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Engineering

IMPACT ANALYSIS OF THE COVID19 ON THE ATMOSPHERIC AIR QUALITY AND ELECTRICITY CONSUMPTION PER DAY IN INDIA.

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ABSTRACT The corona Virus pandemic is an unexpected part of our life. Following the lockdown procedures implemented by the Indian government, the atmospheric air quality and the power sector of India noticed decadent changes. However, the relaxation in lockdown brought situations almost back to normal. The paper focuses on analyzing these changes to review the current scenario according to the published studies. It focuses on electricity consumption, night light intensity, and variations in many pollutants like NO2 and PM. For ease, the main cities chosen for the research are the metropolitan cities of India. The data are from US-EPA, POSOCO, VIIR satelites and so on. The paper helps us understand if this variation is a boon or bain for the Indian economy.

KEYWORDS : COVID-19, Electricity Consumption, Air Quality, Atmosphere, Energy Consumptions, Night Light Intensity.

INTRODUCTION

On March 25th, Prime Minister of India Narendra Modi announced a nationwide lockdown, accounting for the safety precautions required to fight against the Coronavirus (SARS-CoV- 2). Ever since then, there has been an exponential surge in the number of infections reported per day. From April to September 2020, as the number of cases kept increasing, more people restricted themselves from going out to keep themselves safe and well. As of September 7th, 2020, India recorded 41.13 Lakhs of confirmed infections, making her the second most affected country in the world after the USA. On July 15th, 2020, the phase-1 clinical trials for the first indigenous Coronavirus Vaccine, Covaxin, developed by Hyderabad-based pharmaceutical company Bharat Biotech and the National Institute of Virology and Indian Council of Medical Research, starts across the country.

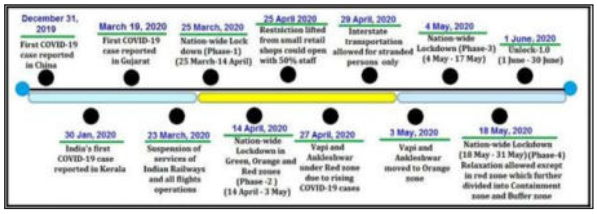

***Fig: 1 (6)**-Corona-Virus Pandemic India-Timeline.*

Simultaneously, many researchers have been working on the impact of lockdown on atmospheric CO2 levels and electricity consumption per day. While e-collaborations positively impact the present climate and environment, it is definite that reduction will be short-lasting, attributing it to the close-down of transport, construction works, and industrial activities.

The Corona-Virus pandemic has an unparallel effect on our everyday life, which will continue until a minimum of the next three years. While research, vaccination, and protocol documentation procedures are currently ongoing, the impact of lockdown on the environment is also a widely inspected topic. A calculated set of restrictions imposed on the economy to reduce the spread of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS- CoV-2) has an overall positive effect on the environment. The beneficial impact includes reduced particulate matter levels in the atmosphere, decreased carbon dioxide (CO2) levels, reduced kerosene or related fuel use, and increased awareness about the importance of the 5Rs. A study conducted by analyzing the data and images collected from the Sentinel satellite-ESA revealed a 45% decline in atmospheric NO2 levels in India(1). Air pollution takes the lives of almost 1.7 million per year. Besides global warming, Air pollution has fueled many recent disasters, namely the Kerala floods of 2018-2019, the Assam floods 2019-2020, the Amazon Forest Fire, the Sydney forest fires, Australia floods 2021, and it keeps going on. Air pollution symptoms include aggravated respiratory diseases like asthma and bronchitis, dry throat, wheezing, nausea, and headache. In India, the Northern parts are the most polluted areas, especially Delhi, mainly due to emissions from Vehicles, brick kilns, coal- based thermal power plants, and crop remnants(2). The total energy consumption (ameasure for the amount of electricity consumed) and the lights per area (a measure of the intensity of light in the area) are the proxy indicators for consumption level measurements (3). Ever since the nationwide lockdown, there is a decline in daily energy consumption. The official power consumption data captured by POSOCO (Power System Operation Corporation) has recorded a 26% decline since the nationwide lockdown. The table below represents a section of the data released by POSOCO (4).

Date	Energy Consumption (GWh)					
	Northern Region	Western Region	Southern Region	Eastern Region	North-Eastern Region	All India
18-Mar-20	827	1187	1148	383	42	3586
22-Mar-20	734 (-11%)	971 (-18%)	975 (-15%)	315 (-18%)	36 (-13%)	3030 (-15%)
23-Mar-20	724 (-12%)	996 (-16%)	1030 (-10%)	325 (-15%)	39 (-5%)	3113 (-13%)
24-Mar-20	695 (-16%)	944 (-20%)	983 (-14%)	314 (-18%)	39 (-7%)	2975 (-17%)
25-Mar-20	665 (-20%)	844 (-29%)	911 (-21%)	320 (-16%)	36 (-13%)	2777 (-23%)
26-Mar-20	628 (-26%)	771 (-34%)	891 (-23%)	327 (-15%)	35 (-16%)	2652 (-26%)

Figures in parentheses indicate percentage change from 18th March 2020

Table 1.1 (4)-POSOCO Data.

The data collected from the different sources suggests a pollution reduction, but the trend is inconsistent. Analyzing these trends and converting them into more consistent data is of the highest priority right now. COVID19 is posing as an opportunity to do the same. The paper has put together a review of the recent researches analyzing this impact.

Atmospheric Air Quality

Researching and identifying air quality index measures of a particular area requires humongous data on the primary sources in the area, optimal pollution levels, meteorology, demographics, geography, and computational capacity (7). PM-2.5 and PM-10 are the most dangerous types of pollutants released into the atmosphere. PM-2.5 is a type of particulate matter whose size is less than 2.5 micro-meter, which is small enough to enter our lungs and bloodstream. Numerous studies link PM-2.5 to various health risks compared to other pollutants.

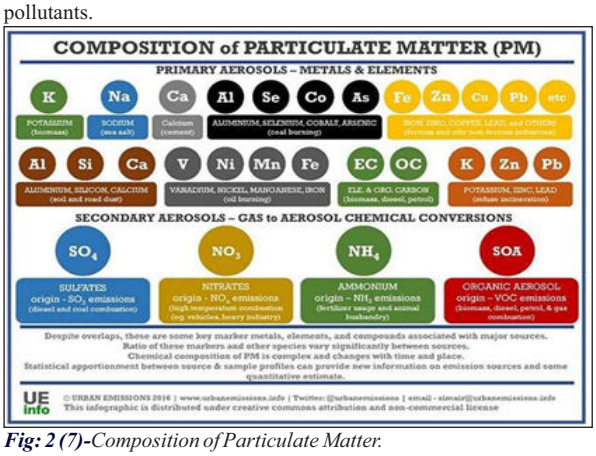

***Fig: 2 (7)**-Composition of Particulate Matter.*

Table-2 (8)- Percentage Reduction In Emissions During The Lockdown Period 25/03/2020 To 15/04/2020 Compared To 24/03 To 15/04, 2019.

Pollutant	Date	Bengaluru	Chennai	Hyderabad	Mumbai
NO_2	24, Mar–15 Apr,2019	67.1	47.6	39.7	6.8
	BaU 25, Mar–15 Apr,2020	57.7	28.7	30.1	27.9
$PM_{2.5}$	24, Mar–15 Apr,2019	45.1	45.7	18.9	42.0
	BaU 25, Mar–15 Apr,2020	45.2	28.7	12.3	39.9
SO_2	24, Mar–15 Apr,2019	1.7	8.2	9.4	3.4
	BaU 25, Mar–15 Apr,2020	10.7	33.0	-17.2	45.2
CO	24, Mar–15 Apr,2019	23.2	39.6	24.6	-55.1
	BaU 25, Mar–15 Apr,2020	27.6	13.4	9.8	37.1

Change In Pm-2.5 And Pm-10

The inevitable parameter in determining the air quality of a particular area concerning PM is identifying the optimal ambient concentration levels of the pollutant. Table 2 shows the percentage reduction in emissions during the lockdown period 25/03/2020 to 15/04/2020 compared to 24/03 to 15/04, 2019. (Eregowda, n.d.)(8) tabulated the results by collecting data from Bengaluru, Chennai, Hyderabad, and Mumbai. Table-2 shows a 5.1, 45.7, 18.9, and 42% decrease in PM-2.5 pollutant emission. (Ghosh, n.d.) (9) has tabulated the results by collecting data from the Indian Metropolitan cities NCR-Delhi, Mumbai, Chennai, and Kolkata. Figure 3 shows the results obtained by Ghosh, n.d. from the Landsat 8 OLI and TIRS- Derived Data and Mamdani Fuzzy Logic Modelling Approach to understand PM-10 concentration Variation.

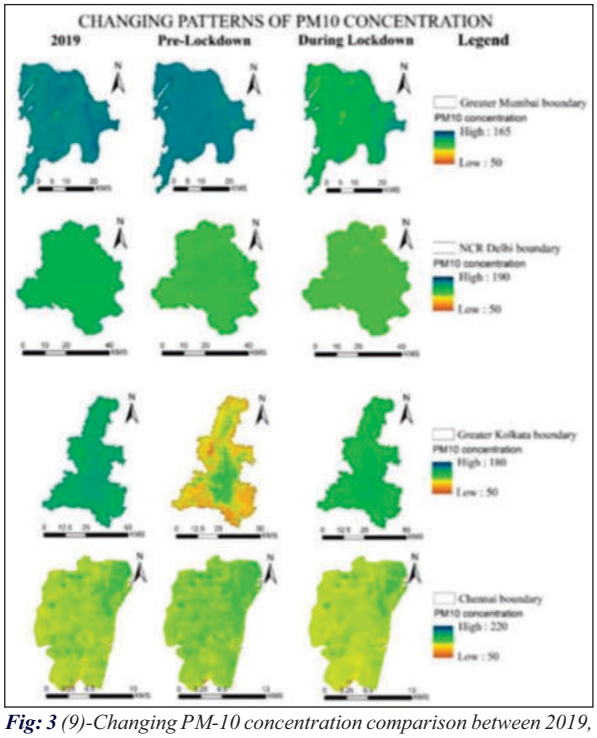

Fig: 3 *(9)-Changing PM-10 concentration comparison between 2019, pre-lockdown 2020, and during lockdown 2020.*

The PM-10 sources include motor vehicles and construction works. It is the causes numerous health risks, environmental harm, and reduced human comfort levels. While the concentration legends for Mumbai and Chennai are decreasing, Delhi and Kolkata show an increase in PM-10 concentration between pre-lockdown and during the lockdown (9). The variation may be due to the shutdown of industries and restricted human movement compared to other cities. Mr. P. Singh, in his research work, focused on the Air Quality Index and PM2.5 levels by collecting data from the cities with a branch of the US Embassy in India (10). The Embassies collect the data via US Environmental Protection Agency (EPA) through the Air-Now portal (11).

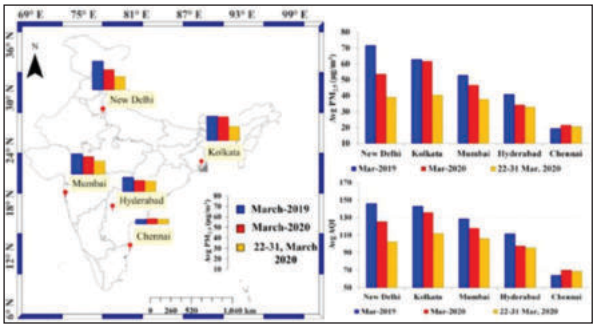

Fig: 4 (10)- *The left panel shows the locations for the research work done by Mr. P. Singh. The right panel presents the Average PM2.5 and Air Quality Index (AQI) chart for the area.*

Analyzing the data represented in fig-1, it's clear that the PM2.5 and AQI at the areas of study as reduced noticeably during the lockdown period. The pollution levels at Mumbai, Hyderabad, and Chennai have decreased by 19.25%, 3.99%, and 5.40%, respectively. At the same time, Kolkata and Delhi show a considerable reduction of 34.52% and 27.57%, respectively, in the pollutant levels. The northern parts of India, especially the Indo-Gangetic Plains (IGP), have higher levels of PM2.5 throughout the year. The factors includedemographic, geographic, seasonal activities, and meteorological parameters. The proximity to the sea for Chennai and Mumbai can cause air mass circulation from the sea surface, which is a possible explanation for the reduced pollution levels. The same is applicable for New Delhi and Kolkata.

Change In No_2

NO_2 is one of the most common pollutants which is highly dependent on the local sources. The dependency is due to its short residence time in the atmosphere. Ms. Eregowda stated in her paper that the NO2 concentration levels at Bengaluru fell from 50 µg/m3 to 10 µg/m3 throughout the lockdown period. The same follows for Chennai, Hyderabad, and Pune. Figure 5 presents the above data graphically.

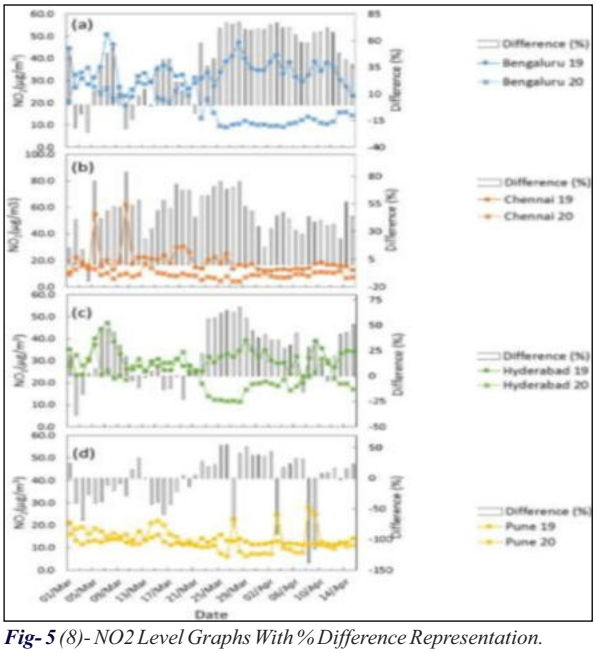

Fig- 5 *(8)- NO2 Level Graphs With % Difference Representation.*

Mr. P. Singh considered the tropospheric NO2 measure by analyzing the data from the Ozone Monitoring Instrument (OMI). The Ozone Monitoring Instrument (OMI) is a section of NASA's A-Train Satelite that measures the levels of various atmospheric gas concentrations. Table-3 represents the box coordinates of the US-embassy locations chosen by Mr. Singh for the research.

Table-3 (10)- The Locations Of The Us-embassies And Their Box Coordinates From OMI.

Location	Latitude	Longitude	Box Coordinates
Delhi	28.59	77.18	W-76.68, S-28.07, E-77.68, N-29.07
Kolkata	22.54	88.35	W-87.86, S-22.08, E-88.86, N-23.08
Mumbai	19.06	72.86	W-72.42, S-18.55, E-73.42, N-19.55
Hyderabad	17.44	78.47	W-77.78, S-17.01, E-78.78, N-18.01
Chennai	13.05	80.25	W-79.76, S-12.56, E-80.76, N-13.56

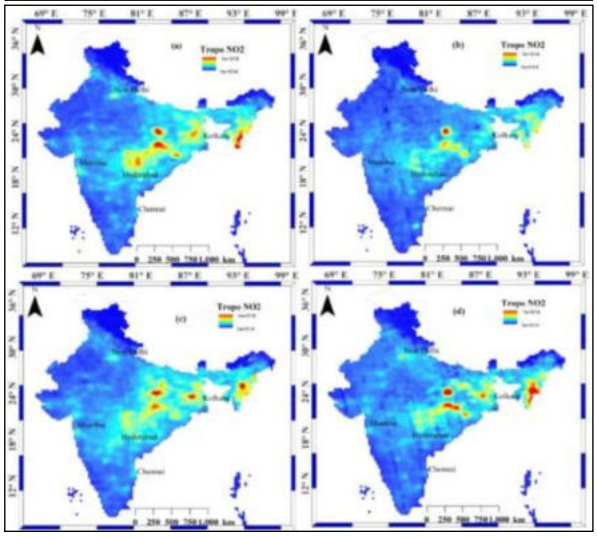

Fig- 6- *Tropospheric NO2 (spatial Variations)- a)10–21March 2019, (b)10–21 March 2020, (c)22–31 March 2019, and (d)22–31 March 2020.*

Fig-6 represents the results tabulated by Mr. P. Singh. An HYPSPLIT Model prepared by Mr. P. Singh shows that long-range air mass transportation affects the air quality at the five selected locations. The westerly air mass transfer is what affects Kolkata, a city located in the eastern Indo-Gangetic Plain. The sources of NO2 in Mumbai, Delhi, and Kolkata are anthropogenic. While so, the release of NO2 in Chennai and Hyderabad is due to the burning of biomass. Hence the decline in NO2 levels during the lockdown is mainly due to the reduction in anthropogenic emissions.

Change In Land Surface Temperature(lst)

LST is an important factor for environmental health, as it depends on numerous physical and atmospheric parameters (9). Factors like cloud conditions, month, Land Use/Land Cover (LULC) patterns, and so on governs the results. The LST map for 2019, before lockdown 2020 and after lockdown 2020, is given in Figure-7. The transition period in India from winter to summer is from February to March. And the summer season is From March to May.

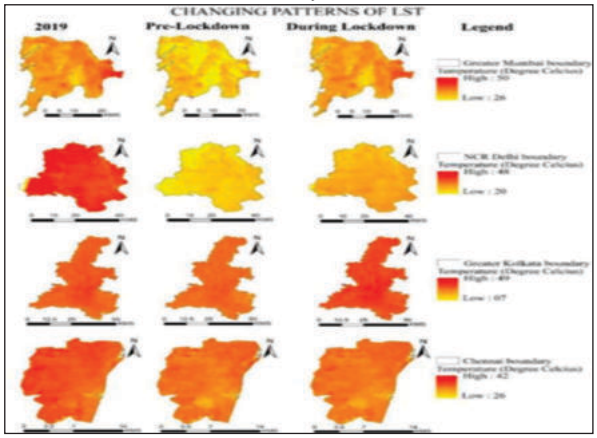

Fig- 7-(9) *Changing variations in LST. The LST Map.*

These variations in seasonal temperatures can show an increasing trend in the land surface temperature. From the map, it is clear that the temperature map during the pre-lockdown period is less compared to the others. Even though the maps show a similar trend in the four cities, the temperatures in Mumbai, Delhi, and Kolkata are around 48ºC to 50ºC. Chennai records lower temperatures in the range of 42ºC to 44ºC.

Electricity Consumption

India is the second most populated (1,391.99 Million) and the seventh-largest country in the world(16). The lockdown has imposed several restrictions on many industrial and everyday goods and other service-related activities. Between January and February of 2019 and 2020, the energy demand increased by 3% and 7%, respectively (17). But, during March 2020, the supply-demand reduced by 3%. Between March 24th and April 19th, the power supply decreased by 25%.

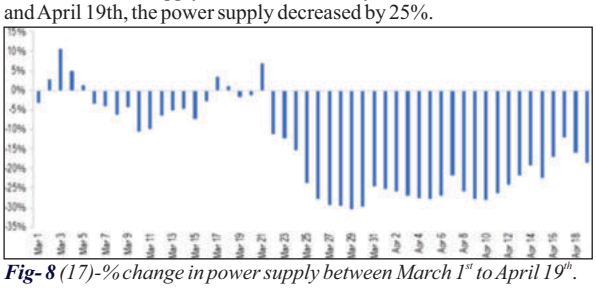

Fig- 8 *(17)-% change in power supply between March 1st to April 19th.*

It is necessary to understand the power consumption in different sectors of India to analyze the power demand variation in India. Fig-9 presents the power consumption in consumer segments of India in 2018-19. Since the government forced the industrial and commercial sectors to shut down during the lockdown, the decrease in demand is self-explained. Table- 4 shows the contribution of different sources to energy production in India.

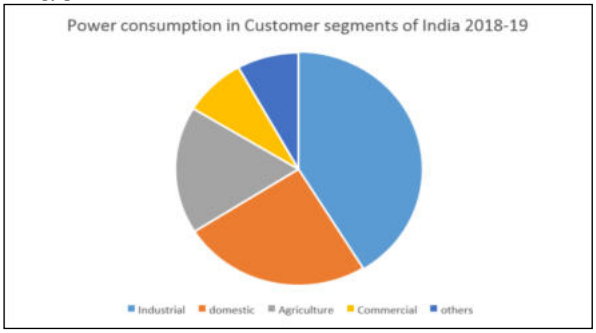

Fig- 9 *(17)- Power consumption in Customer segments of India 2018-19.*

Table-4 (17)- The contribution of different sources to energy production in India from March 1st to April 19th, 2021.

Energy Sources	Average Generation			Contribution to Total (in %)	
	Mar 1-Mar 24	Mar 25-Apr 19	% change	Mar 1-Mar 24	Mar 25-Apr 19
Coal	2,511	1,873	-25%	72.5%	65.6%
Hydro	302	331	10%	8.7%	11.6%
Renewables (of which)	325	312	-4%	9.4%	10.9%
a. Solar	*157*	*162*	*3%*	*4.5%*	*5.7%*
b. Wind	*97*	*96*	*0%*	*2.8%*	*3.4%*
Gas, Naptha, Diesel	132	146	11%	3.8%	5.1%
Nuclear	113	114	1%	3.3%	4.0%
Lignite	82	78	-5%	2.4%	2.7%
Total	**3,465**	**2,854**	**-18%**	-	-

Amid the lockdown, the power generation reduced by 25%, compensating for the decrease in demand (17). While considering electricity variations, night light intensity is also a contributing factor. Night light intensity provides information regarding energy consumption in areas with high spatial granularity. Electricity consumption and night light intensity are contributing factors for the analysis of national GDP (18).

For instance, the demonetization in India, 2016 was highly backed up by night light intensity analysis (19). Asmentioned, the impact of the nationwide lockdown on India remained even after the release of a few restrictions. The consumption levels were below 14%, and the average monthly fluctuations remain 6% to 10% below the normal (18). Fig-10 shows the trend in electricity consumption from 2013 to 2020.

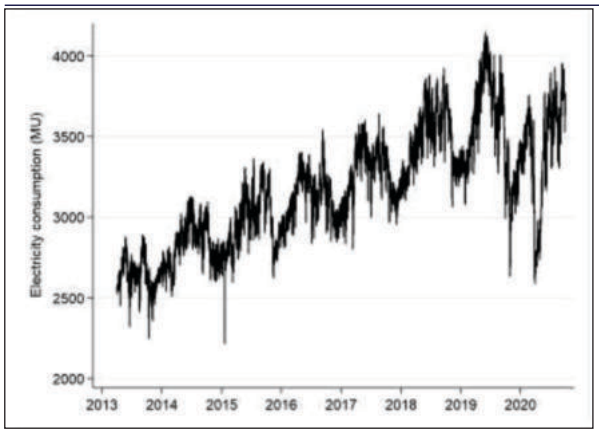

Fig-10 *(18) The trend in electricity consumption in India from 2013 to 2020*

C. M. Beyer extracted the nighttime light data from the VIIRS-DNB Cloud made available by the Earth Observation Group at the National Oceanic and Atmospheric Administration (NOAA). The data collected was from April 2013 to April 2020 (18). IIRS satellites have a resolution of 15-arc seconds. Fig-11 shows the changes in the night light time trends in India.

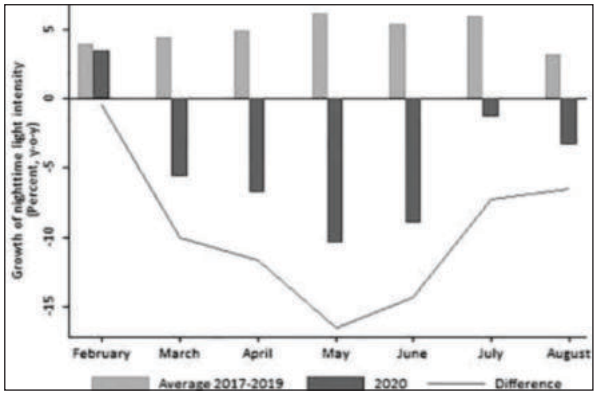

Fig-11 *(18)the Changes In The Night Light Time Trends In India.*

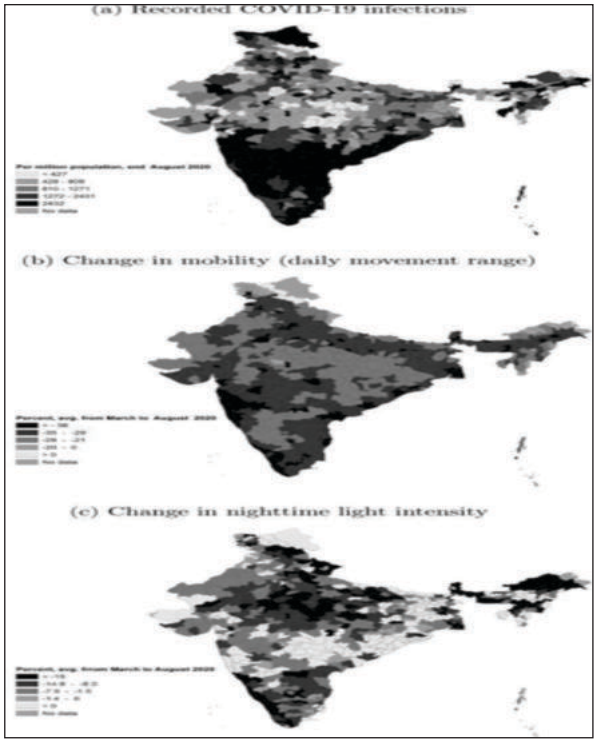

Fig-12 *(18)- The spatial variation and impact of COVID-19 across India.*

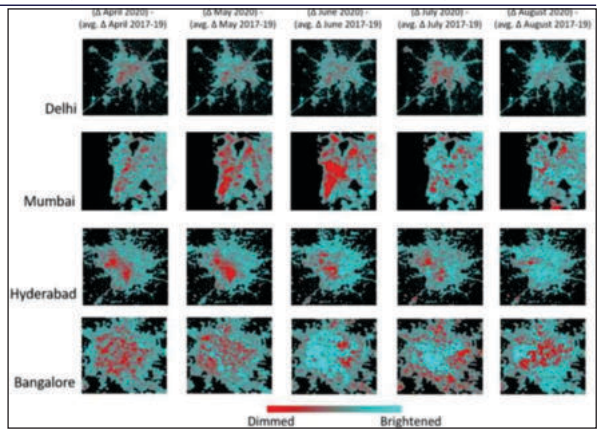

Fig- 13*-(18)- The changes in night light intensity across India during the lockdown.*

CONCLUSION

The impact of lockdown on India is a huge game-changer. The decrease in pollutant levels and electricity consumption rates are posing as an opportunity and a threat at the same time. Through this paper, we have discussed the findings achieved by the researchers for the betterment of our environment. India can rewrite its future to become a sustainable country. The documented results are proof highlighting our potentials.

As the COVID virus spread out, the government keeps extending the lockdown. The positive impact through this episode is huge. Since the energy consumption levels are proportional to household income, the reduced consumption can show the deteriorating levels of the economy. The Corona Virus pandemic will negatively impact all industries, including the power sector of India. But, so far, the impact is positive. Now we get to decide if it will remain the same or not.

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