



# Impact of COVID-19 Pandemic Outbreak: CO<sub>2</sub> and SO<sub>2</sub> Emission Reduction over China\*

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## Abstract

The COVID-19 pandemic has disorganized humans economically, physically, socially and psychologically. More than 353,334 people died in China and about 5,593,631 cases are confirmed so far (with thousands of new cases per day) all over the world and others are still quarantined or confined. Beyond such odd impact with the geometrical death rate, this paper gives a different consideration of the pandemic effects, such as the environment preservation during the height of the pandemic which is a positive impact. In fact, because of the lockdown all over the world, commercial airlines have stopped operating for at least 3 months. This represents about 257.5 MMT of CO<sub>2</sub> emission that has been so far avoided. On the other hand, the consumption of fossil-fuel or other fossil energy sources has been reduced. This paper shows that in 63 days of lockdown, 3458.175 tons of SO<sub>2</sub> and 1745.33 MT of CO<sub>2</sub> were not emitted into the atmosphere because of the drop in coal consumption only in China.

## Subject Areas

Environmental Sciences

## Keywords

COVID-19, Fossil-Fuel, Coal, CO<sub>2</sub> and SO<sub>2</sub> Emission

## 1. Introduction

Since December 2019, the Chinese city of Wuhan reported an outbreak of typical pneumonia caused by the 2019 novel coronavirus (2019-nCoV). It is a SARS-CoV-2, the virus that causes COVID-19. Cases were exported to other

\*Special description of the title: Not only COVID-9 caused serious negative impacts, but also the lockdown to contain it reduced energy consumption (fossil fuel and coal) and therefore, greenhouse gas emission was reduced as well, which is a positive impact.

Chinese cities, as well as outside China, thus triggering a global outbreak. On January 30, 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 as a Public Health Emergency of International Concern (PHEIC). On March 11, 2020, WHO characterized the outbreak of COVID-19 as a pandemic [1].

With continuously rising numbers of confirmed cases in many countries over the globe, the 2019 novel coronavirus (2019-nCoV) was pronounced as a pandemic. This paper is not focusing on the evolution stages of COVID-19 but its positive impact. Nevertheless, when talking about the impacts of the pandemic, the recent statistics about the confirmed cases and the deaths are depicted in this study. The table below shows the global situation by May 28, 2020. The main objective of this paper is to show the positive impact of the pandemic, especially during the lockdown period. The perception of this positive impact may not be obvious; however, the environment got a little bit to breathe. The rhythm of emission of greenhouse gases (GHG) due to the transport and fossil-fuel or other fossil energy consumption has been reduced.

## 2. Context of the Study

### 2.1. Global Situation of COVID-19

New cases of COVID-19 were rising exponentially from Wuhan in China which was considered as the epicentre. The trend of daily new infected cases ranged from 14,177 cases on February 12<sup>th</sup> to 117,309 new cases on May 30<sup>th</sup> 2020 [2]. **Table 1** shows the global situation of new infected and deaths by May 28<sup>th</sup>, 2020 according to WHO (2020). Globally, 5,593,631 cases are confirmed within 104,505 new cases on May 28<sup>th</sup>, 2020. The total deaths attain 353,334; within 4221 deaths on May 28<sup>th</sup>, 2020. The World Health Organization published a map (**Figure 1**) that shows the global distribution of reported cases of coronavirus 19 infected by May 28<sup>th</sup> 2020 [3].

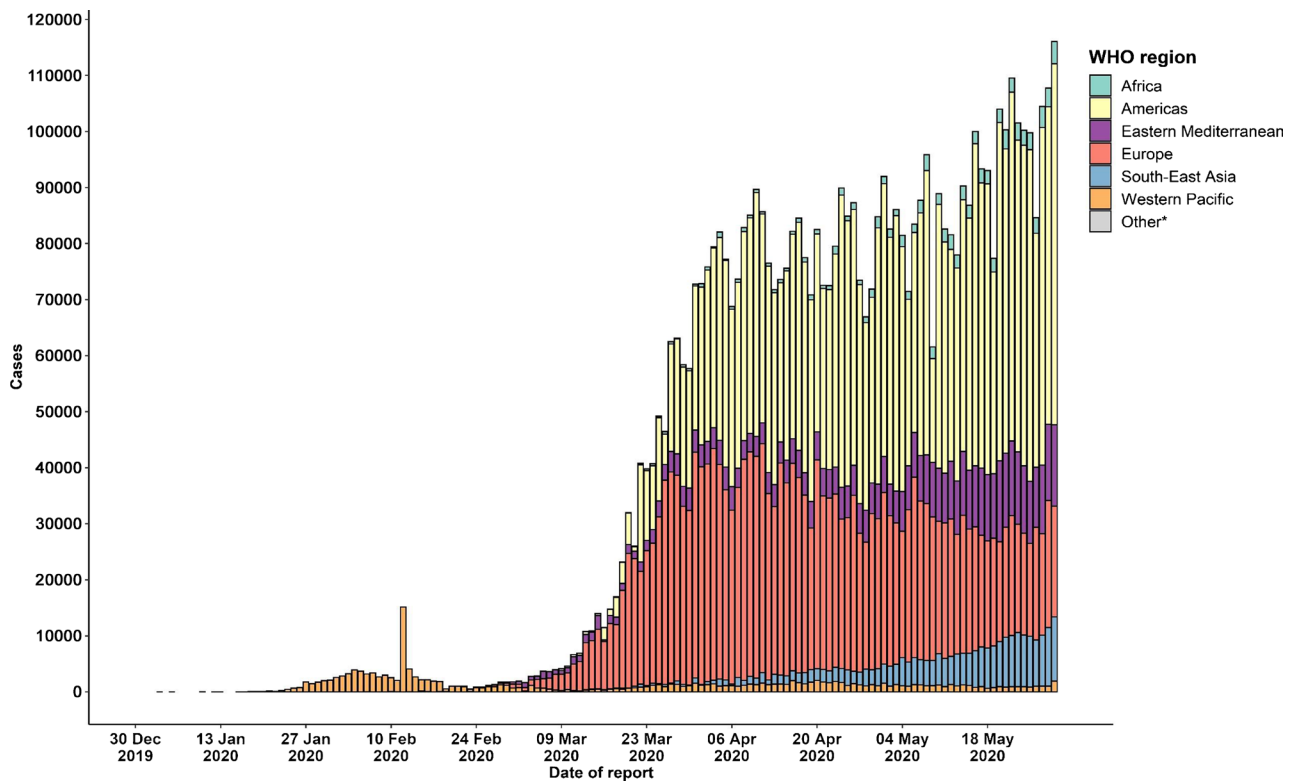
### 2.2. Global Flights

Commercial airlines are among the most CO<sub>2</sub> emission actors in the transportation sector. An average of 102,465 flights can be observed per day [4]. The airline

**Table 1.** Global infected and deaths cases of COVID-19\*.

Globally	Total cases 5,593,631	Total daily cases: 104,505	Total deaths: 353,334	Total daily deaths: 4221
Africa	89,592	3777	2370	62
Americas	2,556,479	60,254	148,412	2584
Eastern Mediterranean	461,824	12,234	11,621	169
Europe	2,079,924	18,096	177,331	1105
South-East Asia	227,611	9088	6630	271
Western Pacific	177,460	1056	6957	30

\*WHO, May 28<sup>th</sup>, 2020 [3].



**Figure 1.** Number of confirmed COVID-19 cases, by date of report and WHO region, 30 December 2019 through 30 May 2020.

industry spends 210 billion USD on 273 billion litres of fuel every year and is responsible for 2% of the world's emitted carbon dioxide [5]. According to [6], the Worldwide CO<sub>2</sub> emissions from commercial flights are rising to 70% faster than predicted by the UN's International Civil Aviation Organization. International Civil Aviation Organization (ICAO) made a study on 39 million flights from 2013 to 2018 and concluded that the total CO<sub>2</sub> emissions from all commercial operations, including passenger movement, belly freight, and dedicated freight, totaled 918 million metric tons (MMT) [7]. That is 2.4% of global CO<sub>2</sub> emissions from fossil fuel use. The consumption of fuel by commercial airlines is increasing every year. The increase of emission from 2013 up to 2018 was 33.5%. The study made by the International Aviation Transport Association (IATA) shows an increase of 5.2% from 2017 to 2018, respectively represented by 860 MMT and 905 MMT of CO<sub>2</sub> from global aviation [8].

According to the statistics published by the International Council on Clean Transport (ICCT) also shown in **Table 2**, the flights departing airports in the United States and its territories emitted about one-quarter (24%) of global passenger transport-related CO<sub>2</sub>, 2/3 of which came from domestic flights [9]. Flights from European Union follow those of US departing airports with 19% of global total CO<sub>2</sub> emission through total passenger operation. The top five countries for passenger aviation-related carbon emissions were rounded out by the USA, China, the United Kingdom, Japan, and Germany. 43% of CO<sub>2</sub> from commercial aviation was linked to passenger movement in narrow-body aircraft,

**Table 2.** Country-specific operations and CO<sub>2</sub> emissions data for commercial passenger transport by ICCT [9].

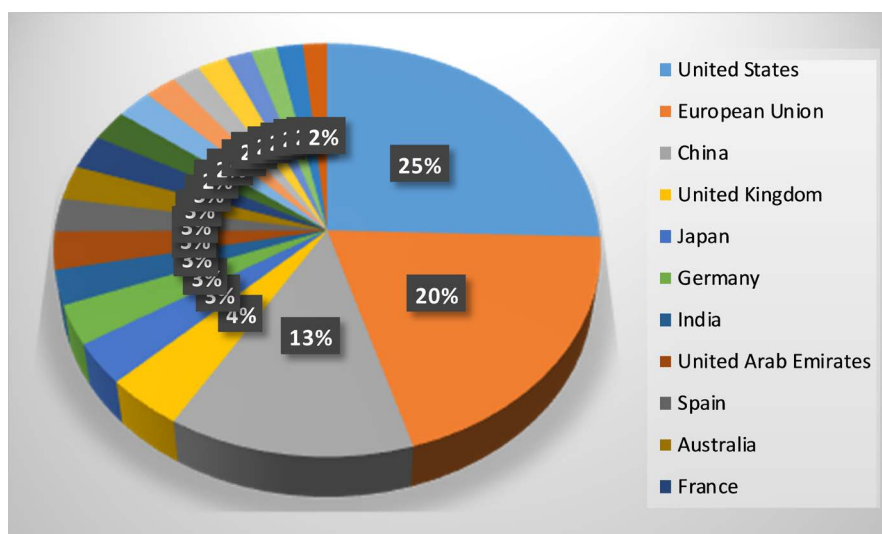
No.	Departure Country	TOTAL PASSENGER OPERATIONS	
		CO <sub>2</sub> [MMT]	% Global Total
1	United States <sup>a</sup>	181.91	24.36%
2	European Union <sup>b</sup>	141.74	18.98%
3	China <sup>c</sup>	94.91	12.71%
4	United Kingdom	29.85	4.00%
5	Japan	23.42	3.14%
6	Germany	22.17	2.97%
7	India	19.38	2.59%
8	United Arab Emirates	21.14	2.83%
9	Spain	18.52	2.48%
10	Australia	19.00	2.54%
11	France	19.15	2.56%
12	Canada	17.16	2.30%
13	Russian Federation	16.28	2.18%
14	Brazil	14.81	1.98%
15	Thailand	13.07	1.75%
16	Indonesia	13.89	1.86%
17	Turkey	11.93	1.60%
18	Italy	11.89	1.59%
19	Republic of Korea	12.17	1.63%
20	Mexico	11.18	1.50%

<sup>a</sup>United States includes American Samoa, Guam, Johnston Island, Kingman's Reef, Midway, Palmyra, Puerto Rico, Saipan (Mariana Islands), U.S. Virgin Islands, and Wake Island; <sup>b</sup>European Union includes Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and applicable territories; <sup>c</sup>Emissions and activity from flights between China Mainland, Hong Kong, and Macau are included in the domestic totals.

followed by wide-body jets with 33% CO<sub>2</sub> emission, and regional aircraft 5% with CO<sub>2</sub> emission [9]. Also, the USA emits 22.7% of all passenger emissions, followed by China (10.4%), according to ICCT and emissions from India are growing fast, making up 3.5% of aviation passenger emissions [9]. As shown in **Figure 2**, the top regions in terms of aviation emissions are North America, Europe and South-East Asia (including China).

### 3. Methodology

This research gives a brief background of the COVID-19 pandemic and data were collected from the WHO website, published articles and few primary data. As the paper is focused on the impact of the COVID-19 pandemic outbreak with



**Figure 2.** CO<sub>2</sub> emission from total passenger operation in (MMT).

emphasis on CO<sub>2</sub> and SO<sub>2</sub> emission reduction over China, there was a scarcity of data. Therefore, data from previous years before the pandemic were used. Thus, the coefficient of the evolution of emitted gas in the atmosphere was calculated to predict the situation of 2020. The used data are from International Civil Aviation Organization (ICAO), International Aviation Transport Association (IATA), International Council on Clean Transport (ICCT), Transportation Security Administration (TSA), and Energy Information Administration (EIA). Data for coal consumption in China was collected on WIND Information site and from some articles. The data analysis was followed by arithmetic calculations to predict the avoided quantity of CO<sub>2</sub> and SO<sub>2</sub> emission during the lockdown. Advanced data analysis tools were not used to provide accurate results because of the lack of efficient and recent data for the study period.

#### 4. Results and Discussion

Due to the COVID-19 pandemic spread across the globe, the airline industry was seriously impacted. According to data published by the Transportation Security Administration, major airlines such as American Airlines, Delta Air Lines, British Airways, United Airlines, Lufthansa, Virgin Atlantic, Cathay Pacific, Qantas and others have had to eliminate flights due to lack of demand and store hundreds of jetliners until their return to service. Permanent retirements of some older aircraft such as Boeing 757 s and 767 s, and Airbus A 340 - 600 s, have also been accelerated. Many are being stored at airports such as Pittsburgh, Tulsa, Atlanta, Sky Harbor in Phoenix, Mobile, San Antonio and Birmingham in the United States [10]. In Europe, airliners are being parked at airports in Frankfurt, Copenhagen, Paris Vienna, and London, among others. Other airports around the world at which aircraft are parked include Seoul, Hong Kong and Delhi. The reduction of this emission is a result of the drop in airlines coupled with the measures taken by governments to contain the spread corona-

virus resulted in the closure of many industries' activities. These actions impacted the environment positively with concomitant reduction in fossil fuel, biomass resources and Green House gases (GHG) emission.

#### 4.1. CO<sub>2</sub> Reduction during 3 Months of Lockdown

Data published by the Transportation Security Administration (TSA) showed airline transport has increased by 33.5% of CO<sub>2</sub> emission from 2013 up to 2018 [11]. The CO<sub>2</sub> emission increased by airlines from 2017 to 2018 was 5.2%. However, since the beginning of March, the number of travelers screened at U.S. airports was reduced by more than 96% [12]. Considering the increase of 33.5% of CO<sub>2</sub> emission from 2013 up to 2018, and the increase of 5.2% from 2017 to 2018, the average rate of CO<sub>2</sub> increase ( $R_{av}$ ) per year can be estimated as follow:

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5 \quad (1)$$

$$R_{av} = \frac{R_T}{5} \quad (2)$$

where  $R_T$  denotes the total rate of CO<sub>2</sub> emitted from 2013 to 2018 which equals 33.5%;  $R_1, \dots, R_5$  are annual rates, and  $R_{av}$  is the annual average rate of CO<sub>2</sub> emission which is 6.7%. Further, using that average rate, the estimated quantity of CO<sub>2</sub> emitted in 2019 and what was supposed to be emitted in 2020 in normal conditions of economy and health can be calculated as follow:

$$E_{19} = E_{18} + (E_{18} \times R_{av}) \quad (3)$$

$$E_{20} = E_{19} + (E_{19} \times R_{av}) \quad (4)$$

$$A_{CO_2} = \frac{E_{20}}{12} \times 3 \quad (5)$$

where  $E_{19}$ ,  $E_{20}$  are annual CO<sub>2</sub> emissions.  $E_{19} = 965.6$  MMT and  $E_{20} = 1030.3$  MMT.

Assuming that the airlines were grounded for at least 3 months, the quantity of non-emitted CO<sub>2</sub> would be 257.5 MMT. This is an approximated result because airline traffic is not the same for every month. However, it gives an idea of the positive impact of COVID-19 pandemic on the environment.

#### 4.2. Comparison of Coal Consumption in 63 Days of 2019 and 2020 in China

In this analysis, the example taken into account is the Daily coal consumption at six major power firms in China during the shutdown. Here we consider 63 days after Chinese New Year. The quantity of consumed coal will help to estimate how many tons of greenhouse gases (CO<sub>2</sub> and SO<sub>2</sub>) emitted into the atmosphere.

**Table 3** shows the quantity of Coal consumption per day in Kilo tones (kt) for 63 days in 2019 and 2020. The comparison of the Coal consumption in those two years reveals a total drop of 922.18 kt of Coal. Assuming that the burning 1 ton of coal produces 0.00375 tons of SO<sub>2</sub> then: 922.18-kilo tons of Coal produces 922,180 tones  $\times$  0.00375 = 3458.175 tons of SO<sub>2</sub> [13].

**Table 3.** Comparison of coal consumption in 63 days of 2019 and 2020<sup>a</sup>.

Days	Coal consumption in kilo tons							
	2019	2020	Days	2019	2020	Days	2019	2020
0	37.1	46.93	22	60.55	38	44	66.91	52.41
1	36.56	45.03	23	66.82	38.2	45	65.46	52.81
2	37.13	43.53	24	67.64	38.8	46	66.86	51.56
3	37	42.73	25	70.24	38.93	47	67.01	52.52
4	36.65	41.13	26	71.93	39.33	48	68.3	50.73
5	38.43	43.73	27	70.19	42.14	49	66.47	53.38
6	38.9	42.83	28	68.22	42.13	50	65.12	53.47
7	43.7	39.93	29	67.78	42.08	51	68.01	52.25
8	44.46	38.51	30	68.87	41.88	52	68.55	54.17
9	44.51	37.55	31	67.21	42.67	53	67.28	51.82
10	46.12	38.05	32	65.02	41.57	54	71.67	54.66
11	45.58	37.76	33	63.76	42.86	55	70.61	55.03
12	47.23	37.66	34	63.92	42.75	56	68.37	54.57
13	48.45	37.04	35	64.89	43.11	57	66.68	55.01
14	49.3	37.42	36	62.16	43.36	58	64.14	54.77
15	51.73	37.52	37	60.91	43.36	59	66.37	55.01
16	57.35	37.81	38	60.52	45.07	60	67.75	57.44
17	58.7	36.92	39	62.55	45.6	61	65.93	61.67
18	61.51	37.2	40	66.22	47.68	62	61.7	58.68
19	66.3	37.24	41	65.56	49.33	63	61.49	59.94
20	66.6	38.49	42	65.49	50.41	Total	3837.27	2915.09
21	65.56	38.11	43	63.27	50.81			

<sup>a</sup>Data for this table was collected from WIND [16].

The 63 days of lockdown have avoided 3458.175 tons of SO<sub>2</sub> emission in the atmosphere, which is a positive impact of the pandemic of COVID-19. The carbon dioxide emission factors are expressed in terms of the energy content of coal as pounds of carbon dioxide per million BTU (British Thermal Units). The carbon dioxide (CO<sub>2</sub>) forms during coal combustion when one atom of carbon (C) unites with two atoms of oxygen (O) from the air. Because the atomic weight of carbon is 12 and that of oxygen is 16, the atomic weight of carbon dioxide is 44. Based on that ratio, assuming complete combustion, 1 pound of carbon combines with 2.667 pounds of oxygen to produce 3.667 pounds of carbon dioxide [14].

Pounds of carbon dioxide are calculated by considering coal with a carbon-containing 78% and a heating value of 14,000 BTU per pound. This can emit about 204.3 pounds of carbon dioxide per million BTU when completely

burned. For that coal, once the combustion is completed, 1 short ton (2000 pounds) can generate about 5720 (2.86 short tons) pounds of carbon dioxide [14]. The burning of 1 ton of coal releases 4172.4891 pounds of CO<sub>2</sub> and having the quantity of consumed coal, it is possible to calculate the quantity of CO<sub>2</sub> emitted during the considered period [13].

The 922.18 kt of coal should release 4172.4891 pounds of CO<sub>2</sub>  $\times$  922.18 = 3,847,785.998238 pounds of CO<sub>2</sub>.

The conversion of this into short tons gives 3,847,785.998238 pounds of CO<sub>2</sub>/2000 = 1923.89299919 short tons of CO<sub>2</sub>.

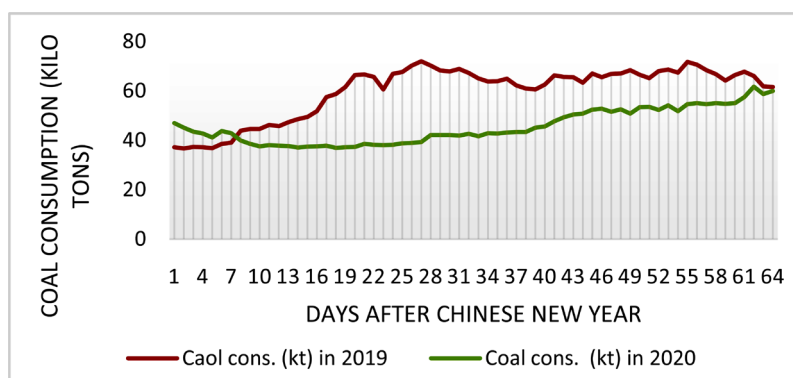
Then the metric ton of CO<sub>2</sub> is calculated as follows: 1923.89299919  $\times$  0.9071847 = 1745.33 MT of CO<sub>2</sub>, which represents the avoided CO<sub>2</sub> emission in the atmosphere in 63 days of lockdown due to COVID-19, and can be considered as a positive impact of the pandemic.

A similar study showed that the reduction in fossil-fuel consumption during the lockdown reduced 36% of NO<sub>2</sub> in China 2020. This is average lower than the NO<sub>2</sub> emitted in the same period in 2019. Over that period in 2019, China released around 800 million tons of CO<sub>2</sub> (MtCO<sub>2</sub>) [15].

**Figure 3** shows an important drop in coal consumption from the 9<sup>th</sup> to the 39<sup>th</sup> day of the study period. This may correspond to the critical period of the pandemic with rigorous measures to contain it. The trend of the two graphs for the first 7 days of the considered period, the coal consumption in 2020 was higher than that of 2019. This means that if there was no lockdown, the consumption would be bigger than that of the same period of 2019, and then the pollution should have been more severe.

## 5. Conclusion

This paper has given an idea of positive impacts of the pandemic COVID-19. There are not visible impacts for every person because they refer to greenhouse gases responsible for global warming and climate change. However, the avoided GHG emission on the atmosphere contributed a lot to reducing air pollution. Despite the COVID-19, some other diseases might have been avoided as well because of the reduction of pollution from transport and industries. This paper



**Figure 3.** Comparison of coal consumption in 2019 and 2020 (60 days).



is just an essay to detect positive impacts of the lockdown, and the sample consumption of coal was only taken in China. Many other developed countries might have reduced fossil energy source consumption because the lockdown is global. There must be several other examples of positive impacts because, for every situation, there are always advantages and disadvantages.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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