3.9 years (Kumar et al., 2015). However, lockdown measures initiated in the world to fight the coronavirus have improved the air quality of mega-polluted cities, including New Delhi, the capital city of India. Particulate matter was found to be decreased by 15 percent in New Delhi, 11 percent in Beijing, 13 percent in Chicago, and 16 percent in London. There was a drastic reduction in the concentration of various pollutants $PM_{2.5}$, PM_{10}, and NO_2 at 42.27%, 69.28%, and 74.80% in Delhi, Mumbai, and Kolkata respectively (Chhikara & Kumar, 2020), with a 52% mean reduction of PM nationwide under lockdown enforcement (Sharma, Zhang, Gao, Zhang, & Kota, 2020). The imposition of a total lockdown in India from March 24, 2020, initially for 21 days and then for a prolonged period, with restrictions on all industrial operations, business, movement, transportation, and gatherings of people has resulted in the improvement of air quality in India (Lokhandwala & Gautam, 2020). Sikarwar & Rani (2020) reported a lowering of $PM_{2.5}$, PM_{10}, and NO_2 by 93&, 83%, and 70% in Delhi (India) during Feb-April, 2020. So, there was a maximum reduction of pollutants, $PM_{2.5}$, PM_{10}, CO, and NO_2. by 43%, 31%,

10%, and 18% respectively in most regions of India, along with an increase of O_3 by 17%. Also, AQI has improved remarkably in North, South, East, Central, and Western India by 44%, 33%, 29%, 15%, and 32% respectively during the lockdown period (Sharma, Zhang, Gao, Zhang, & Kota, 2020). Particulate matter and NO_2, which are the cause of pollution were found to be reduced remarkably after the enforcement of the national lockdown, due to the sudden closure of thermal power stations, production industries, and modes of transportation. This implies that environmental deterioration can be recovered quickly, provided human interruptions are suspended.

Changes in the composition and quantity of littered waste, freedom and regeneration of biodiversity, environmental noise level, land surface temperature, cleaner beaches, and water bodies

When governments implemented lockdown policies to flatten the curve of infection, there was a drastic change in the quantity and composition of municipal solid waste, a reduction of littered waste in the urban recreational public areas (Yousefi, Oskoei, Jafari, & Torkashvand, 2021), changes in biodiversity, and cleaner water bodies (Somani, Srivastava, Gummadivalli, & Sharma, 2020). Biodiversity is human's coexistence with plants and animal species in their natural habitat. Human activities and other encroachment in the name of development often disturb this biodiversity and ecological balance. However, during the period of lockdown and quarantine, birds started to fly in the sky while animals such as monkeys roamed around in the human habitat, which signals the recovery of ecological balance. Within a few weeks of the world lockdown, its benefits can be felt in the marine eco-systems with higher water quality in the ocean, canals, and lakes as reported in the news and other media. For instance, it has been reported that water canals in Italy and India became cleaner and more transparent than in previous years (Somani, Srivastava, Gummadivalli, & Sharma, 2020). Similarly, there was a reduction of pollution in beaches and other tourist places drastically (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020), as there was the closure of all tourist sites, recreational centers and parks, marine attractions, and beaches and this has led to a significant decrease in the amount of litter on the beaches. Another study reported a reduction of land surface temperature (LST) in India by 3-5°C, improvement of waterbodies and river surface water quality, and noise reduction from 85 dBA to < 65 dBA (Mandal & Pal, 2020). Similarly, Thailand reported a reduction in municipal waste in urban tourism areas such as Phuket (13%), and Pattaya (55%) (Liu, Bunditsakulchai, & Zhuo 2021). Also, marine resources, have time to recover and regenerate during the closure of all human activities between April and May 2020 with cleaner beaches, oceans, and the re-emergence of rarer aquatic animals in tourist hot spot areas of Thailand (Israngkura, Yasen, & Kovavisarach, 2020). Suspension of all modes of transportation and industrial operations during the pandemic also led to the reduction of surface environmental noise (Lecocq et al., 2020). It has been observed that urban noise level dropped more than 4dB (A) in Sweden on a daily average in April 2020(Rumpler, Venkataraman, & Goransson, 2020), while London observed an average reduction of 5.4 dB (Aletta, Oberman, Mitchell, Tong, Kang, 2020). Also reported sightings of wildlife moving freely in the open space and park could be related to a change in the distribution and behaviour of animals due to reduced human activity, providing the availability of a larger habitat to the animals (Rutz et al., 2020).

Negative environmental impact of COVID-19

Increase generation of medical waste

One of the environmental impacts of the pandemic is a massive increase in the quantity of medical waste such as plastic protective equipment (PPE), gloves, masks, respirators, syringes, etc. which are highly in demand to protect the health of service workers, the general public, and patients. In this regard, it can be mentioned that the massive global demand for basic protective and safety equipment, such as masks and gloves was approximately 129 billion and 65 billion respectively per month (Kalina & Tilley, 2020). This massive generation of medical waste was due to changes in people's lifestyles and the estimated waste quantity throughout the world increased from 200 tonnes per day on February 22 to more than 29,000 tonnes per day at the end of September 2020 (Liang, Song, Wu, Li, Zhong, & Zeng, 2021). In China, the epicenter of COVID-19, during the peak infection time in February 2020, the quantity of face masks' production reached 116 million that is, twelve times more than the month before (Wang et al., 2020). The World Health Organization (WHO) classified medical waste as waste released for testing or treatment of mankind, or non-mankind (Klemes, Van Fan, Tan, & Jiang, 2020). For a long time, worldwide waste management systems faced difficulties to cope with the enormous volume of waste, particularly plastic in the environment and the massive surge in volume due to COVID-19 has heightened in managing normal household solid waste as well medical waste. It is important to separate medical waste from other municipal waste, as handling or disposal of medical waste needs precaution, as it is highly contagious and thus risky for healthcare personnel and then for the environment. In March 2020, the volume of medical waste generated in China increased sharply, about 370 % in Hubei, the affected hotspot province, due to a sudden increase in demand for safety measures and protective equipment that can be disposed of immediately after a single-use (Ma et al., 2020). This has resulted in a sharp increase of medical waste in Wuhan, the epicenter of the pandemic from 40tonnes per day during normal times to 240 tonnes per day during the pandemic and so China has constructed emergency waste plants, having facilities of 46 mobile waste treatment (Das, Sharma, Saha, & Satapathy, 2021). Approximately 1.5-2 million facial masks were disposed of daily in the garbage of urban areas such as Bangkok and the daily increased rate was 1.7 tons/day (Somani et al., 2020). In the Indian city of Ahmedabad, medical waste was 1000 kg/day, while in Gurugram was increased 40 times (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020).

Sudden surge of plastic waste, disposable packaging waste, and food waste

Even though the pandemic has had many positive impacts on the environment, it also resulted in numerous negative impacts environmentally, and among the top negative impacts, included the massive volume generation of plastic waste (Klemes, Van Fan, Tan, & Jiang, 2020). Social distancing practices during the pandemic caused changes in people's lifestyles, where people prefer to remain at home, increasing online shopping and widespread use of home delivery services to get daily necessities and ready-to-eat meals. Subsequently, this has led to an increase in Municipality solid waste (MSW), consisting of packaging paper, food waste, and plastic waste. About 1.6 million tonnes of plastic waste were generated per day globally (Benson, Bassey, & Palanisami, 2021). These wastes were generated from homes, hospitals, medical facilities, and plastic-made personal protective equipment of frontline health workers as well as online food dealer and consumer, consisting of medical kits, hand gloves, face shields, surgical masks, bottles for hand sanitizers, and drinking water, online food packaging items (Haque, Uddin, Sayem, & Mohib, 2020). Massive generation of plastic waste was due to the

different ways of virus protection adopted by different countries. For instance, there is a safety concern and fear of infection in using reusable plastic products. So, most consumers prefer single-use plastic as it is considered to be safe for various purposes in terms of its disposal ability to protect from virus retention since it has been reported that coronavirus can survive on different surfaces including plastics for up to 9 days (Kampf, Todt, Pfaender, & Steinmann, 2020). Also during the lockdown, all businesses, food stalls, and restaurants were closed and this has led to the increasing demand for online food and drinks delivery services, and take away food which further resulted in to increase in the release of food waste and plastic waste that was used for food packaging, increased about 43% and 53% respectively (Leal Filho et al., 2021). So this increase in waste resulted mainly due to the measures taken to prevent and control the spread of COVID-19, affecting the food supply, ways of eating and buying food, and the type of food consumption practices of millions of people worldwide. For instance, at the beginning of the pandemic, panic buyers around the world stored large amounts of household food, especially canned goods, frozen and dry food which can be kept for a long time on the shelf or refrigerator, due to the fear that there may be a shortage of food. This happened throughout different countries of the world. For example, packed food sales in Italy heightened in mid of March 2020, an increase of 33.8% as compared to the previous year. Similarly, in the USA packed food sales have increased from 10% to 77% within the first two weeks in March 2020 (Leal Filho et al., 2021). Also, home delivery and takeaway sales have increased since the outbreak of the pandemic around the world, which has led to a rise in disposable waste, plastic packaging, and food waste (Rhee, 2020). On the other hand, some countries preferred home-cooked food to avoid virus transmission and this has led to a rise in household waste generation. For instance, in Bangkok, Thailand, after the enforcement of social distancing measures, there was a sudden surge of single-use plastic(SUP) packaging, bags, containers, water bottles, etc. used in online food delivery services due to the rise of public demand (Praveena & Aris, 2021). Also reported a 100% expansion of food delivery services in Bangkok which consequently resulted in more plastic usage for its packaging (Liu, Bunditsakulchai, & Zhuo, 2021). According to Thailand Environment Institute(TEI), there was an increase in plastic waste (62%) from 2120 tonnes /day in 2019 to about 3440tonnes/day in April 2020 (Jirawattanasomkul et al., 2021), which has been the result due to the sudden increase of single-use plastic usage. Even though single-use plastic (SUP) products are considered beneficial due to concerns of safety and health consideration, they resulted in a generation of massive plastic waste, which further increased the challenges in waste management, especially in developing countries with inadequate waste management facilities and technology. For such developing low-income countries, including Thailand and India, as they are not well equipped with innovative and sophisticated machinery for waste treatment and management, they commonly dump and burn the waste in open spaces and this causes more problems to the environment (Haque, Uddin, Sayem, & Mohib, 2020). Even before the pandemic, even though plastic can be used for various purposes, its waste takes a long time to degrade and the burning of plastic releases chemicals such as phosgene and dioxide, that are hazardous to the ecosystem. So, efficiency in plastic waste management is important to solve the environmental crisis (Rajmohan, Ramya, Viswanathan, & Varjani, 2019). Even though plastic wastes cause lots of hazards to the environment, it is a boon in times of the pandemic due to its immense contributions to ward off infection and the spread of COVID-19. So, mankind needs to manage plastic usage efficiently. Mankind needs to adopt the reduction, recycling, and recovery (3Rs) strategies, to turn plastic into a protector for human beings. This can be enhanced through

consumer education for awareness of our environment along with waste management innovation to help in creating a sustainable environment.

Problem of safety concern in waste management

Even though COVID-19 has positive environmental impacts in terms of improvement of air quality, biodiversity, and reduction of noise in the environment, there are alarming negative impacts on waste management due to an unusual amount of waste generated, comprising municipal and hospital wastes (Ma et al., 2020). Social distancing measures during the pandemic increased the number of panic buyers, who stored basic protective sanitizers, food, groceries, tissue papers, masks, and cleaning products and thus increased the disposal of garbage with tonnes of daily waste (Sarkodie & Owusu, 2020). A comparative study of the amount of waste produced before and after the pandemic found municipal solid waste to be increased during the pandemic due to changes in people's consumption behaviour and this put more additional work on waste management systems (Leal Filho et al., 2021). Even before the COVID-19 pandemic, there was a problem with global waste management. The outbreak of the pandemic amplifies the problem of managing an unusual volume of waste, with the available facilities in low-income countries without efficient waste management technologies like Thailand and India, with a concern for safety, air pollution, viral transmission, and other health risks. If hazardous wastes are not well-managed, they may increase the spreading of infection from human to human. In addition, inadequate waste management like not properly closing bags, and throwing and burning them in an open space can worsen the air quality in the environment as well as cause fatal health outcomes to human beings due to exposure to harmful elements. Medical waste generated in Thailand caused a challenging situation in solid waste management if such wastes were disposed of in the public waste bin improperly without separation from other wastes or proper sealing (Kamvanin & Noosorn, 2020). In India, about 4 million workers responsible for waste collection, sorting, and recycling working faced a high-risk infection of the disease, as they were not properly provided with protective equipment to safeguard them from health risks. So, these sanitation workers, especially from developing countries, if not properly protected with equipment were at risk and many of them suffered from stress and anxiety. If the garbage is properly bagged and workers wear protective equipment there is less chance of getting infected. Therefore, sanitation workers, in particular, should wear appropriate protection, including boots, aprons, masks, thick gloves, and face shields, as improper management of medical waste is hazardous to them (Mihai, 2020). Changes in the composition of waste, comprising of medical, plastic, and food waste, generated during COVID-19 caused new challenges in waste management. Also, the disposal of medical waste requires an efficient waste management system for sorting, storage, and transport to meet emergency demand and at the same time maximize the available infrastructure (Sharma et al., 2020).

Conclusion and Suggestions

This study provides a rapid review of the environmental impact of COVID-19 in the world, particularly in Thailand and India. The study highlights both the positive and negative impact of the COVID-19 pandemic on the environment. The positive environmental impact obtained from the review includes a reduction in various types of particulate matter and emissions that cause air pollution, litter, and waste at tourist sites, in rivers, at sea beaches, and in marine parks. The improvement in the ozone layer, noise, and land surface temperature, cleaner air and water body, regeneration, and revival of biodiversity and wildlife are positive outcomes arising

from COVID-19 lockdown and social distancing measures. On the contrary, the negative impact includes an increased massive generation of medical waste, an increase in municipal solid waste (MSW), a sudden surge of disposable packaging and plastic waste, and safety concerns in waste management. However, it has to be noted that the positive impact of the pandemic on the global environment is only for a temporary period because the environmental quality will be back to before once the global population is opened to the new normal. It can be concluded that humans can mitigate the climate change crisis if humans cease disturbing the natural process of mother nature, that is, by suspending all agents that are the cause of pollution and environmental degradation while giving freedom to natural bodies for revival and regeneration. So, from this temporary improvement in air quality, ecology, water, and other natural bodies during COVID-19 global lockdown and quarantine impact, individuals and government policymakers can comprehend the impact of human activities on the environment which can change individual behaviour and support sustainable policies for long term implementation for the mitigation of environmental change. This suggests that in the "new normal" a key determinant in ensuring development with environmental sustainability is through controlled human lifestyle and activities that is, sustainable development of marine, and coastal resources, including fisheries, aquaculture, fuel, renewable energy, minerals, tourism, and recreation without environmental degradation. From this lesson regarding the COVID-19 environmental impact, while the reduction of greenhouse gas concentrations was achieved on a short-term basis, this is not the solution for environmental improvement but it is indicative of a road map of a sustainable environment that depends on changing human behaviour and activities that cause deterioration of the environment on a long-term basis. Finally, the result obtained from the study will enable us to rethink our responsibility for this environmental crisis.

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