



Impact of COVID-19 related shutdown on atmospheric carbon dioxide level in the city of Kolkata

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Abstract

We studied the atmospheric CO₂ levels at 12 sites in the city of Kolkata during April, 2019 (pre-COVID-19 phase) and April, 2020 (lockdown phase due to COVID-19). Significant temporal variation of CO₂ level was observed ($p < 0.01$), but no statistically significant variation was observed between sites. The interpretation of the results can be substantiated with the lockdown effect due to COVID-19 in the city on account of complete closure of industries, transports, markets, shopping malls, recreation units, construction works *etc.* which are the main sources of CO₂ emission. The patchy vegetation in some pockets of the city (like Deshbandhu Park and Tala Park) did not allow the atmospheric CO₂ level to have a deep dip as the previous CO₂ level in these sites were not very high due to carbon storage potential of the floral species.

Keywords: Atmospheric CO₂, COVID-19, Spatio-temporal variation, Carbon storage.

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1. Introduction

Today the greatest threat on the planet Earth is the invasion by the tiny particle causing Corona Virus Disease (COVID-19). Most people infected with the COVID-19 virus usually experience mild to moderate respiratory illness and recover without requiring special and very advanced treatment. Older people and those having medical problems like cardiovascular disease, diabetes, chronic respiratory disease and cancer are more likely to develop serious illness.

The best way to prevent and slow down transmission is to have proper knowledge about the COVID-19 virus, the disease it causes and its transmission. One of the best practices to stay safe from infection is by washing hands or using an alcohol based rub (sanitizer) frequently without touching the face.

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it is important to practice respiratory etiquette (for example, by coughing into a flexed elbow).

COVID-19 is transmitted *via* airborne droplets. Therefore, reducing the effective population density in public meeting places is the basic rationale behind the quarantine strategy favored by most countries responding to the outbreak. But as more and more people live in crowded cities, it becomes harder to control a pathogen that takes days to manifest.

COVID-19 is expected to seriously scratch the world economic profile. The global economy could shrink roughly around 1 per cent in 2020 due to the corona virus pandemic, a reversal from the previous forecast of 2.5 per cent growth. The analysis by the UN Department of Economic and Social Affairs (DESA) revealed that the COVID-19 pandemic has disrupted global supply chains and International trade (<https://economictimes.indiatimes.com/topic/World-Economic-Forecasting-Model>). The tourism sector is facing the worst crisis and the associated block like transportation has almost crashed.

The industries hardest hit by COVID-19, including commercial aerospace, travel, oil and gas, apparel/fashion/luxury and insurance, may get a slower recovery, though recovery may be quicker for domestic travel. The crisis has also amplified existing challenges or vulnerabilities in the aerospace and automotive industries, which is

expected to affect their recovery rates.

Millions of workers all over the world are facing the bleak prospect of losing their jobs. Governments are considering and rolling out large stimulus packages to avert a sharp downturn of their economies, which could potentially plunge the global economy into a deep recession as the packages are likely to be pumped from the monetary reservoir of the Nation to keep the existing socio-economic structure floating in the midst of the disaster.

The education sector is also oscillating pan world basis as the COVID-19 pandemic is first and foremost a health crisis and maintaining absolute solidarity is a dream in educational institutions. Many countries have (rightly) decided to close schools, colleges and universities. The crisis crystallizes the dilemma between the policymakers who are facing the problem of closing schools (reducing contact and saving lives) and on the other hand keeping them open (allowing workers to work and maintain the economy). Many families around the world feel the severe short-term disruption in the educational panorama. Home schooling is not only a massive shock to parents' productivity, but also to children's social life and learning. Teaching is moving online, on an untested and unprecedented scale. Student assessments are also moving online, with a lot of trial and error and uncertainty for everyone. Many assessments and assignments have simply been cancelled. Importantly, these interruptions will not just be a short-term issue, but can also have long-term consequences for the affected cohorts and are likely to increase inequality.

At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments.

Fresh air is the best ventilator and can serve as a unique natural remedial measure. The testament to that is not from COVID-19, but from SARS. A relevant case study to support this statement is the outbreak of SARS during 2003 in Vietnam. It was observed that there were deaths and extensive transmission in hospital having closed air condition system. On contrary, in a hospital with spacious rooms, high ceilings, ceiling fans and large windows kept open for cross-ventilation, there were no cases of transmission [1]. There



were other factors, but the evidence suggests the ventilation may have a key role in combating the situation. This is the bottom line story that emerged from the 2003 SARS outbreak in Vietnam. The virus spreads easily indoors, not just by coughing, but through breathing, conversation etc., and hence proper ventilation is important to get rid of the rapid transmission. "According to the US Centers for Disease Control and Prevention, the virus spreads from person to person when people are within about 6 feet of each other" through respiratory droplets produced when an infected person coughs or sneezes. Thus if a person spends time in spacious room with open doors and windows, the breeze will likely to disperse it and the probability of infection will reduce [2]. Air-conditioned rooms have high probability of transmission compared to open spacious rooms where there is sufficient ventilation. The moral coming out from this discussion is to stay inside with open windows and not to congregate so that the air can disperse the germ. However, it is necessary to check the air quality as poor quality of air with GHGs and SPM may give rise to several other health problems, which may aggravate the infection. On this background, a study was conducted to scan the air quality change during the lockdown phase of COVID-19 in the city of Kolkata (India) on 2nd April, 2020 and compare the same with the data of April, 2019, when the COVID -19 outbreak was not visualized. We monitored 12 sites in the city during both the survey periods (Table 1) and

used atmospheric carbon dioxide level (in ppm) as proxy to air quality.

2. Materials and methods


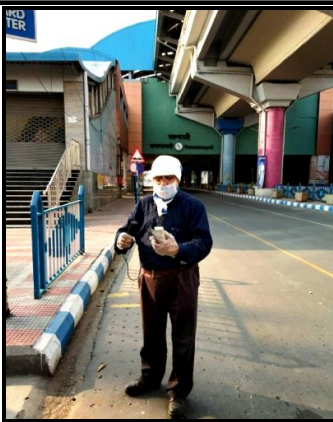

The atmospheric carbon dioxide concentrations at 12 different sites of the city of Kolkata were measured with a portable CO₂ analyzer (Lutron CO₂ meter, GCH-2018) during April, 2019 and April, 2020 during the afternoon hours. 10 readings were taken from each site at a distance of 10 meter apart and the mean values were considered for statistical analysis. The two periods are significantly different in terms of anthropogenic disturbances as April, 2019 was the period before lockdown and April 2020 is the month under the lockdown phase. The results obtained from these two phases were subject to ANOVA using SYSTAT.

3. Results

The lockdown phase exhibited significant decrease in CO₂ level in all the selected sites. The decrease percentage ranged from 24.56 (at Deshbandhu Park) to 45.37 (at Sealdah station), which may be attributed to presence of different activities and vegetation in the respective sites (Table 1). The prevailing air quality in all the selected sites (as documented from the data bank of April 2019) also has a role to evaluate the percent decrease of CO₂ in these sites.



Table 1: Level of atmospheric CO₂ (in ppm) and (%) of decrease of CO₂ at 12 sites in the city of Kolkata during 2019 and 2020.

Sites	Coordinates	Atmospheric CO ₂ (ppm)		Decrease of CO ₂ (%)
		2 nd April, 2019	2 nd April, 2020	
 Laketown Crossing	22°36'02.9"N 88°24'22.7"E	390	238	38.97
 Karunamoyee Crossing	22°35'08.5"N 88°25'18.3"E	401	247	38.40
 Techno India University, WB, India	22°34'32.8"N 88°25'43.1"E	396	230	41.92



Ballygunge Phari

22°31'32.6"N
88°21'58.7"E

408

241

40.93



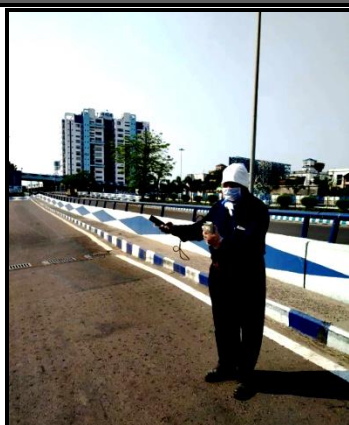
Park Circus

22°32'21.1"N
88°21'55.1"E

402

237

41.04



Nabanna

22°33'55.4"N
88°18'55.2"E

399

226

43.36



Howrah station Crossing

22°34'49.4"N
88°20'33.9"E

413

255

38.26



Moulali

22°33'40.2"N
88°22'04.7"E

407

232

43.00



Sealdah

22°34'08.3"N
88°22'13.4"E

410

224

45.37



	<p>22°35'05.8"N 88°22'29.4"E</p>	<p>398</p>	<p>233</p>	<p>41.46</p>
<p><i>Maniktala Crossing</i></p>				
	<p>22°35'48.9"N 88°22'38.6"E</p>	<p>338</p>	<p>255</p>	<p>24.56</p>
<p><i>Deshbandhu Park</i></p>				
	<p>22°36'26.8"N 88°22'55.0"E</p>	<p>386</p>	<p>259</p>	<p>32.90</p>
<p><i>Tala Park</i></p>				

Source: Authors.

4. Discussion

The entire Planet has changed within a period of few months due to pandemic COVID-19. Industries have been closed down, transport sectors are dwindling due to complete shutdown of domestic and International flights, tourism activities have ceased and hence all hotels, tourism units, home stays and other recreational activities (like water sports, amusement parks *etc.*)

related to tourism have been stopped. The running of trains, buses and passenger vessels have also been ceased. All these have significantly reduced the consumption of fossil fuels and subsequently emission of CO₂ has touched the trough in the existing CO₂ profile of the region.

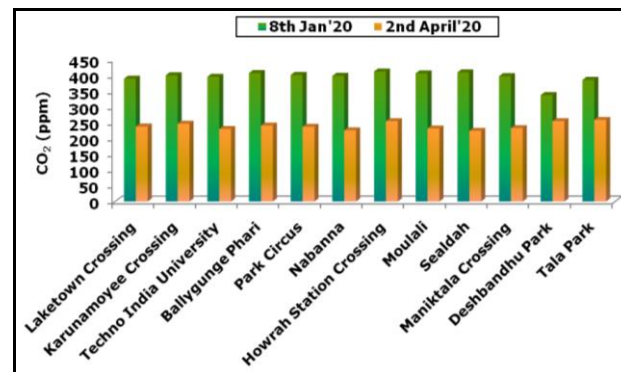


The streets of the thickly populated and urbanized city of Kolkata are deserted after authorities implemented a strict lockdown. The normally bustling pubs, bars, markets, shopping malls and theatres are closed and people have been asked to stay in their homes. Those who are able to do so are hold up at home, practicing social distancing and working remotely.

This lockdown aims to control the spread of COVID-19, and reduce the death toll. However, all these changes have also led to some unexpected consequences in the environment. As industries, transport networks, recreational units, offices and businesses have been closed down, it has brought a sudden drop in carbon dioxide emission profile in the atmosphere of the Kolkata city. Similar picture was observed in New York. Compared with the last year (*i.e.*, 2019), levels of pollution in New York have reduced by nearly 50% because of measures to restrict the spread of the virus [3].

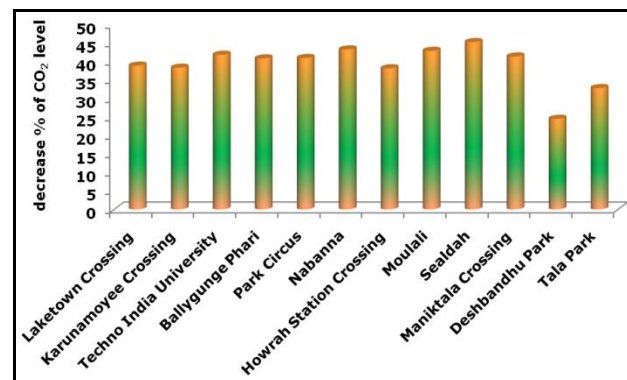
In the present study, it is seen that the decreased percentage of CO₂ in Kolkata ranged from 24.56 (at Deshbandhu Park) to 45.37 (at Sealdah station) (Figure 2). ANOVA showed significant decrease between years but not between stations (Table 2). The variation in CO₂ level between years can be substantiated by COVID-19 pandemic, but the apparent variation between sites as highlighted in Figure 1 (not statistically significant as revealed from Table 2) is attributed to existing vegetation in the site along with anthropogenic activities of various dimensions.

Figure 1. Spatio-temporal variation of atmospheric CO₂ (in ppm) in the study areas.



Source: Authors.

Figure 2. Percentage rates of decrease atmospheric CO₂ level in the study areas.



Source: Authors.

Table 2. ANOVA showing the variations of atmospheric CO₂ between sites and years in the city of Kolkata.

Source of Variation	SS	df	MS	F _{obs}	P-value	F _{crit}
Between sites	1797.458	11	163.4053	0.442347	0.90406E-1	2.817930
Between years	145,860.000	1	145,860.0000	394.851	5.73E-10	4.844336
Error	4,063.458	11	369.4053			

Notes: SS = Sum of Squares, df = Degree of Freedom, MS = Mean Sum of Squares, F_{obs} = Observed F, P-value = Probability, F_{crit} = Critical F.

Source: Authors.

Sites like Deshbandhu Park and Tala Park already have good patch of vegetation with species like *Mangifera indica*, *Delonix regia*, *Peltophorum pterocarpum*, *Ficus benghalensis*, *Azadirachta indica* and *Ficus religiosa* and hence the average CO₂ in the atmosphere was not very high during April 2019, due to which the final CO₂ value recorded during April 2020 did not show much difference unlike other sites of the city.

The role of urban vegetation in storing carbon was already cited by several researchers in and around the present study area [4-15]. The overall results strongly speak in favor of the regulatory influence of COVID-19 connected lockdown in slashing down the CO₂ level in the urban atmosphere.



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