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Temporal change in Carbon dioxide levels in atmosphere during weekend lockdown restrictions amid COVID-19 pandemic in Jammu City (J&K Union Territory, India)

Mahender Singh[1], Vishaw Vikas[2*], Rohit Sharma[3]
[1] Agrometeorology Section, SKUAST Jammu, Jammu and Kashmir, India
[2] AMFU, RARS- Rajouri, SKUAST Jammu, Jammu and Kashmir, India

Abstract
An analysis was done to evaluate the change in Carbon dioxide level due to the implementation of weekend lockdown restrictions. The data was analyzed through Descriptive Statistics and Pearson Correlation using SPSS 16.0. Through the analysis, it was observed that the deviation in Carbon dioxide levels during 1st weekend of lockdown compared to weekdays was -2.41% and during 2nd week, the deviation between weekends to weekdays was -1.90%. Also, graphical analysis depicted that during the enforcement of restrictions in 1st week; the values of CO_2 level in atmosphere went below 405 ppm, however during weekdays it surged to >420 ppm. Again in 2nd week, the CO_2 levels were below than weekdays but slightly above 1st weekend lockdown values. Thus, the consistently dropping pattern noticed in CO_2 levels describes weekend lockdown an effective solution to curb the pace of emissions.

Keywords: carbon dioxide (CO_2), COVID-19, weekend lockdown

1. Introduction
The current situation of the COVID-19 pandemic seems more fictional than actual but it is the hard reality that humanity needs to accept and same is with the projection and results appearing after analysis of weather and air parameter data collected during lockdown restrictions. Carbon dioxide in fact is an important and one of the abundant gases in atmosphere. A molecule of carbon dioxide (CO_2) is made up of one carbon atom and two oxygen atoms. Carbon dioxide is also considered as one of the important greenhouse gas that favors the heat entrapment in atmosphere. Therefore, increased or decreased concentration matters a lot in understanding and management of the world temperatures. However, a gradual increase of CO_2 more than normal level is now driving our planet towards global warming. Due to enhanced anthropogenic activities, CO_2 levels are currently higher than past 800,000 years (Lindsay, 2020). In another aspect of studying emissions, the population density in India over last two decades has increased with a growth rate of 37.60 %, thereby having a direct impact on demand supply ratio, e.g. it has been noticed that sales of vehicle since 2008 has been increased with a rate of 15% per annum and in relation to this, the transport demand is expected to rise by 200% between 2015-2030 (SIAM, 2013 and Amann *et al*. 2017) [1]. So, the sure consequence of the rise of demand supply ratio and anthropogenic activity is going to impact the CO_2 levels of the Sub-Himalayan region.
Coronavirus disease 2019 was first traced in Wuhan, China in December 2019 (Zhu and Xie, 2020) [15]. The World Health Organization declared COVID-19 as pandemic (WHO, 2020) because of its rapid spread in several countries outside China and as a result of which India imposed restrictions in the form of total lockdown for 21 days (in 1st phase) and subsequent lockdown and unlock down phases to avoid the spread of coronavirus. After the complete unlock down in Jammu during March to June 2020, the district again witnessed a surge in coronavirus cases (Singh *et al.* 2020a; Sharma *et al.* 2020) [8], in response to which the Jammu Kashmir Union Territory administration implemented weekend lockdown strategy i.e. Friday 6:00 PM to Monday 6:00 AM (72 hours) from July 24, 2020 (services.jammu.gov.in) onwards to minimize the human-human interaction and disease spread. The weekend lockdown restrictions not only proved to be an effective strategy to curb the infection rate but indirectly also worked as a medium to improve the Carbon dioxide level in atmosphere.
The present study is an effort in this direction to assess the usefulness of the weekend lockdown as an alternative strategy for analyzing the changing Carbon dioxide level in Jammu district of Jammu Kashmir. The objectives of the study:

1. To quantify the change in concentration of Carbon dioxide due to the implementation of weekend lockdown regulation
2. To study the correlation among the Carbon dioxide and weather parameters
3. To analyze the efficacy of lockdown in improvising the Carbon dioxide level in atmosphere

Focusing on the Jammu district, the study is thought to be a plausible addition to the scientific community and policy makers not only to assess the impact of lockdown restrictions on improving the carbon dioxide levels, but also its efficacy as an easy alternative action plans for managing optimum carbon dioxide levels within the region with public involvement in upcoming years.

2. Material and Method
Jammu occupies an area of about 3097 sq. kms and lies in between 32°39'35.5"N latitude and 74°47'35.0"E longitude at an elevation of 332 meters above the mean sea level in site the Shivalik foothill plains of North-Western Himalayas and is the winter capital of Jammu Kashmir. It is largest populated District

of the Union Territory and second largest in terms of population density. In order to analyze the changes in Carbon dioxide level during weekend restrictions, the data was collected between 31st July to 24th August 2020. The real time data pertaining carbon dioxide levels of the mentioned timeline was collected through CO_2 meter. The daily data pertaining Temperature and Rainfall of the area was collected from accuweather.com. The data was analyzed through Descriptive Statistics and Pearson Correlation using SPSS 16.0.

3. Results and Discussion

The descriptive coefficients are stated in Table 1. Through the analysis the deviation observed in 1st weekend of lockdown compared to weekdays was -2.41% and during 2nd week, the deviation observed in Carbon dioxide levels between weekends to weekdays was -1.90%. However, as per the cumulative analysis, the highest value observed was 401 ppm and lowest value was 423 ppm with a mean value of 412.5 ppm. The standard deviation observed was 6.8 with a CV value of 1.7 %. The same trend of carbon dioxide projections were also declared by Yusup Y., 2020; Bradley D., 2020 and Quere CL. *et al.,* 2020.

Table 1: Descriptive Coefficients of Carbon dioxide (CO_2) of Jammu district during weekend lockdown restrictions

Descriptive Coefficients	Value
Highest	401.0
Lowest	423.0
Mean	412.5
Standard Error	2.1
Standard Deviation	6.8
CV (%)	1.7
Kurtosis	-0.1
Skewness	-0.3

The Carbon dioxide wasn't found significant with any of the weather parameter thereby stating that the Carbon dioxide levels were not affected by change in temperature and rainfall patterns.

Table 2: Correlation of coefficients among Carbon dioxide (CO_2) and Weather parameters

	Carbon dioxide	Temperature
Temperature	-0.05	
Rainfall	-0.25	-0.73*

*Correlation is significant at 5% level of significance

The graphical representation gives an insight of changed CO_2 concentration in atmosphere during the implementation of weekend lockdown restrictions (Figure 1). It can be noticed that during the enforcement of restrictions in 1st week the values of CO_2 level in atmosphere went below 405 ppm, however during weekdays it surged to >420 ppm. Again in 2nd week, the CO_2 levels were below than weekdays but slightly above 1st weekend lockdown values. In overall, it can be highlighted that weekend lockdown proved to be an effective strategy in lowering CO_2 emissions. The decreasing pattern observed in CO_2 emissions can be attributed to reduction in consumption of fossil fuels for energy and reduction in the anthropogenic activities leading to less CO_2 gas liberation in atmosphere (Bhatt R.P. 2018). Also, changes in the economic output, lack of energy consumption, decreasing emission from land usage, livestock, septic processes and reduced usage of fertilizers could have lowered the CO_2 release in the atmosphere (Singh *et al.,* 2020). Decreased industrialization, reduced burning of fossil fuels and other human activities might also have halted the rising atmospheric CO_2 levels; thus reducing threat to our environment (Williams K.D. 2017; Manabe S. 2019).

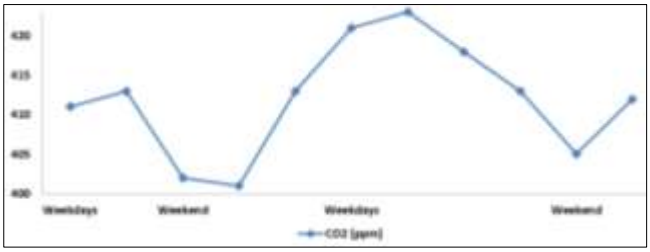

Fig 1: Graphical representation of Carbon Dioxide level in atmosphere during weekdays vs. weekend (lockdown)

4. Conclusion

Despite rising concerns over increased greenhouse gases in the atmosphere, an indirect ray of hope in controlling the CO_2 emissions is emerging in the form of Lockdown in the Jammu region (Singh M. *et al.,* 2020; Sharma R. *et al.,* 2020). The consistently dropping pattern noticed in CO_2 levels; however describes lockdown an effective solution to curb the pace of emissions but to implement the same is not at all a feasible and economical option. Thus, implementing the stepwise lockdown or weekend lockdown like strategies can be an acceptable option to reduce the climate change effect to some extent. The results of the study will therefore attract the attention of the Jammu Kashmir Union Territory administration to ponder on how to lower the Carbon footprints which will also be beneficial to the policymakers and environmentalists to analyze and assess the efficacy of weekend lockdown restrictions on reduction of Carbon dioxide levels, so that the policies can the framed accordingly taking care of sustainability, productivity and health.

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