Environmental Data Analysis and Visualization

1Manish Singh Bhandari, 2Rishabh Mishra, 3Naman Aggarwal, 4Adarsh Pal
1Student, 2Student, 3Student, 4Student
Sharda University

Abstract - **Delhi, India's environmental issues are a risk to the well-being of urban and rural people, as well as to the flora and fauna. Delhi is one of India's sixth most populated metropolises (including all NCRs and being the second most populous metropolitan area), with one of the most highly polluted cities with for example the largest pollution in the world. In May 2014, New Delhi was declared as the most contaminated city in the world by the World Health Organisation. Overcrowding and the resultant excess of finite commodities, such as water, placed extreme environmental strain. The town suffers from air contamination induced by rolling dust and manufacturing, with very limited contributions from the usage of unclean transport vehicles, in particular diesel city buses and trucks and 2-wheelers and 3-wheelers with two-stroke engines. Water degradation and shortage of solid waste treatment plants also caused significant harm to the Yamuna River, which grew on the banks of Delhi. Vehicle emissions and manufacturing practises have been reported in Delhi as being related to both indoor and outdoor air pollution. Delhi air quality and mortality research showed that all-natural mortality and morbidity rose as air pollution increased. Delhi has taken many measures over the past 10 years to mitigate air pollution in the region. More needs to be achieved, however, to further reduce air emission standards."**

keywords **- component; formatting; style; styling; insert (key words)**

I. INTRODUCTION

Air contamination is intertwined in the framework of our daily lives. Air pollution is the residue that remains from the manner in which we manufacture our products, ship our goods and create heating energy and lighting the areas where we live, play and work. Combustion and combustion were the primary source of air emissions. "As combustion happens, the fuel mixes hydrogen and carbon with air oxygen to create flame, light, dioxide and water vapour. Impurities in gasoline, insufficient air to fuel or too high or low temperatures for combustion induce the production of side products such as carbon monoxide, sulphur oxides, nitrogen oxides, fly ash and unburned hydrocarbons, both of which are air contaminants. Air pollution may be described as an existence in the open air of one or more pollutants or combinations in the amounts and lengths which can or may appear to damage or interfere unreasonably with the comfort of property or industry or to hurt humans, plant or animal lives or property.

II. LITERATURE REVIEW

Delhi (or the National Capital Territory of Delhi), is jointly administered by the central and state governments. It accommodates nearly 167.5 lakh people (2011 Census of India).

1) Worldwide subways carry the largest emissions brunt; likewise, Delhi is at the receiving end in India. A survey was undertaken in 1991-1994, sponsored by the Development Research Division of the World Bank, to study the impact of air pollution.

2) During the study period, the overall Delhi amount of total suspended particulate matter (TSP) was around five times the annual average of the World Health Organisation. Moreover, the overall suspended particulate amount in Delhi during this time surpassed the 24-hour norm of the World Health Organisation by 97% of all day-listening. The study showed that the effect of particulate matter on overall non-trauma mortality in Delhi was lower than in the United States, but found that the consequence was a reduction of life-years as a result of the death connected with air pollution in Delhi, since these deaths occurred at a younger age.

3) One of the areas of concern found in this report was air quality. It was calculated that approximately 3000 metric tonnes of air contaminants were released per day by cars in Delhi (67%), followed by carbon-based thermal power plants (12%). The National Emission Control Board (CPCB) tracked the pattern from 1989 to 1997. The carbon monoxide concentration from automobile emissions in 1996 reported a 92 percent rise over the values reported in 1989, attributed to an increase in the automotive population. The amounts of particulate lead seemed to be under control and this was attributed to deluding of fuel and limitations on commercial plumbing units. Delhi is the largest cluster of small factories in India that along with other industrial units contribute 12% of air pollutants.

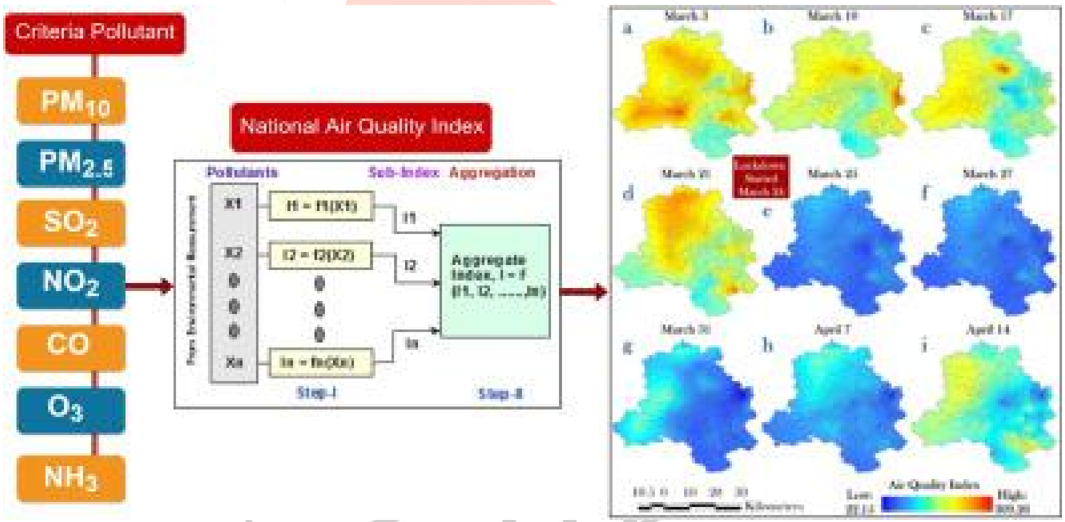
Vehicular pollution is an important contributor to air pollution in Delhi. According to the Department of Transport, Government of National Capital Territory of Delhi, vehicular population is estimated at more than 3.4 million, reaching here at a growth rate of 7% per annum. Although this segment contributes to two-thirds of the air pollution.

The PM10 norm is commonly used for air quality assessment. The PM10 norm requires particles of 10 µm or less diameter (0.0004 inches or 1-seventh of a human hair width). These microscopic particles are likely to have harmful health consequences since they may enter the lower parts of the respiratory tract. According to the World Health Organization's Air Quality

Directive, the annual average concentration recommended for PM10 was 20 µg / m^3, which raises the likelihood of cardiopulmonary impact.
4) The major human health issues resulting from exposure to PM10 include the impact on breathing and respiratory processes, lung tissue injury, cancer and premature death. The consequences of particulate matter are highly responsive to elderly persons, infants, and people with chronic lung disease, influenza, or asthma. Delhi has announced that the urban air database published in September 2011 by the World Health Organisation, which trailed to third place after Ludhiana and Kanpur, surpassed the PM10 cap by almost 10 times at 198 µg/m^3.
5) Automobile emissions and industrial practises in Delhi have been found to be related to indoor and outdoor air pollution.

III. Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India

In India a national lockout is initially enforced across three weeks between 24 March and 14 April 2020, and is expanded to 3 May 2020, in the sense of the COVID-19 pandemic. "As a result of the forced bans, the amount of emissions in cities across the world slowed sharply within a few days, magnetising lockout talks as successful potential mechanisms for regulating air pollution. In the middle of the lockout time the present article finally focused on this direction in order to look at the air quality situation with a particular relation to Delhi. We have used the national air quality Index (NAQI) to illustrate the air quality spatial trend at pre-lock-down and during lock-down periods by utilising air quality details of seven contaminant parameters (PM10, PM2.5, SO2, NO2, CO, O3 and NH3) for the 34 monitoring stations distributed around megacity. The findings revealed that air quality was substantially enhanced during the lock-down phase. The concentrations of PM10 and PM2.5, as opposed to the pre-lockdown period, have been observed as maximum (> 50%) among the pollutants selected. The PM-10 and PM-2.5 decline were around 60% and 39% respectively, in contrast to the prior year (i.e. 2019). NO2 (−52,68%) and CO (−30,35%) were decreased during the lock-down process among the other contaminants as well. Air consistency gain of roughly 40 percent to 50 percent is observed only after four days of locking. In middle, eastern, southern, western and northern sections, about 54 percent, 49 percent, 43 percent, 37 and 31 percent of NAQI reduction is observed. The research is considered to be a valuable contribution to the regulatory bodies since it has demonstrated that air quality may be attenuated by the regulation of emission source. Temporarily such regulation of the source will cure the environment in an acceptable interval.



ALL AROUND THE GLOBE

The WHO announced COVID-19 to have been a pandemic on 11 March 2020 (WHO 2020d) as a consequence of the novel coronavirus SARS-CoV-2. As of May 15, 2020 (WHO2020a), the Coronavirus had killed 3,00,000 people in nearly 216 countries around the world. The Chinese government has been compelled to adopt the social-distancing measure which is universally recognised as a preventive mandatory strategy for coping with the pandemic of coronavirus where there is little option to fight the deadly disease (Huang et al. 2020a, b, Zhang et al. 2020). Since the end of March 2020, nearly half of the world 's people are expected to live under lock-out. In this regard, it should be noted that India listed 81,970 verifying cases and 2649 deaths as of 15 May 2020 in the list of COVID-19 impacted Asian countries. In Kerala, India and the contaminated citizens travelling from China (Gautam and Hens 2020), the first positive COVID-19 case was detected at the end of January 2020. Maharashtra, Tamil Nadu and Delhi are the leading countries in overall reported incidents, while the number of cases of COVID 19 in Maharashtra, Sikkim, and Mizoram are exceedingly few. The noble Indian prime minister called on the people to enforce the lock-down mechanism successfully. A national lock-in has been imposed by halting economic production and limiting citizens' movement in order to avoid the rapid transfer of coronavirus. In India, Delhi experienced the vicious coronavirus attack with a steadily increasing rate of reported cases, while the state's epicentre of COVID-19 is Delhi (Fig. 1). In order to tackle the accelerated outbreak of global emergency of the COVID-19 pandemic, India has already introduced lock-down laws and adopted social distancing requirements from March 24, 2020 and continues until May 31, 2020. Delhi is in an exceptionally vulnerable condition among the heavily impacted states COVID-19 in India and is the state's epicentre (the Health and family welfare departments of India 2020), with a number of instances of 2461 reported incidents before 15 May 2020, and Delhi (the capital of India) is seriously affected by COVID-19. The fundamental issue in this regard is that the COVID-19 infection incidence and deaths in Delhi City rise frequently day by day, owing to co-morbidity among individuals, such as breath disorder and chronic obstructive lung disease. The World Health Organisation has also reported specifically that major diseases have occurred attributable to extreme air pollutants such as respiratory diseases (26%), persistent pulmonary obstacles (25%) and stroke and ischaemic heart (17%). Delhi, India's third largest city, has a population of 4.5 million (Indian Census 2011). Delhi is classified as a dusty city as regards urban air quality, as well as the 25 most polluted cities in India (WHO 2011), in Kumar and Singh 2003. In addition, it has 10 worst contaminated cities in India. In comparison with other major cities such as Bombay, Bengaluru, Chennai, Hyderabad etc., the Central Pollution Control Board of India (2012) announced that the eastern economic pivot of India (Delhi) is recorded as the poorest contaminated city with regard to air pollution and the city is nearly equal to Delhi (2015). Air quality improvements in the city of Delhi can be estimated to raise the volume of respiratory and allergic diseases. The key goal of this analysis was therefore to assess air quality in Delhi City of India and to propose a long-term sustained environmental protection plan during the pre-COVID 19 lockdown process. Although the bulk of the inhabitants of the planet have not historically been exposed to long-term lockout, but have simultaneously enhanced the wellbeing of the whole ecosystem, including humans, owing to the closure of trade, building activity and manufacturing operations. In this present sense, the research demonstrates how significant the volume of air pollution decreased during lockdown phases and the particular sources of air pollution were found in this science study. The uniqueness of the analysis represents the true realities of air quality levels and conditions in and before the lock-up process. The lethal global emergency of the COVID-19 pandemic offers experts, operators and politicians' tremendous scope to re-think public health rejuvenation. Policymakers should adopt the sustainability strategy set out in the report, and this kind of theoretical fundamental science would certainly lead to the development of a simulation model to boost sustainability. Many of the recent studies have been carefully formulated on air quality level evaluation, overall environmental condition and explanations for variations of particular COVID-19 emission parameters during and before the lock-up process, and this review has aimed not only to analyse the air quality status but also to suggest sustainable environmental long-term management plans. Similarly, intensity of the study was amplified because it is validated in the European Space Agency (ESA) and the national aircraft management and space administration (NASA) in and before lock-up phases through the concentration mappings of NO2 and aerosol in the Indian Subcontinent. Meanwhile, the analysis was successfully completed, taking into consideration certain drawbacks, such as insufficient automated air quality measuring fields, ineffective manual stations and minimal expert contact and laboratory assistance during COVID-19.

Air quality scenarios of Europe and Asian countries during COVID-19 pandemic

The ecosystem is being stressed out of the strain of worrying anthropogenic nuisance since the factories and the production, power and transport sectors almost stop during lockdowns. The world environment and public health welfare would eventually tackle the awful effects of coronavirus thus restricting human behaviour and intervention significantly lowers the amount of contamination. The 2019 high pollution rate at the Yangtze river delta area in China has decreased in lock-down periods with NO2, SO2 and PM2.5 than the high emission rate. In addition, the quarantine session of the Kazakhstan-based district of Almaty, Kazakhstan saw a substantial decrease in CO, NO2, and PM2.5 amounts (by 49%, 35% and 21%) relative to the last year. The concentration amount of NO2 and PM2.5, attributable to the partial closure of various factories (ESA 2020c; CAMS 2020) was considered very low atmosphere in major cities of the world (during lockdown).

IV. Data Sources and data acquisition

In this study, six parameters like CO, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$ have been considered to evaluate the deviation of air quality during lockdown and pre-lockdown period. "The concentrations of these parameters were correlated with the same lockout duration in the previous 3 years (2017, 2018 and 2019) between 25 March-15 May 2020. The Pollution Control Board under Govt has received hourly emission levels of the above-mentioned selected pollution parameters regular. Of Delhi. In order to track the improvements in the trend of concentration intensity of these parameters, day by day data (4 years) have been obtained. Because of the accessible pollution-related data stations such as Lajpat Nagar, Punjabi Bag, Huaz khas, Chattarpur and Chandani Chaowk are chosen from the Delhi Metropolitan Area. In order to plan land surface temperature mapping for temperature variance pre- and post-lock-down study, LANDSAT 8 OLI and LANDSAT 7 ETM plus photos (row 138, row 44 and resolution 30 m) have also been used. The NO2 and aerosol variance maps were collected independently from the European Space Agency (ESA) and national space and aerosol administration (NASA) during lock-up and pre-locking process in India. In this segment, ESA collected NO2 concentration data using the Tropospheric Monitoring Instrument Copernicus Sentinel-5 Precursor (S5P / TROPOMI). Some technological restrictions, such as restricted automated data collection and laboratory analyses, were discussed during the lock-down process. In order to measure the accumulation of and magnitude of contaminants in particular areas of time, numerous modelling models as well as modern devices are built through the development of science and technology. Despite this, it is worthwhile to measure, using ground automated station, satellite, R S&GI and descriptive statistical technology, the short-term impacts of COVID-19 on urban air quality in Delhi City and a long-term environmental management planning. The research on the major impacts on urban emissions by the European Space Agency (ESA) and the National aeronautics and Space Administration (NASA), via the maps of NO2 and aerosol concentrations in the Indian subcontinent, was authenticated.

V. Data analysis

Applications of RS & GIS Techniques

During (in 2020) and pre-lockdown years 2017, 2018 and 2019 the diurnal and monthly average of the selected parameters were determined at each station throughout Delhi Area. In order to explain the evolving essence of air quality, the time and space difference of various component parts was measured. During the sample times, graphical representation has been created by grapher 13 software based on the regular average of these parameters. The numerous interactive maps on the Arc GIS 10.3 platform have been created.

Statistical Analysis

Various statistical multivariate approaches such as HCA and PCA have been used to investigate the value of the selective air quality parameters in Delhi City by utilizing IBM SPSS (16.0) statistical tools. It is a class-specific algorithm between identical artifacts that analyses the similitude or discrepancy between the variables. The relation is drawn by many proper metrics with the correlation theory in the hierarchical cluster review. Some typical metrics (between a and b variables) have been implemented in HCA framework. These are as follows:

$$\text{Euclidean distance } // a-b // 2 = \sqrt{\sum I (a-b)2}$$

$$\text{Squared Euclidean distance } // a-b // 2=\sum I (ai-bi)2$$

$$\text{Manhattan distance } // a-b // 1=\sum I |ai-bi|$$

$$\text{Maximum distance } // a-b // \infty = \max I |ai-bi|.$$

Patterns between the variables are then created by PCA. In view of the six various air quality level criteria pre- and after lock-out, PCA has been introduced and PCA primarily reflects a more accurate data collection. Any mathematical algorithms are used to generate PCA. The following measures were taken to examine the relationship between the variables. These are as follows:

- Standardization
- Covariance matrix
- Computation of eigenvector and value.

Each material radiates thermal electromagnetic energy which is calculated in addition to the LST of various objects whether the Earth surface temperature is greater than absolute zero (-273 °C/K). Signals are obtained from various sensors such as TM, ETM, TIRS and converted into radiant sensors.

The numerous techniques for exact LST extraction are possible while the Landsat Project Science Office (LPSO 2002) invents these methods. A radiometric correction was added to the translation of DN values into reflectance value. The LANDSAT 8 OLI and LANDSAT 7 ETM+ band data are translated with the following method for extracting the Top Atmospheric Radiance (TAR) data:

$$L\lambda = ML * Q_{cal} + AL - O_i \qquad (1)$$

where $L\lambda$ = Top of Atmospheric Radiance,

M_L = band-specific multiplicative rescaling factor,

Q_{cal} = Band10 image,

AL = band-specific additive rescaling factor, and

O_i = correction for Band10.

The temperature of luminosity was then calculated by means of a thermal constant from a metadata file to transform radiance to a sensor temperature. The same is valid for the following:

$$BT = K2 / \ln[(K1/L\lambda) + 1] - (-273.1515) \qquad (2)$$

where BT = brightness temperature. K_1 and K_2 = band-specific thermal conversion constants from the metadata file.

As the proportion of vegetation (PV) is interrelated with the NDVI, NDVI is considered an imprescinct method for LST estimation. The estimate was rendered using the following equation

$$NDVI=NIR-R/NIR+R \qquad (3)$$

where NIR = near-infrared band (Band5) and R = red band (Band4).

The following formula has been used to calculate the proportion of vegetation (PV)

$$PV=(NDVI-NDVIs) / (NDVIv). \qquad (4)$$

The emissivity of every pixel has been measured from the PV value. The land surface emissivity has been derived using the following formula

$$\varepsilon\lambda= \varepsilon V\lambda Pv + \varepsilon s\lambda(1-Pv) + C\lambda \qquad (5)$$

where $\varepsilon_{\lambda=}$ Land surface Emissivity, $\varepsilon_{V=}$ vegetation emissivity, ε_s = soil emissivity, C = surface roughness (C = 0 for homogenous and flat surfaces) considered as a constant value of 0.005 (Sobrino and Raissouni 2000).

Finally, the extraction of LST has been executed using the following equation

$$Ts=BT/[1+\{(\lambda BT/\rho)\cdot \ln\varepsilon\lambda\}] \qquad (6)$$

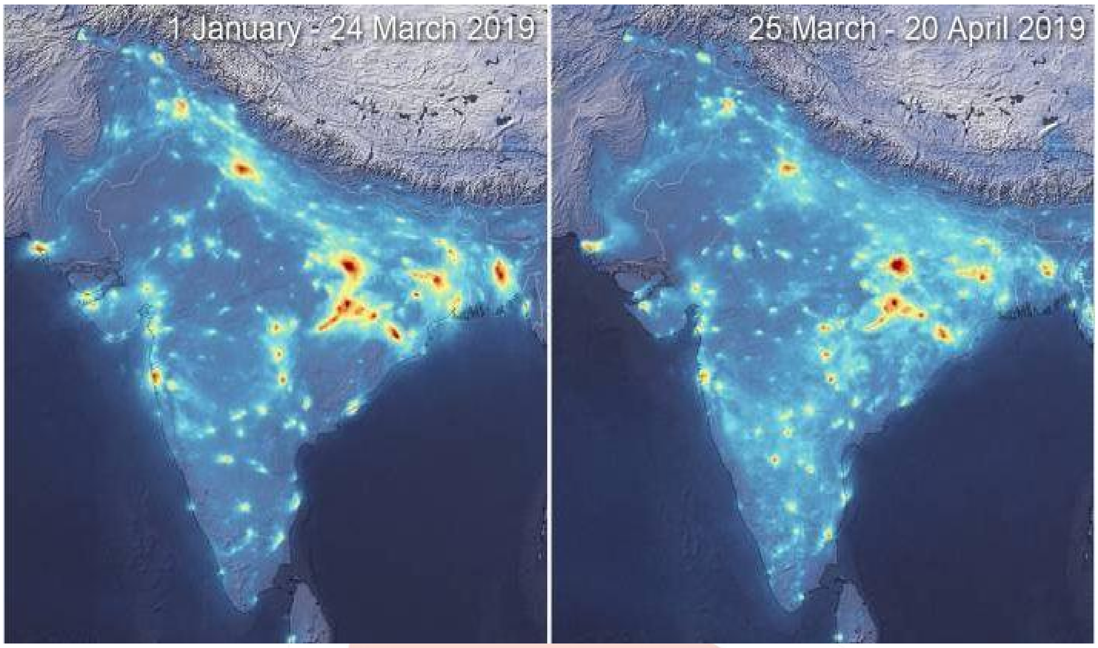
where T_s = LST in Celsius (°C), BT = brightness temperature, λ = wavelength of emitted radiance (λ = 10.895), ε_λ = calculated emissivity.

LST mapping on the Arc GIS 10.3 framework is done after LST calculation during the sampling cycle to compare the change between a locking and pre-locking step of the surface temperature of the earth. In comparison, a graphical representation of MS Excel 2016 shows the extent of temperature variations.

VI. Data analysis

Changing trend of CO, NO2, SO2 and O3 during and pre-lockdown phase over Delhi City

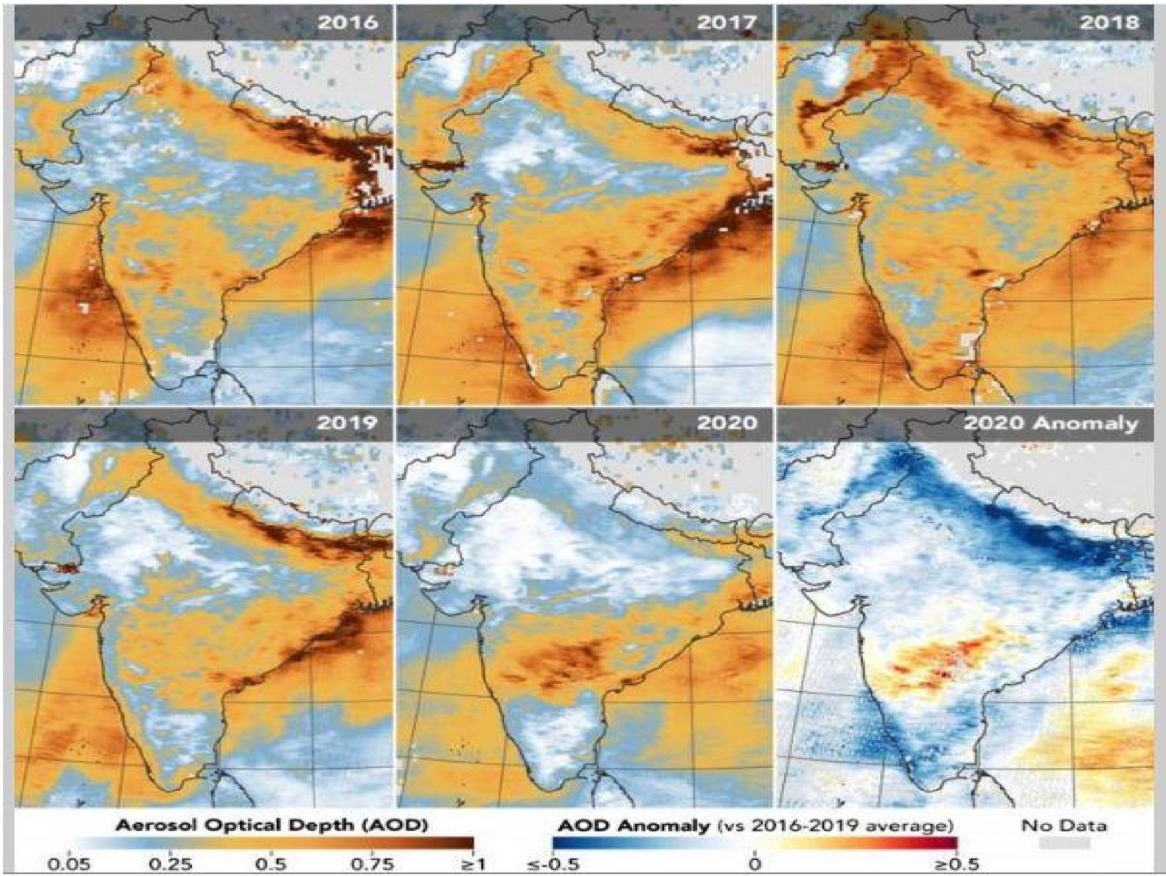
The qualitative aspect of air is recognized as an indispensable criterion for the health-related issues of human being, while 91% population of the world survives in the areas where the inferior air quality surpasses the desirable limit (WHO 2016). The concentration of NO_2 and aerosol has been massively reduced over India in the lockdown period compared with the prior years. The average level of CO, NO_2 and SO_2 is significantly decreased in the year 2020 during the lockdown



phase (March 25 to May15) compared with the identical time period from 2017 to 2019. From March 25 to March 31 in 2017, 2018 and 2019, the average concentration levels of CO were 0.63 mg/m^3, 0.59 mg/m^3 and 0.63 mg/m^3, respectively, whereas in the same months in 2020 the average CO concentration has been reduced up to 0.59 mg/m^3 Supplemental Materials S1, S2, S3 and S4. The similar scenario is observed during April and May of 2020 when the share of CO is radically dropped up to 6.34% and 6.88%, respectively, from April and May of 2019. It is surprisingly noticed that highest monthly average concentration level of CO was 34.88% in May 2018 during pre-lockdown, while the maximum monthly average decrease in CO (14.99%) has been recorded in May 2020 during lockdown period. On the other hand, the reduction rate of NO_2 is highest (12.98%) in the month of April 2020 throughout the lockdown periods, whereas the maximum amount of NO_2 emission (40.19%) was measured in March 2019. The month-wise concentration of mean NO_2 has been declined up to10.66 µg/m3 in May 2020 from 24.74 µg/m3 in May 2017; Supplemental Materials S1, S2, S3 and S4). It is focused that about 19.46% NO_2 is reduced during the quarantine phase in Delhi, while emission of NO_2 is dwindled by 22.79% from March 2019 (41.58 µg/m^3) to March 2020 (18.01 µg/m3). Beside this, the slashing trend of another crucial pollutant (SO_2) has been registered throughout the lockdown period in this overcrowded city of India. In April of 2018, the accumulation of SO_2 in the lower atmosphere was 9.47 µg/m3, whereas the quantity has been diminished up to 5.36 µg/m3 in the same month of 2020 Supplemental Materials S1, S2, S3 and S4). Around 13.4% drop of this lethal gaseous substance (SO_2) occurred during this critical period. In the same way, the extreme concentration of SO_2 (42.92%) had been recorded in May of 2017, while during the lockdown, the highest emission of SO_2 (30.41%) has been found in March of 2020. Moreover; it is an exceptional incident that the density of O_3 has been amplified in Delhi during this ongoing lockdown period. The result shows that the concentration of O_3 is boosted up to 9.73% in April of 2020 and the similar increasing trend has been reported in March and May of 2020 compared with 2019. The quantity of O_3 was 28.08 µg/m3 in April 2019, while it has been increased up to 45.56 µg/m^3 in this particular month of 2020 Supplemental Materials S1, S2, S3 and S4) and it is representing the rebounding tendency of this significant parameter of air quality in Delhi.

Fluctuation of the concentration of suspended particulate matters (PM10 and PM2.5)

The concentration of suspended particulate matters above 100 µg/m^3 in the lower atmosphere is injurious for the health of human being (WHO 2006).



Year	Month	Monthly Average of emission of selective pollutants					
		CO (mg/m^3)	NO_2 (µg/m^3)	SO_2 (µg/m^3)	O_3 (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
2017	March	0.63	20.19	8.21	51.78	85.09	–
	April	0.59	29.15	7.59	62.01	777.95	–
	May	0.68	24.74	10.24	64.65	67.01	–
2018	March	0.59	23.69	7.74	28.81	92.78	44.38
	April	0.63	24.21	9.47	44.18	65.26	32.84
	May	0.83	20.47	4.27	54.61	63.40	37.91

2019	March	0.63	41.58	9.13	43.56	103.21	67.62
	April	0.54	25.55	8.27	28.08	75.79	42.20
	May	0.52	16.48	6.82	31.92	88.99	34.81
2020	March	0.59	18.01	10.96	53.48	71.70	42.82
	April	0.40	11.77	5.36	45.56	44.79	24.32
	May	0.36	10.66	2.54	38.68	35.66	16.86

The continuous dropping of PM_{10} and $PM_{2.5}$ has been recorded from March 25 to May 15, 2020, in comparison with the preceding 3 years (2017–2019). During the lockdown phase in the year 2020, the monthly average concentration of PM_{10} is varied from 13.98 to 20.32% (Table 2). Just during the initiation of lockdown (in the end of March 2020), PM_{10} level is dropped to 8.94% in comparison with 2019 and the magnitude of reducing trend becomes sharply vibrant through the lockdown months (Table 2). PM_{10} is reduced by 11.75% and 20.91% in April and May of 2020, respectively, from same months of the year 2019 (Table (Table2).2). The maximum monthly average quantity of this suspended pollutant (103.21 µg/m^3) was found in March 2019, while the highest average concentration of PM_{10} (71.70 µg/m^3) is measured in March 2020 throughout the continuing lockdown (Table (Table1;1; Fig. 4; Supplemental Materials S1, S2, S3 and S4). Moreover, throughout the lockdown, the extreme decrease in PM_{10} emission (35.66 µg/m^3) has been recorded in May 2020. Similarly, in May of 2020, $PM_{2.5}$ is decreased up to 23.5% compared with May 2018 (Table (Table2).2). During the lockdown period in Delhi, the maximum reduction of $PM_{2.5}$ is recorded around 16.86 µg/m3 in May, whereas during pre-lockdown scenario, the maximum accumulation of this suspended particulate matter was registered around 67.62 µg/^{m3} in March of 2019 (Table 1.1; Supplemental Materials S1, S2, S3 and S4). The decline of $PM_{2.5}$ in lockdown phase has been restricted within the range of 16.86–42.82 µg/m^3 which reflects approximately 16–20% reduction in comparison of $PM_{2.5}$ in 2019.

Impact of Air Quality change on land Surface Temperature

The LST documents indicate the distinct difference between the lock-down and pre-lockdown conditions at Delhi's surface temperature. The analysis indicates that surface temperatures have fallen substantially in contrast with previous years since the lockdown persists (2017–2019). Surface temperatures range between 26.39 and 33.34 ° C during the lockout period from 25 March to 15 May 2020 (Figs.55 a and b, b,6,6 and 7).7). The ambient temperature rise has been expressed from 26.62 to 36.54 ° c over the previous duration of lockdown status (2017–2019) and it is to be remembered that the temperature inside a lockdown setting has been lowered by 0.23 to 3.2 ° c. The average surface temperature for the above duration has been defined in 2020 at 29.98 ° C, while the average temperature for 2017–2019 was 31.84 ° C. Lower atmosphere temperature raises steadily as suspended particulate matter and other contaminants increase." The presence of pollution is thus explicitly related and the temperature is reduced.

VII. Conclusion

The COVID-19 pandemic lockout solution sends an important warning in order to restore environmental health and security to all countries around the world. The relentless lockout of a slaughterer seems to have been a plague of millions and the global economy is experiencing huge shocks as a result of this grotesque and unusual event. In the meantime, water purification and air quality improvements have undoubtedly been useful gifts for the temporary lockout mechanism in a global emergency. "Delhi is certainly taking the healthier atmosphere during a time of lock-down with the upgrade of air quality standards and decreasing weather patterns. The severe air pollution is the principal regulating factor for mortality in the Delhi. This study revealed that the concentration of pollutants like NO2, CO, PM10 and PM2.5 over the Delhi during lockdown phase was significantly low compared with previous years. This scientific analysis has attempted to include a range of long-term steps to enhance the health of Delhi 's environment. Applied research with instrumental and methodological advancement is strongly needed in the numerous polluted cities in India in order to tackle such damaging air pollution. Both state governments, along with the central government," can integrate numerous related environmental aspects as mandatory in academic curricula and support young scholars and researchers for these applicable research programmes.

REFERENCES

[1] Acharya S, Jena RC, Das SJ, Pradhan C, Chand PK. Assessment of air pollution tolerance index of some selected roadside plants of Bhubaneswar city of Odisha State in India. Journal of Environmental Biology. 2017;38:1397–1403. doi: 10.22438/jeb/38/6/MS-183. [CrossRef] [Google Scholar]

[2] Andrade MF, Kumar P, Freitas ED, Ynoue RY, Martins J, Martins LD, Nogueira T, Perez-Martinez P, Miranda RM, Albuquerque T, Gonçalves FLT, Oyama B, Zhang Y. Air quality in the megacity of São Paulo: evolution over the last 30 years and future perspectives. Atmospheric Environment. 2017;159:66–82. doi: 10.1016/j.atmosenv.2017.03.051. [CrossRef] [Google Scholar]

[3] Arden Pope C, Burnett Richard T, Thurston George D, Thun Michael J, Calle Eugenia E, et al. Cardiovascular mortality and long-term exposure to particulate air pollution. Circulation. 2004;109:71–77. doi: 10.1161/01.cir.0000108927.80044.7f. [PubMed] [CrossRef] [Google Scholar]

[4] Bamniya BR, Kapoor CS, Kapoor K, Kapasya V. Harmful effect of air pollution on physiological activities of Pongamia pinnata(L.) Pierre. Clean Technologies and Environmental Policy. 2011;14:115–124. doi: 10.1007/s10098-011-0383-z. [CrossRef] [Google Scholar]

[5] Bashir MF, Ma B, Komal B, Bashir MA, Tan D, Bashir M. Correlation between climate indicators and "COVID-19 pandemic in New York, USA. Science of the Total Environment. 2020;728:138835. doi: 10.1016/j.scitotenv.2020.138835. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[6] Bherwani, H., Gupta, A., Anjum, S., Anshul, A., Kumar, R. (2020). Exploring Dependence of COVID-19 on environmental factors and spread prediction in India. *Research Square*. 10.21203/rs.3.rs-25644/v1.

[7] CAMS (2020) CAMS, 2020. https://atmosphere.copernicus.eu/amid-coronavirus-outbreak-copernicus-monitors-reduction-particulate-matter-pm25-over-china.

[8] Census of India, Govt. of India. (2011). Provisional Population Totals. Registrar General & Census Commissioner. https://censusindia.gov.in/2011-prov-results/prov_results_paper1_india.html.

[9] Chakraborty I, Maity P. COVID-19 outbreak: migration, effects on society, global environment and prevention. Science of the Total Environment. 2020;728:1–7. doi: 10.1016/j.scitotenv.2020.138882. [PubMed] [CrossRef] [Google Scholar]

[10] Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, Li J, Zhao D, Xu D, Gong Q, Liao J, Yang H, Hou W, Zhang Y. Clinical characteristics and intrauterine vertical transmission potential of COVID19 infection in nine pregnant women: a retrospective review of medical records. Lancet. 2020;20:30360–30363. doi: 10.1016/S0140-6736(20)30360-3. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[11] Coronavirus in India. (2020). https://www.covid19india.org/.

[12] CPCB. (2009). Comprehensive industry document stone crushers, Central Pollution Control Board, Govt. of India, Series: COINDS/78/2007–08, 1.1–8.21. https://cpcbenvis.nic.in/scanned%2520reports/COMP_IND_STONE_CRUSHER_REPORT.pdf.

[13] CPCB. (2020). Impact of lockdown (25th March to 15th April) on air quality. Ministry of Environment, Forest and Climate Change, Govt. of India, Delhi, 1–62. https://cpcb.nic.in/latest-cpcb.php.

[14] Das R, Khezri B, Srivastava B, Datta S, Sikdar PK, Webster RD, Wang X. Trace element composition of PM2.5 and PM10 from Kolkata—a heavily polluted Indian metropolis. Atmospheric Pollution Research. 2015;6:742–750. doi: 10.5094/APR.2015.083. [CrossRef] [Google Scholar]

[15] Dutheil, F., Baker, S. J., Navel, V. (2020). COVID-19 as a factor influencing air pollution?. *Environmental Pollution*. 10.1016/j.envpol.2020.114466 [PMC free article] [PubMed]