Decreasing trend of near surface atmospheric CO_2 level in the city of Kolkata during COVID-19 lockdown phase

Arpita Saha, Indra Narayan Sardar, Prosenjit Pramanick, Sufia Zaman and Abhijit Mitra

Abstract

The lockdown phase associated with COVID-19 pandemic started in full swing on and from 25th March, 2020 with the aim to retard the spreading of the virus. We made an in-depth study on the near surface atmospheric CO_2 level at three different sites in the city of Kolkata before and during the lockdown phase from 20.03.2020 to 26.04.2020. A significant decrease in the CO_2 level is observed in all the three selected sites (42.18% at Ramkrishna Ghat, 43.47% at Botanical Garden and 42.48% at Babughat), which may be due to absence of transport systems, industrial operations and other human activities in the megacity.

Keywords: COVID-19, Lockdown, Atmospheric CO_2, Kolkata

Introduction

The whole world is under the appalling shadow of COVID-19 pandemics and the city of Kolkata is no exception to this event. With a population of 1,48,50,066 and a population density of 24,000/sq km (https://worldpopulationreview.com/world-cities/kolkata-population/), the city has initiated a total lockdown of all activities on and from 25th March, 2020. Our team was in the process of monitoring the near surface atmospheric CO_2 since 20th March, when the lockdown was not in full swing in the megacity. We therefore got a scope to compare the level of atmospheric CO_2 just before the lockdown and during the complete lockdown phase associated with COVID-19. The present paper, thus, aims to assess the effects of non-functioning of all human activities on the atmosphere CO_2 level during the complete lockdown phase as ordered by the Central and State Governments of the country. In this paper, we made a time series analysis of atmospheric CO_2 for 10 days (20th March, 2020 to 26th April, 2020) at three sites of the megacity of Kolkata having anthropogenic activities of varied nature.

Materials and Methods

Study site

The megacity of Kolkata is the third largest city in India and situated in the east bank of the Hooghly River with an area of 187.33 km^2 in the state of West Bengal. Three sites along the bank of the River Ganga were selected for the present study namely Ramkrishna Ghat (22°34'19.8"N; 88°20'17.0"E), Botanical Garden (22°33'06.4"N; 88°18'06.6"E) and Babughat (22°34'10.3"N; 88°20'28.5"E).

Analysis

The near surface atmospheric carbon dioxide concentrations at three selected sites were measured with a portable CO_2 analyzer (Lutron CO_2 meter, GCH-2018) during 20th March, 2020 to 26th April, 2020 during the afternoon hours. 10 readings were taken from each site at a distance of 8 meter apart and the mean values were considered for statistical analysis. The results obtained from these dates of observation were subject to ANOVA using SYSTAT.

Results

The lockdown phase exhibited significant decrease in CO_2 level in all the selected sites (Fig. 1). The decrease percentage ranged from 42.18 at Ramkrishna Ghat to 43.47 at Botanical Garden, which may be attributed to different anthropogenic activities in the respective sites (Figs. 2 and 3). The maximum decrease in the site of the Botanical garden may be attributed to the presence of a large chunk of producer, which includes trees of various types. The role of urban vegetation in storing carbon was already cited by several researchers in and around the present study area (Mitra et al., 2012; Mitra and Zaman, 2014; Banerjee et al., 2015; Mitra et al., 2015; Mitra and Zaman, 2015; Mitra et al., 2016; Mitra and Zaman, 2016; Agarwal et al., 2017a,b; Banerjee et al., 2017; Mitra, 2019; Pal et al., 2019). The overall results strongly speak in favor of the regulatory influence of COVID-19 connected lockdown in slashing down the CO_2 level in the urban atmosphere.
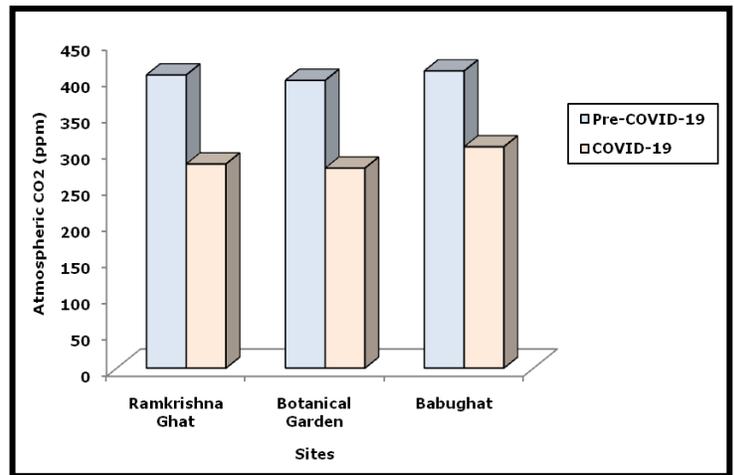

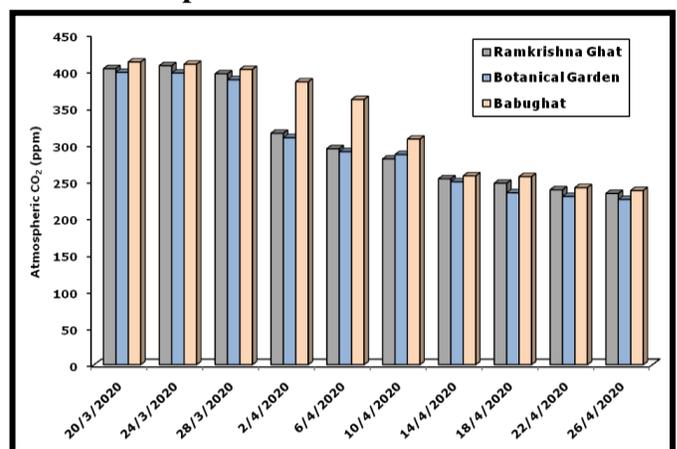**Fig. 1. Variation of atmospheric CO_2 (in ppm) level in the study sites during pre-COVID-19 and COVID-19 period**

Fig. 2. Spatio-temporal variation of atmospheric CO_2 in the study sites during the lockdown phase
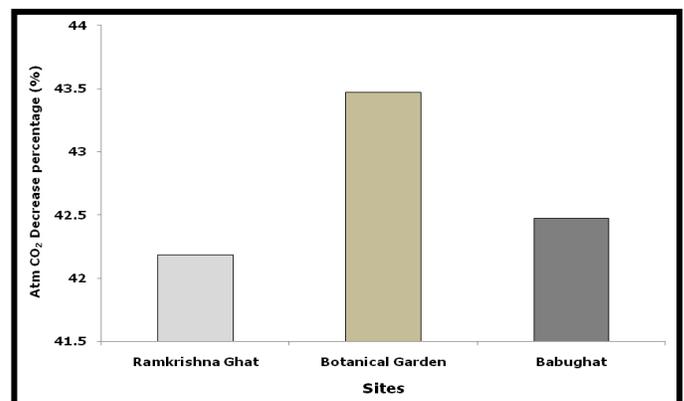

Fig. 3. Decrease percentage of atmospheric CO2 in study sites

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ANOVA data highlight significant variations in near surface atmospheric CO_2 between stations and days ($p < 0.01$) (Table 1).

Table 1. ANOVA for the atmospheric CO_2 between stations and between days

Source of Variation	SS	df	MS	F	P-value	F crit
Between days	135427.9	9	15047.54	65.94764	6.12E-12	2.456281
Between stations	3758.867	2	1879.433	8.23684	0.002884	3.554557
Error	4107.133	18	228.1741			
Total	143293.9	29				

Discussion

The city of Kolkata is noted for its crowd in shopping malls, markets, busy office zones, small scale industries, educational hubs, traffic, recreational centers *etc*. In all these units, probability of spreading virus is almost near to unity as social distancing is practically a dream in these areas/units. To prevent the rapid spread of the virus, these units were completely shut down on and from 25th March, 2020 that resulted in the reduction of CO_2 emission (Mitra et al., 2020). The city of Kolkata is almost near to the World average CO_2 level of 417.31 ppm (https://www.co2.earth/ as per the record of 30th April, 2020). The increasing trend of CO_2 as highlighted in Fig. 4 since 1960 in the result of intense industrial activities and urban developments at the cost of forests and wetlands. The city of Kolkata also followed similar footsteps since last few decades, which has pushed the city to touch 403 ppm, 398 ppm and 412 ppm atmospheric CO_2 at Ramakrishna Ghat, Botanical Garden and Babughat respectively as recorded on 20th March,

2020. However, the air quality increased a lot with a decrease of 42.18%, 43.47% and 42.48% at Ramkrishna Ghat, Botanical Garden and Babughat respectively during the COVID-19 lockdown phase. The improvement of air quality in the megacity of Kolkata is thus an eye opener to the magnitude of damage caused by unregulated anthropogenic activities in the city. Strict implementation of environmental related laws along with mass awareness is of utmost importance to eco- restore the city atmosphere.
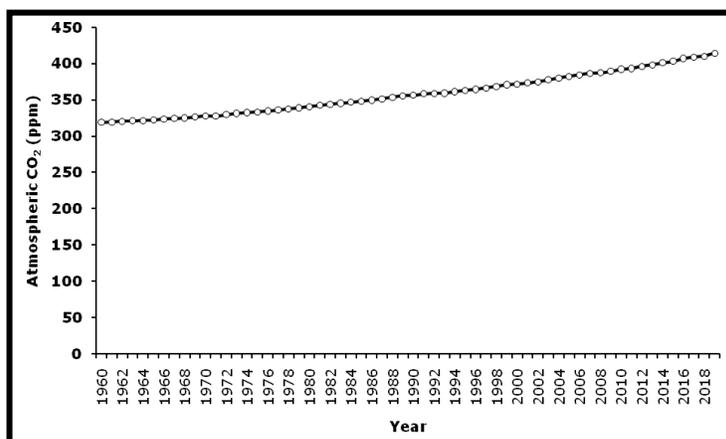

Fig. 4. Continuous yearly data of atmospheric CO_2 for six decades (1960-2019) according to Mauna Loa Observatory (MLO), NOAA (https://www.co2.earth/monthly-co2)

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