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ABSTRACT

Air quality index instrument is used for air quality monitoring. These five pollutants use for AQI indexing, NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone was used to study air quality in Jodhpur during lockdown (2019-2021). The mean value of NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone were in 189.8, 86.2, 28.8 , 53.3 μg/m^3 and 1.15mg/m^3 in observed in 25 March to 31 March 2019 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 214.4, 106.4, 40.7, 51.8μg/m^3 and 1.20mg/m^3in observed in 1 April to 31 April 2019 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 241.7, 11.4, 34.4, 63.6 8μg/m^3 and 1.2320mg/m^3in observed in 1 May to 31 May 2019. The mean value of NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 85.4, 44.0, 21.8, 43.0, μg/m^3 and 1.07mg/m^3 in observed in 25 March to 31 March 2020 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 98.5, 48.0,20.5, 40.5μg/m^3 and 0.61mg/m^3in observed in 1 April to 31 April 2020 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 138.0, 69.8, 20.5, 50.1μg/m^3 and 0.64mg/m^3in observed in 1May to 31 May 2020 . The mean value of NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 256.0, 108.3, 27.1, 46.2 μg/m^3 and 0.82mg/m^3 in observed in 25 March to 31 March 2021 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 212.5, 88.9, 29.0, 40.9 μg/m^3 and 0.82mg/m^3in observed in 1 April to 31 April 2021 and NO_2, $PM_{2.5}$, CO, PM_{10}, Ozone are in 154.8, 66.5, 16.6, 32.5 μg/m^3 and 0.79mg/m^3in observed in 1 May to 31 May 2021.

Keywords: *Ambient air quality, Residential area, air pollutant (PM_{10},$PM_{2.5}$,NO_2 , CO, Ozone), Air qua lity index , Jodhpur city, etc.*

INTRODUCTION

Since the beginning of 2020, the unique coronavirus illness (COVID-19) contamination has exposed the entire world to a severe pandemic and difficult conditions. Wuhan, China, recorded the discovery of the first case in December 2019 [3]. The WHO proclaimed the new coronavirus to be a global pandemic on March 11, 2020. On July 8, 2020, it had spread to over 210 nations, sickened over 11 million individuals, and claimed 539,026 lives1. Since COVID-19 is highly contagious and has a high fatality rate2, several nations have implemented preventative measures, including widespread COVID-19 screening tests, quarantines, social seclusion, the wearing of masks, hand sanitization, etc. The communicable disease has spread globally at an increasing rate, leading to the designation of COVID19 as a global pandemic [9]. To stop the spread of COVID-19, many nations have enacted a rigorous national lockdown with a variety of rules and regulations. Borders, airports, hotels, places of business, and educational institutions were all shuttered in numerous parts of the world. Many academics have noted a global decline in air pollution as a result of constrained social and economic activity during a lockdown [6].

The first COVID-19 case in India was discovered on January 30, 2020 in Trisharu, Kerala (India) (WHO, 2020), and further cases were found in other regions of the nation the following week. Eventually, the Prime Minister of India declared a "Janata Curfew" for the entire day of March 22, 2020, with no normal everyday operations allowed. Subsequently, it was officially stated that all of India will be in complete lockdown from March 25 to April 14, 2020. As to May 21st 2020, over 1 lakh cases have been confirmed in India, with over 3700 deaths [11]. Subsequently, the lockdown was extended to May 3, 2020, to deal with the pandemic's fall in the country. It was prolonged with slight relaxation till May 31, 2020 after considering the challenging scenario. The result of the covid-19 lockdown is that there has been a reduction in the amount of pollution of many pollutants, which has improved the air quality. The lockdown has helped the environment by enhancing the quality of the air and water and reducing noise pollution [5].

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In today's urban areas, the quality of air is continuously deteriorating due to increasing commercial activities, industrial activities and transportation. Which has a direct effect on the health of human. The substance polluting the environment are called pollutant. Particulate matter (PM_{10},$PM_{2.5}$), ground level Ozone(O_3), Nitrogen dioxide (NO_2) and Carbon monoxide (CO) are the most common air pollutants. Construction area and unpaved road, agricultural are source of PM_{10} and$PM_{2.5}$. Long-term exposure to them includes many serious diseases like cancer, stroke, lunges or an increase in non-accidental mortality.NO_2 pollution is emitted by vehicles, power plants, off roads and welding and using explosive. Elevated level of NO_2 can cause damage to the human lunges and respiratory infection. Ozone is formed in the atmosphere though chemical reaction between pollutants emitted from combustion, evaporation of paints and it is the cause of many diseases like chest pain, throat irritation. CO generally occur in areas with heavy traffic congestion and it is produced by fossil fuel-powered engine. The most common effect of CO exposure are headaches, fatigue and it displaces oxygen in the blood and other vital organs of oxygen. Poor air quality suppresses the immune system, leading to virus replication [4]. The Air Quality index is used to prepare the daily air quality report of the atmosphere. AQI is used by Government agencies to aware the public how polluted the air currently is. The AIR (Prevention and Control of Pollution) Act was passed by the Indian Parliament in 1981. The Environment (Protection) Act followed in 1986. The Central Pollution Control Board, which is part of the Indian Government's Ministry of Environment, Forests, and Climate Change, launched the National Air Quality Index (NAQI) to track the air quality index of the country's major urban areas based on eight pollutants. Air Quality Index is used by a total of 223 stations in India that are part of the Central Pollution Control Board (CPCB) of the Ministry of Environment, Forests, and Climate Change to continuously monitor the air quality (AQI). This study has made use of the National Air Quality Index. The effects of pollution on health can be understood with the aid of NAQI. AQI refers to analysing of complex data of various air pollutants into a single number which is called index value along with nomenclature and colour.

Jodhpur is considered as one of the famous tourist destinations of Rajasthan and according to the report of the World Health Organization (WHO) in May 2016; it is the most polluted city in Rajasthan. AQI based on 5 Pollutants respectively particulate matter (PM_{10}, $PM_{2.5}$), ground level Ozone (O_3), Nitrogen dioxide (NO_2) and Carbon monoxide (CO) were studied in Jodhpur during lockdown [2]. The purpose of this work is to compare air quality data from 25 March to 31 May 2019 ,2020 and 2021 in order to analyse the effects of total lockdown in Haryana on air quality during COVID-19. The restoration of air quality is significantly aided by lockdown [1]. The temporal variation of the air quality index has been attempted to reflect in this work. This study will assist us in revaluating potential strategies for raising air quality while maintaining the principles of ongoing sustainable development. The purpose of the paper is to ascertain the effect of lockdown on air quality in a specific area in Jodhpur. The goal of the paper is to compare the pollution levels in Jodhpur City for the years 2019, 2020, and 2021, which demonstrates how they changed before, after, and during lockdown. As it is clear from this study that humans put a lot of strain on our planet prior to the spread of this virus, this type of research is applicable in the current scenario. Also, it will assist in creating a plan of action for unforeseen episodes of high levels of air pollution in metropolitan settings.

MATERIAL AND METHOD

Sampling station Collector ate, Jodhpur - RSPCB, was chosen for monitoring the air quality in Jodhpur City's commercial areas for the analysis of air pollution and determination of the Air Quality Index. Using a respirable dust sampler, fine particle sampler, gaseous sampling attachment (EPA Modified-West and Geake method for SO_2 and Modified Jacobs Hochheiser method for NO_2), and CO metre, five ambient air pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_2, and CO) were identified. According to the Central Pollution Control Board's standards, readings were taken from 25 March to May 31 of years- 2019, 2020 and 2021. The Central Pollution Control Board (CPCB) site at http://app.cpcbccr.com/ccr/#/caaqmdashboardall/caaq

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m-landing/caaqm-comparison-data provided the dataset for the current study. The CPCB has established a number of instruments with sensors that have been approved by international meteorological organisations in order to collect data.

OBSERVATIONS & ANALYSIS

Table 1 represents the breakpoint concentration of various pollutants. It used to calculate the sub index of each pollutant and value of highest sub index is called AQI. Table 2 represent average value of sub index of pollutant for Collectorate, Jodhpur – RSPCB.

Table 1: Breakpoints for AQI Scale 0-500 (Units: µg/m^3 unless mentioned otherwise)

AQI Category	**PM_{10}**	**$PM_{2.5}$**	**NO_2**	**CO**	**Ozone**
(Range)	24-hr	24-hr	24-hr	8-hr (mg/m^3)	8-hr
Good (0-50)	0-50	0-30	0-40	0-1.0	0-50
Satisfactory(51-100)	51-100	31-60	41-80	1.1-2.0	51-100
Moderately polluted (101-200)	101-250	61-90	81-180	2.1-10	101-168
Poor(201-300)	251-350	91-120	181-280	10.1-17	169-208
Very poor(301-400)	351-430	121-250	281-400	17.1-34	209-748
Severe(401-500)	430+	250+	400+	34+	748+

Table 2: Central Pollution Control Board's Air Quality Standards

Air Quality Index (AQI)	**Category**
0-50	Good
51-100	Satisfactory
101-200	Moderate
201-300	Poor
301-400	Very Poor
401-500	Severe

Table 3: Sub Index of Pollutants during lockdown month but at different year for Jodhpur

Station Name: Collectorate, Jodhpur - RSPCB,						
March (25-31)		**Pollutants**				
		PM_{10}	**$PM_{2.5}$**	**NO_2**	**CO**	**Ozone**
2019	Average	189.88912	86.24714	28.86024	1.1531	53.39554
2020	Average	85.47693	44.08698	21.89898	1.07964	43.08751
2021	Average	256.66371	108.36214	27.10292	0.82196	46.29107
April (1-30)		**Pollutants**				
		PM_{10}	**$PM_{2.5}$**	**NO_2**	**CO**	**Ozone**
2019	Average	214.46383	106.42147	40.74345	1.20945	51.82186
2020	Average	98.50902	48.0183	20.53343	0.61081	40.50284
2021	Average	212.58291	88.94	29.03649	0.8277	40.91201
May (1-31)		**Pollutants**				
		PM_{10}	**$PM_{2.5}$**	**NO_2**	**CO**	**Ozone**
2019	Average	241.73479	114.02981	34.49521	1.23059	63.6485
2020	Average	138.03194	69.84478	20.78064	0.64797	50.16087
2021	Average	154.89395	66.5318	16.61253	0.79335	32.57504

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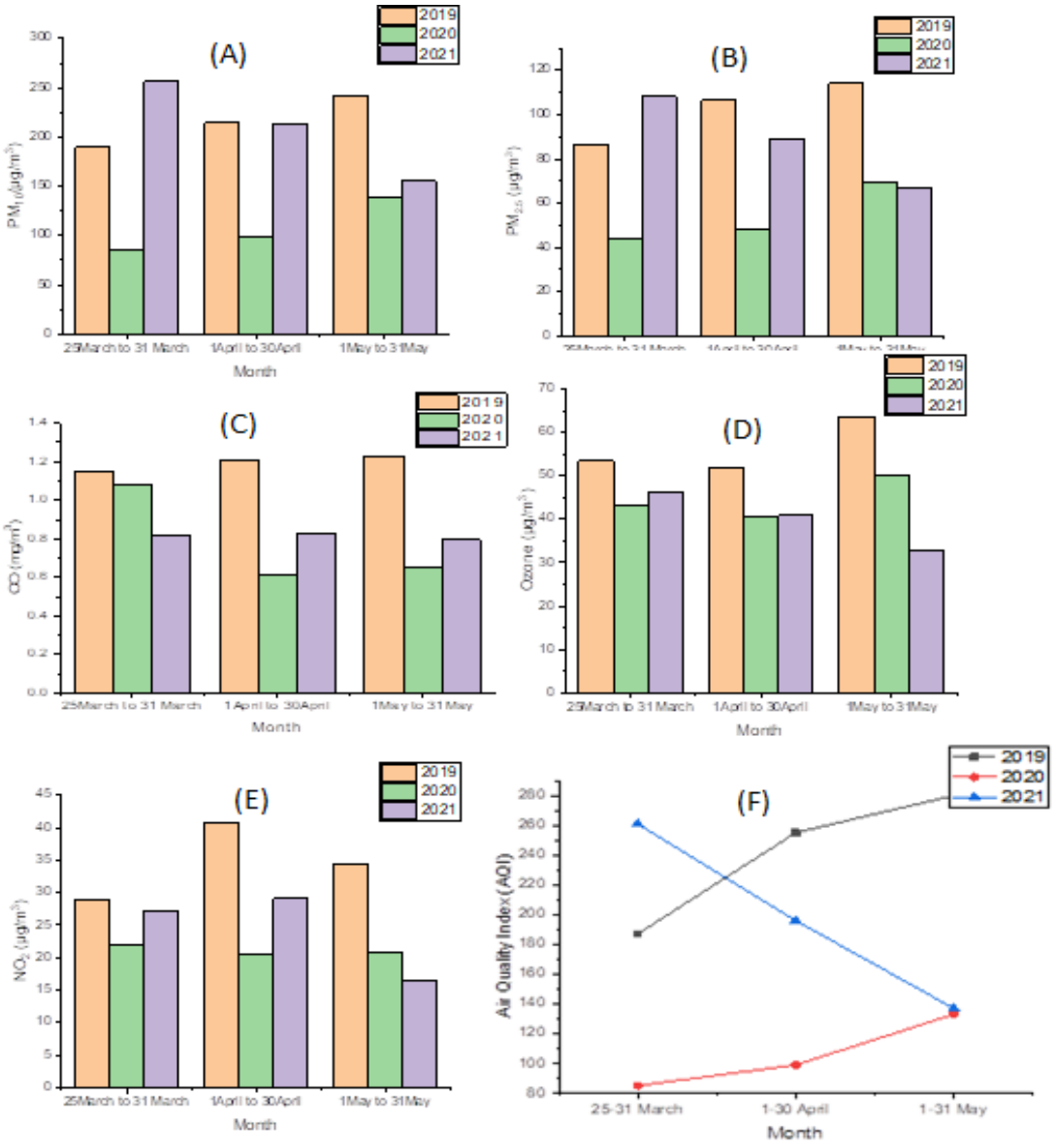
Table 4: Air Quality Index (AQI) for Collectorate, Jodhpur - RSPCB

Year	Air Quality Index (AQI)		
	March (25-31)	**April (1-30)**	**May (1-31)**
2019	187	255	280
2020	85	99	133
2021	261	196	137



Where- (A)- Fig.1: Mean of 24 hours of PM_{10} (µg/m3) Before Lockdown during Lockdown, and After Lockdown in 2019,2020 and 2021, **(B)** Fig.2: Mean of 24 hours of $PM_{2.5}$ (µg/m3) for Before Lockdown during Lockdown, After Lockdown in 2019,2020 and 2021. **(C)** Fig. 3: Mean of 8 hours of CO (mg/***m*^3**) for Before Lockdown during Lockdown, After Lockdown in 2019,2020 and 2021, **(D)** Fig.4: Mean of 8 hours of Ozone (µg/m3) for Before Lockdown during Lockdown, After Lockdown in 2019,2020 and 2021, **(E)** Fig.5: Mean of 8 hours of NO_2 **(µg/m^3)** Before Lockdown during Lockdown, After Lockdown in 2019,2020 and 2021. **(F)** Fig.6: Air Quality Index (AQI) mean of Before Lockdown, during Lockdown, After Lockdown in 2019,2020 and 2021.

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RESULT

According to table number 3**,** different values of pollution of PM_{10}, $PM_{2.5}$, Ozone, CO, NO_2 pollutants have been obtained. In 25-31 March 2019 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 189.88, 86.28, 28.86 ,53.39 μg/m^3 and CO value is 1.15 mg/m^3 and 25-31 March 2020 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 85.47, 44.08, 21.89, 43.08 μg/m^3 and CO value is 1.07 mg/m^3 and 25-31 March 2021 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 256.66, 108.36, 27.16, 46.29 μg/m^3 and CO value is 0.82 mg/m^3. In 1-30 April 2019 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 214.46, 106.42, 40.74, 51.82 μg/$m^3$and CO value is 1.20 mg/m^3 and 1-30 April 2020 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 98.50,48.01,20.53,40.50 μg/m^3 and CO value is 0.61 mg/m^3 and 1-30 April 2021 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 212.58, 88.94, 29.03, 40.91 μg/m^3 and CO value is 0.82 mg/m^3. In 1-31 May 2019 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 241.73,114.02, 34.49, 63.64 μg/m^3 and CO value is 1.23 mg/$m^3$and 1-31 May 2020 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 138.03, 69.84,20.78, 50.16 μg/m^3 and CO value is 0.64 mg/m^3 and 1-31 May 2019 pollution value of pollutant PM_{10}, $PM_{2.5}$, NO_2, Ozone is 154.89, 66.53, 16.61, 32.57 μg/m^3 and CO value is 0.79 mg/m^3.

When contrasting the pollutant value from table no. 3 with the Central pollution control board's Air Quality index (CPCB AQI) category , we found that according to the Central pollution control board's air quality standards in 25-31 March 2019 PM_{10} is Moderately polluted , $PM_{2.5}$ is Moderately polluted , NO_2 is good , CO is Satisfactory , Ozone is Satisfactory category and in 25-31 March 2020 PM_{10} is Satisfactory, $PM_{2.5}$ is Satisfactory, NO_2 is good , CO is good, Ozone is good and in 25-31 March 2021 PM_{10} is poor, $PM_{2.5}$ is poor , NO_2 is good , CO is good , Ozone is good . In 1-30 April 2019 we found that according to the Central pollution control board's air quality standards PM_{10} is Moderately polluted, $PM_{2.5}$ is poor, NO_2 is good, CO is Satisfactory, Ozone is Satisfactory category and 1-30 April 2020 PM_{10} is Satisfactory, $PM_{2.5}$ is Satisfactory, NO_2 is good, CO is good, Ozone is good category and 1-30 April 2021 PM_{10} is Moderately polluted, $PM_{2.5}$ is Moderately polluted, NO_2 is good, CO is good, Ozone is good category. In 1-31 May 2019 we found that according to the Central pollution control board's air quality standards PM_{10} is Moderately polluted, $PM_{2.5}$ is poor, NO_2 is good, CO is Satisfactory, Ozone is Satisfactory category and 1-31 May 2020 PM_{10} is Moderately polluted, $PM_{2.5}$ is Moderately polluted, NO_2 is good, CO is good, Ozone is good category and 1-31 May 2021 PM_{10} is Moderately polluted, $PM_{2.5}$ is Moderately polluted, NO_2 is good, CO is good, Ozone is good category.

From table number 4 Air Quality Index (AQI) in 25-31 March 2019 is 187, 1-30April 2019 is 255 and 1-31 May 2019 is 280 and 25-31 March 2020 AQI value is 85 and 1-30 April 2020 AQI value is 99, 1-31 May 2020 AQI value is 133. Air Quality Index (AQI) in 25-31 March 2021 is 261, 1-30 May 2021 is 196 and 1-31 May 2021 is 137. Air Quality Index category for table number 4 in 25-31 March 2019 AQI category is Moderately polluted and 25-31 March 2020 AQI category is Satisfactory and 25-31 March 2021 AQI category is poor, 1-30 April 2019 AQI category is poor and 1-30 April 2020 AQI category is satisfactory and 1-30 April 2021 AQI category is Moderately polluted, 1-31 May 2019 AQI category is poor, 1-31 May 2020 AQI category is Moderately polluted and 1-31 May 2021 AQI category is Moderately polluted.

As shown in the graph above.

From Fig.1 PM_{10} error which was high before lockdown in 2019 (25 March to 31 march and 1april to 30 April and 1may to 31 may) and decreased during lockdown 2020 (25 March to 31 march and 1april to 30 April and 1may to 31 may) and then again increased after lockdown in 2021 (25 March to 31 March and 1April to 30 April and 1 May to 31 May).

From Fig.2 $PM_{2.5}$ error which was high before lockdown in 2019 (25 March to 31 march and 1april to 30 April and 1may to 31 may) and decreased during lockdown 2020 (25 March to 31 March and 1april to 30 April and 1may to 31 may) and then again increased after lockdown in 2021 (25 March to 31 March and 1April to 30 April and 1 May to 31 May).

From Fig.3 CO error which was high before lockdown in 2019 (25 March to 31 March and 1 April to 30 April and 1 May to 31 May) and decreased during lockdown 2020 (25 March to 31 March and 1

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April to 30 April and 1 May to 31 May) and then again increased after lockdown in 2021 (25 March to 31 March and 1April to 30 April and 1 May to 31 May) but not more than 2019.

From Fig.4 Ozone error which was high before lockdown in 2019 (25 March to 31 march and 1april to 30 April and 1may to 31 may) and decreased during lockdown 2020 (25 March to 31 march and 1april to 30 April and 1may to 31 may) and then decreased after lockdown in 2021 (25 March to 31 March and 1 April to 30 April and 1 May to 31 May).

From Fig.5 NO_2 error which was high before lockdown in 2019 (25 March to 31 March and 1April to 30 April and 1 May to 31 May) and decreased during lockdown 2020 (25 March to 31 March and 1 April to 30 April and 1 May to 31 May) and then again increased after lockdown in 2021 (25 March to 31 March and 1 April to 30 April and 1 May to 31 May) but not more than 2019.

From Fig. 6 Air quality index (AQI) value was very high in 25 March to 31 May, 2019 but in 2020 (25 March to 31 May) the value of AQI is decrease. Again, AQI value was very high in 25 March to 31 May 2021.

DISCUSSION

India enacted a rigorous lockdown beginning on March 25, 2020, as a preventative step to slow the pandemic's spread after the first indication that there might be a mass transmission of COVID-19 on the subcontinent. In result we found that the Air quality index (AQI) change in jodhpur city in before lockdown (2019), during lockdown (2020) and after lockdown (2021) . From table 3 AQI Category range of PM_{10},$PM_{2.5}$ during lockdown (2020) is satisfactory range but in 2019 and 2021 (25-31March, 1-30 April, 1-31 May) PM_{10},$PM_{2.5}$ range is moderately polluted. NO_2 AQI category range is Good in 2019,2020,2021. But Ozone and CO AQI category range is satisfactory in 2019 and in 2020, 2021 AQI category range is Good. From table 4 Air Quality Index value is very high before lockdown (25 March and 31 May 2019) and after lockdown (25March -31 May 2021) again Air quality value is high because of man-made air pollution include vehicle emissions, fuel oils and natural gas used to heat homes, waste products from manufacturing and power generation, mainly from coal-fired power plants, and odours from chemical manufacturing. But during lockdown (25 March-31 May 2020) the amount of pollution of all pollutant (PM_{10}, $PM_{2.5}$, NO_2, CO) decreased. From Fig.1 we find that the PM_{10} value is very high before lockdown and after lockdown but during lockdown PM_{10} value is low and from fig.2 $PM_{2.5}$ value is also very high before lockdown and after lockdown and low in during lockdown and from Fig.3, Fig.4, Fig.5 CO, NO_2 and Ozone value is high before lockdown but after lockdown and during lockdown this pollutant value is low. From Fig.6 it is shown that the Air Quality Index for Collectorate, Jodhpur – RSPCB during lockdown (25 March – 31 May 2020) is decrease but before lockdown and after lockdown AQI value is increase. The significant influence of lockdown on the decrease in atmospheric loading of important anthropogenic pollutants due too little to no impact from industrial operations and vehicle emissions, and relatively clean flow of air masses from the upwind zone. The evaluated research generally came to the conclusion that the lockdown's air quality was better than it had been before [13-15, 21-22]. When pollutants' concentration rose to their pre-lockdown levels as soon as the lockdown period ended, some studies also found increases during the post-lockdown periods [16-20]. Furthermore, research published to date have focused on PM and NO_2, two of the most hazardous air pollutants for human health, which emphasises the importance of calculating the COVID-19 pandemic's effect on air quality in the areas with the worst pollution [10,12].

So, following measures could be taken to reduce the pollution and for the correction of AQI:

1. By reducing fireplace and wood stove use and by avoiding excessive burning of tree leaves, trash and other materials.
2. By introducing environmentally friendly tools, products, and materials, which are designed to minimize waste and energy consumption on construction sites to the local builders.
3. Wearing protective gear or equipment while contacting hazardous materials that cannot be otherwise avoided.
4. The process of construction leads to the production of vast quantities of wastage there is no way to reduced but increasing the efficiency of operation, hence to prevent the dust particles from spreading

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keep the ground wet by using water at construction sites and cover the sand dune of the construction site with dust barrier seat.

5. Exploring industrial recycling options needs to be aimed explicitly. Builder should strictly follow the EPA's industrial recycling program; this debris demolition and help in saving resource to a great extent.

CONCLUSION

A great opportunity to determine the effect of human activity on the deterioration of the environment is the research of air quality during a lockdown situation, when anthropogenic activities were minimised [7]. Our findings indicated that the COVID-19 shutdown was extremely helpful in lowering Air Pollution in India, one of the most polluted countries, in a relatively short amount of time. When there was a lockdown in Jodhpur at the time of Corona, then comparing the amount of pollution of the 5 pollutants (PM_{10},$PM_{2.5}$,NO_2 , CO, Ozone) at that time with the same days of 2019,2021.It was found that at the time of lockdown ,there has been a decline in the amount of pollution of pollutants compare to 2019 and 2021 and outcome indicated that the air quality increased while the area was under lockdown. During the whole lock period in 2019, the air quality was worse than it was in 2020. An excellent opportunity to determine the effect of human activity on environmental deterioration is to study pollution levels during lockdown and shut down scenarios, when anthropogenic (human) activities were curtailed or shut down. The lockdown caused a significant reduction in most activities, including tourism, business, and transportation, which improved the condition of the environment in Rajasthan's designated towns. At Jodhpur City, Rajasthan, the quality of the air showed a pattern of reduced amounts of all contaminants (except ozone) compared to before the lockdown period (March 2020 to August 2020). AQI of Collector ate, Jodhpur - RSPCB station indicates that pollutants concentration in the air of Jodhpur is continuously increasing and deteriorating the quality of air. Also, it was discovered that the air temperature dropped during the lockdown period as the output of greenhouse gases decreased. Particularly for those who are afflicted with respiratory diseases, this study will assist regular people in locating locations of pollution. Those who need to breathe should think about reducing heavy or extended outdoor labour when there is low air quality. The COVID-19 lockout decreased the number of deaths linked to environmental contaminants and may also have a positive effect by reducing the number of life-threatening chronic diseases linked to these air pollutants as well as Reticular activating system. The lockdown has been shown to be the best method for controlling pollution and its detrimental impacts on human health [8].

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