

Article

Assessment of air quality index and pollutants in Chennai city, India: Pre-Covid and during- Covid period

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Abstract

The lockdown was implemented by the government of India during the pandemic period due to Covid-19. This paper presents the effect of lockdown on the air quality index and various pollutants in five major locations in the Chennai city of Tamil Nadu. The air pollutants such as PM₁₀, PM_{2.5}, SO₂ and NO₂ from the monitoring stations were analyzed from 2018 to 2019 (pre-Covid period) and from 2020 to 2021 (during-Covid period). The results demonstrated that the concentration of PM₁₀ and PM_{2.5} reduced about 48% and 39% respectively. Similarly, significant reduction in the pollutants SO₂ (~25%) and NO₂ (~10%) has been observed. In the same way, AQI level before and during lockdown in Chennai city was observed satisfactory to moderate categories. The maximum reduction in AQI was observed in Adyar (~50.38%), followed by Nungambakkam (~44.18%), T-Nagar (~40.31%), Anna Nagar (~39.98%) and Kilpauk (~30.74%). Overall study implies that regulatory measures in a certain location in a suitable time period control the pollution and protects the environment.

Keywords Covid -19; Air Quality Index; air pollutants; Chennai city; lockdown.

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1 Introduction

Chennai, the capital of Tamilnadu is the fourth largest city in India. It is automobile capital of India, also referred as Detroit of South Asia. Almost 10 % of population of Tamilnadu lives in Chennai. More commercial and industrial activities in the immediate vicinity of the city, affects the air quality due to the emissions from industries and from increasing vehicular population. The effect of Covid lockdown on the air quality of Delhi city was discussed elaborately with the help of spatial pattern (Mahato et al., 2020). Impact study due to Covid lockdown on air quality index and pollutants in five cities of Indian National capital was presented (Garg et al., 2021). The interaction study between the metrological factors and air pollutants on the confirmed cases of Covid-19 in cities of China was explored (Zhou et al., 2021). Chhikar and Kumar (2020) reported that AQI values in Delhi, Chennai and Kolkata reduced significantly due to Covid lockdown and improved the air quality. Six ambient pollutant level were reduced during Covid-19 lockdown in two regions in China as compared to

previous year (Wang et al., 2021). The coarse (PM_{10}) and fine particulate matter ($PM_{2.5}$) was studied by using population-weighted exposure assessment to analyze the vulnerable areas in Chennai (Ramachandran et al., 2015). Many researchers studied in detail about the machine learning tools for monitoring and predicting of air quality (Sethi and Mamta, 2020; Tiwari et al., 2021; Iyer and Dharshini, 2020). About 50.7% of the O_3 monitoring stations showed a significant positive trend of $\geq 2 \mu g m^{-3} year^{-1}$ and only 20.9% of NO_2 monitoring stations were associated with a negative trend of $\geq -2 \mu g m^{-3} year^{-1}$ (Maji and Sarkar, 2020). Climatic parameters like average temperature, minimum temperature, maximum temperature, rainfall, humidity, wind speed and air quality are significantly affected with the covid-19 pandemic (Bashir et al., 2020).

In this paper, air pollutants in Chennai city was studied during lockdown period at five locations in city.

2 Materials and Method

2.1 Study area

The study area covers five major locations in the Chennai, which is the capital city of Tamil Nadu. Chennai an area about $426 km^2$ which lies between geocoordinate $13.04^\circ N$ to $80.17^\circ E$ on the southeast coast of India and in the northeast corner of Tamil Nadu (Fig. 1). The data used in the model development was collected from the Tamil Nadu Pollution Control Board (Homepage: tnpcb.gov.in) from 2018 to 2021. Air Quality Index (AQI) is the value which measures the pollution level of the ambient air and it was measured based on four pollutants in air: Sulfur dioxide (SO_2), Nitrogen dioxide (NO_2), $PM_{2.5}$ (particulate matter with diameter less than $2.5 \mu m$) and PM_{10} (particulate matter with diameter less than $10 \mu m$). In Chennai city there were 5 air monitoring stations in operation under TPCB Chennai are Anna Nagar, T-Nagar, Adyar, Kilpauk and Nungambakkam to monitor and record the various pollutants like PM_{10} , $PM_{2.5}$, SO_2 and NO_2 .

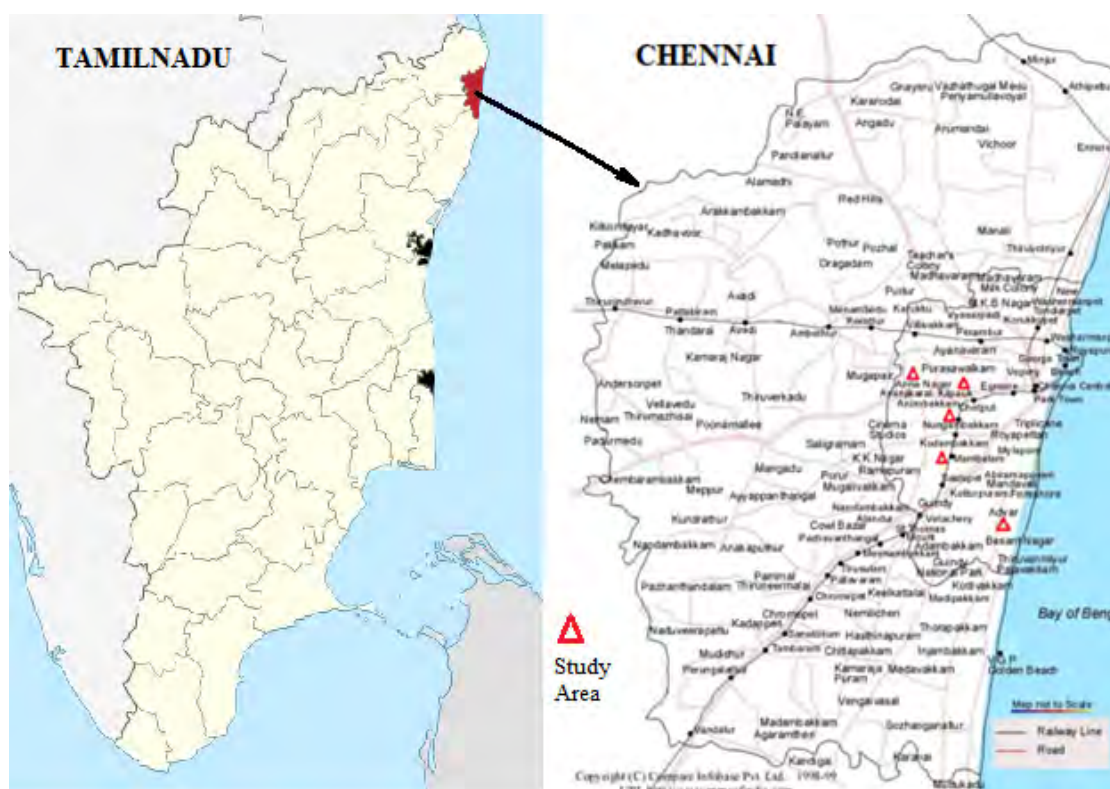


Fig. 1 Map showing the study area location in Chennai city.

3 Results and Discussion

3.1 Understating the pattern of AQI for the period of four years

To analysis the AQI pattern of a station T-Nagar (commercial zone) in Chennai city, daily study on the AQI values were made over the past four years including pre-Covid (2018 & 2019) and during-Covid period (2020 & 2021) (Fig. 2). The continuous observation of AQI values were obtained from TNPCB website (tnpcb.gov.in). The data used for analysis is from the air monitoring station located at T-Nagar as indicated in Fig. 1. Table 1 provides the statistics of AQI values of all five monitoring stations for Covid pre-lockdown period (2018 & 2019) and Covid during – lockdown period (2020 & 2021). It was observed that AQI level during 2018 & 2019 was lies in the satisfactory category except for station Anna Nagar in 2018. But during Covid period (2020 & 2021) AQI values come down to the category of good except T-Nagar.

Table 1 Details of AQI for all five site locations.

Assessment Year	Site Location	Source/Location	Range (Min-Max)	Mean and SD
2021 (During-Covid)	Anna Nagar	Residential	25-142	52.64 , 13.68
	T-Nagar	Mixed	29-280	60.64 , 26.24
	Adyar	Residential	25-89	45.86 , 9.21
	Kilpauk	Mixed	26-268	52.69, 23.84
	Nungambakkam	Traffic Inter-section	17-76	53.38 , 9.41
2020 (During-Covid)	Anna Nagar	Residential	25-97	56.77 , 15.16
	T-Nagar	Mixed	26-92	58.19 , 15.42
	Adyar	Residential	22-67	42.89 , 10.23
	Kilpauk	Mixed	25-98	46.44 , 13.51
	Nungambakkam	Traffic Inter-section	31-87	51.23 , 10.79
2019 (Pre-Covid)	Anna Nagar	Residential	55-173	94.12 , 22.83
	T-Nagar	Mixed	46-300	93.58 , 32.52
	Adyar	Residential	28-217	67.05 , 30.77
	Kilpauk	Mixed	51-164	91.77 , 25.49
	Nungambakkam	Traffic Inter-section	34-187	97.49 , 34.83
2018 (Pre-Covid)	Anna Nagar	Residential	50-242	111.76 , 34.96
	T-Nagar	Mixed	37-166	93.89 , 28.17
	Adyar	Residential	19-151	64.33 , 29.92
	Kilpauk	Mixed	37-155	85.44 , 25.84
	Nungambakkam	Traffic Inter-section	26-292	96.84 , 34.55

*SD – Standard deviation.

3.2 Effect of Covid lockdown on the pollutant levels (from 2018 to 2021)

The concentration of pollutants obtained from five different air monitoring stations were studied for the past four years considering from 1st Jan 2018 to 31st Dec 2019 (Before lockdown) and 1st Jan 2020 to 31st Dec 2021 (During lockdown). From the study, it was observed that the concentration of the pollutants like PM₁₀, SO₂, NO₂ and PM_{2.5} reduced due to the restrictive measures taken by the government authorities during the lockdown period in Chennai city. These pollutant reductions in the locations are listed in Table 2 and shown in Fig. 3a-d. It was found that concentration of PM₁₀ reduced significantly (36.76% - 48%). One third reduction in the level of PM_{2.5} (26.92% - 37.94%) was observed. The reduction in the SO₂ and NO₂ were in the range of 9.09% - 25% and 4.76% - 10% respectively. Similarly, the AQI level before and after lockdown in Chennai city was observed satisfactory to moderate categories. However, during lockdown AQI value reduced by 30.74% -50.38% and came down to good category of AQI level. In Chennai, during lockdown the maximum reduction in AQI was observed in Adyar (~50.38%) followed by Nungambakkam (~44.18%), T-Nagar (~40.31%), Anna Nagar (~39.98%) and Kilpauk (~30.74%). The detailed reduction in the various pollutants and AQI values are shown in Table 2.

3.3 Understating the pattern of PM₁₀ and PM_{2.5} during the month of March and April from 2018 to 2021

The concentration of two major pollutants PM₁₀ and PM_{2.5} for the past four years were studied particularly during Covid full lockdown period between March and April (2020) (Fig. 4) and compared for the same two months of the previous years. Continuous monitoring of pollutants from the station located at T-Nagar, Chennai was used for assessment. The PM_{2.5} for 2018 was not provided in Fig. 4 due to unavailability. It can be noticed that average concentration of PM₁₀ during 2018 and 2019 was about 82.15 $\mu\text{g}/\text{m}^3$ and in compare with the average value of 51.25 $\mu\text{g}/\text{m}^3$ (about 37.61% reduction). Similarly, PM_{2.5} was got reduced by 38.75% whose average concentration was 40 $\mu\text{g}/\text{m}^3$ and 24.5 $\mu\text{g}/\text{m}^3$ for the years 2018 & 2019 and 2020 & 2021 respectively. The percentage reduction of two pollutants PM₁₀ and PM_{2.5} during March and April months of pre-lockdown (2018 & 2019) and during – lockdown period (2020 & 2021) was 37.61% and 38.75% respectively. Thus, implementation of lockdown implies the improvement of air quality of the Chennai city and can be an alternative practice to reduce the air pollution in future.

Table 2 Variation in the pollutants before and after lockdown.

Location	Period	PM ₁₀	SO ₂	NO ₂	PM _{2.5}	AQI
Anna Nagar	Before lockdown	96	10	20	35	94.42
	After lockdown	56	9	19	25	56.67
	Variation	-40	-1	-1	-10	-37.75
	Variation (%)	-41.67	-10.00	-5.00	-28.57	-39.98
T- Nagar	Before lockdown	95	11	21	35	97.49
	After lockdown	58	10	20	25	58.19
	Variation	-37	-1	-1	-10	-39.3
	Variation (%)	-38.95	-9.09	-4.76	-28.57	-40.31
Adyar	Before lockdown	68	10	17	26	93.58
	After lockdown	43	9	16	19	46.43
	Variation	-25	-1	-1	-7	-47.2
	Variation (%)	-36.76	-10.00	-5.88	-26.92	-50.38
Kilpauk	Before lockdown	94	11	20	35	67.05
	After lockdown	46	9	18	22	46.44
	Variation	-48	-2	-2	-13	-20.61
	Variation (%)	-51.06	-18.18	-10	-37.14	-30.74
Nungambakkam	Before lockdown	111	12	19	34	91.78
	After lockdown	48	9	18	23	51.23
	Variation	-63	-3	-1	-11	-40.55
	Variation (%)	-56.76	-25.00	-5.26	-32.35	-44.18

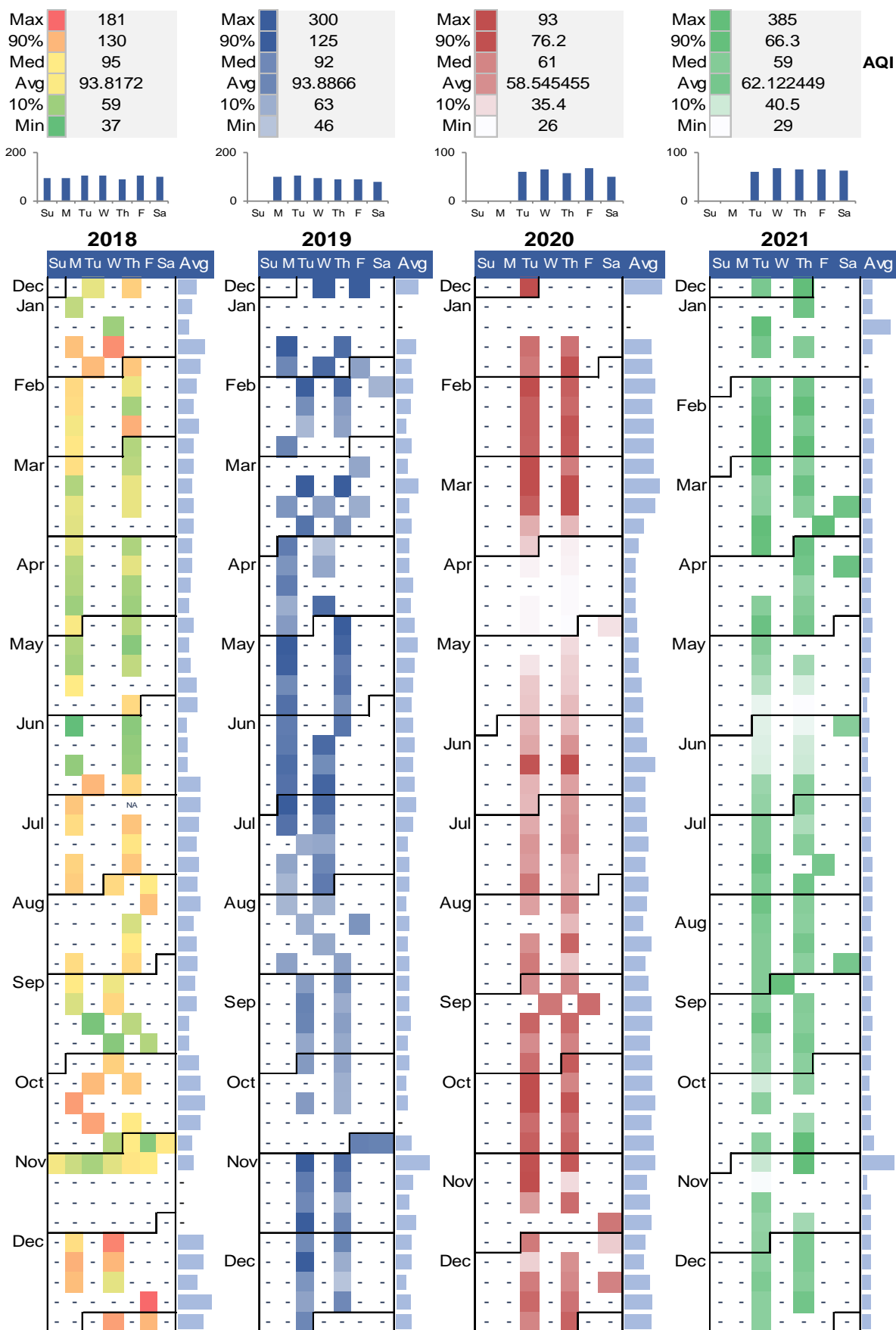


Fig.2 Profile of AQI Values for T-Nagar, Chennai during 2018 to 2021.

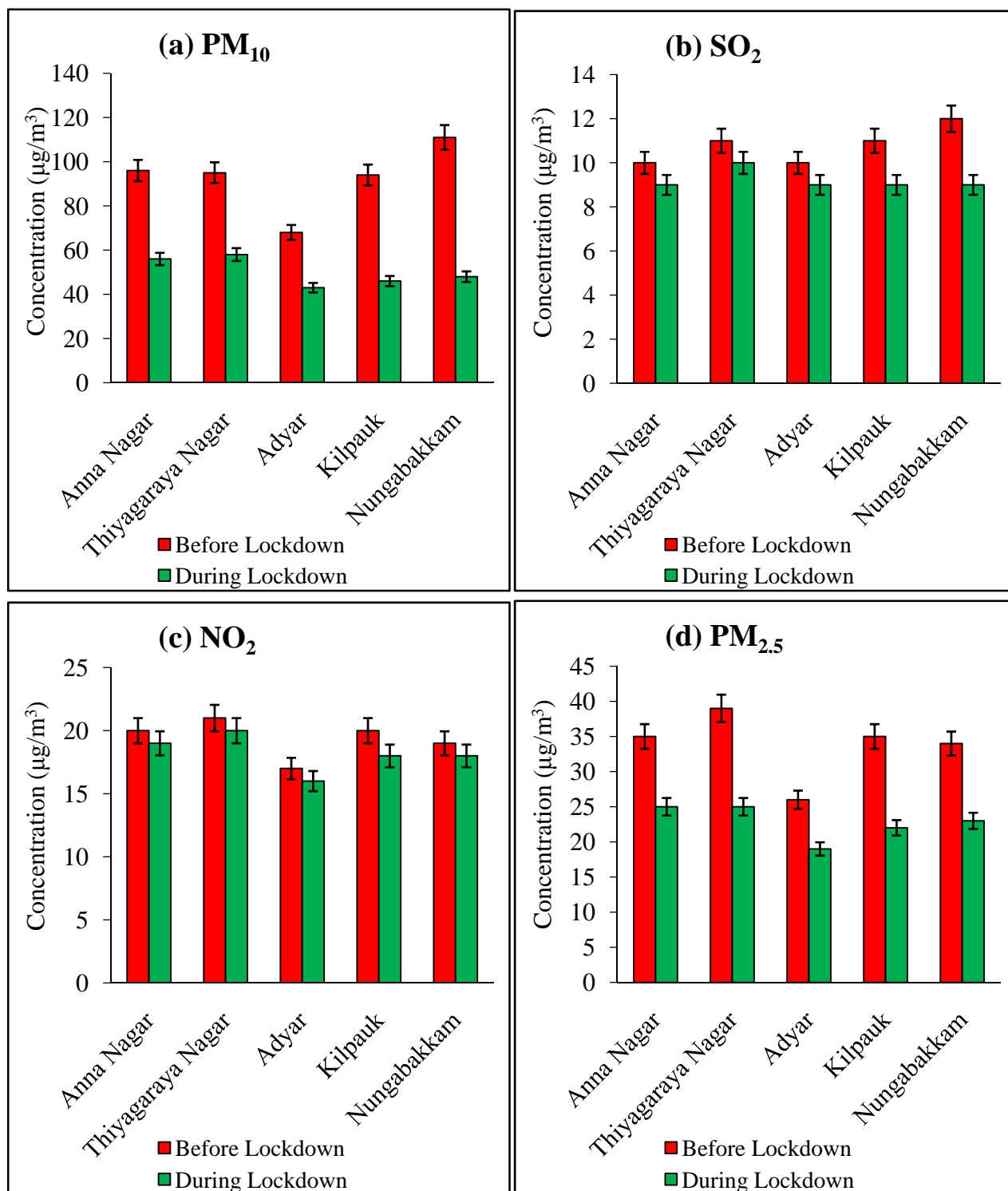


Fig. 3 Comparison of pollutants before and during lockdown.

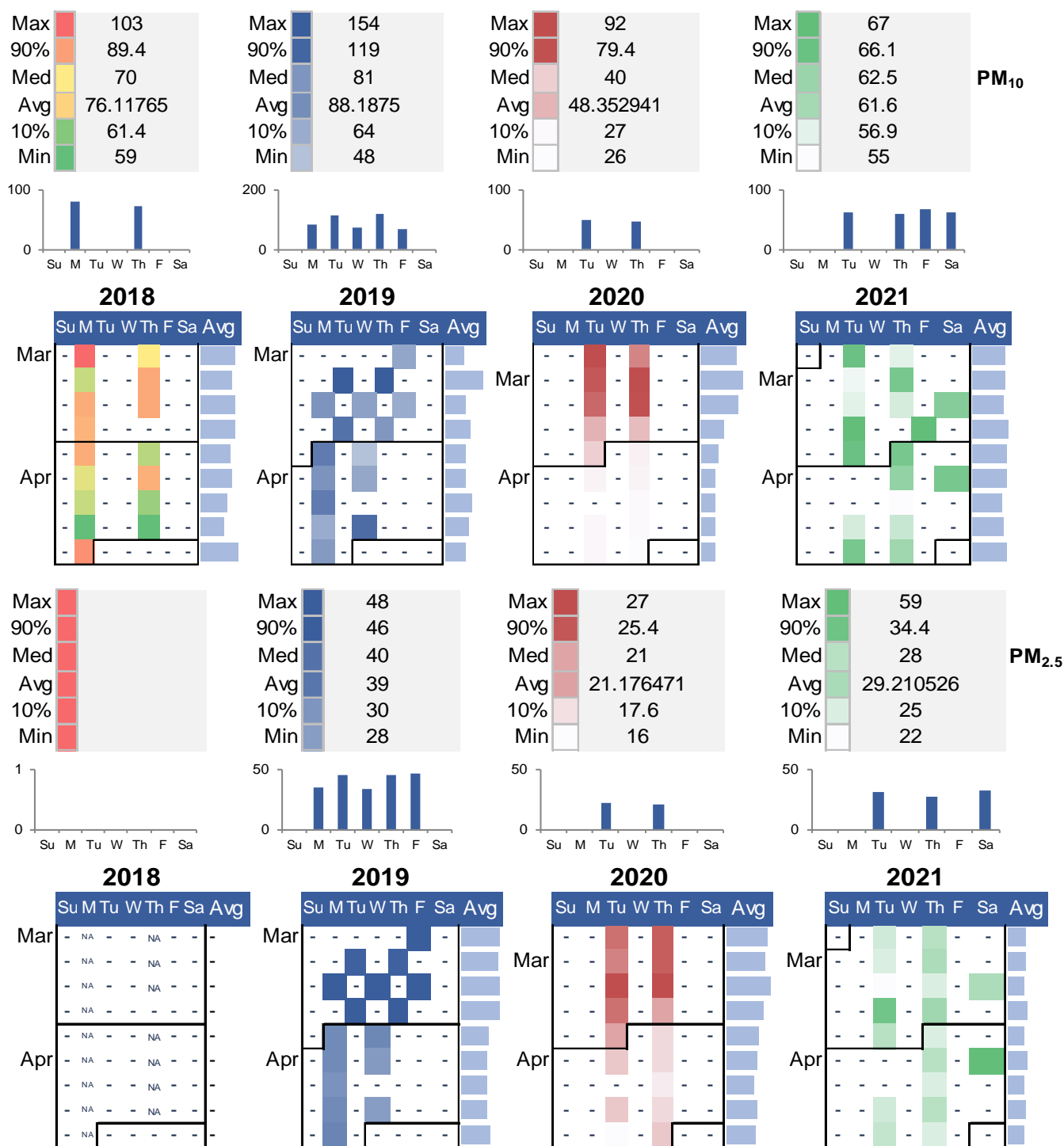


Fig. 4 Profiles of the PM₁₀ and PM_{2.5} concentration for the Month of March and April during 2018 to 2021 in T-Nagar, Chennai.

The effect of COVID -19 on air quality in Chennai city was analysed and presented in Fig. 5 and compared with the pollutants for four years considering pre-Covid and during-Covid period. Fig. 5 presents PM₁₀ values of stations in Anna Nagar, T-Nagar, Adyar, Kilpauk and Nungambakkam from January 2018 to December 2021 that is used as dataset for this study. Table 3 provides the summary of the visualisation from the figure for PM₁₀ concentration during pre-covid and during – Covid period. It was observed that PM₁₀ concentration was higher

during the month of January and November for all four years due to the festival season (Diwali and Pongal) and after that it got descent. The PM_{10} values decreased significantly in Chennai city during Covid-19 full lock down period (March-June 2020 & March-June 2021) when compared to respective months in the year 2018 and 2019 as shown in Fig. 5. From Table it was observed that the Adyar station of Chennai city PM_{10} concentration was comparatively lower than the other monitoring stations. Comparing the pre-Covid period (Jan 2018 to Dec 2019) and during- covid period (Jan 2020 to Dec 2021), the concentration of PM_{10} was reduced nearly to half (44%) as compared to pre-covid period (2018 & 2019).

3.4 Effect of Covid lockdown on the AQI values(from 2019 to 2021)

The daily monitoring of the AQI values in Chennai city during 2019, 2020 and 2021 were presented in Figs 6–8. Analysing the AQI values during 2019 indicates that values are higher than the years 2020 and 2021. From Fig. 7, it was observed the AQI values were very low during the month of March and April 2020 due to full lockdown for Covid (average value of 42.68). The AQI value comes down to 42.68 as compared to the previous year 2019 with an average value of 96.87 during March and April. Similarly, the reduction in AQI value (average value of 39.55) was observed during full lockdown period between May and June 2021. The above study implies that pollution control and air quality of Chennai city can be maintained very well within the safe permissible limit by implementing some strict instructions by the government authorities.

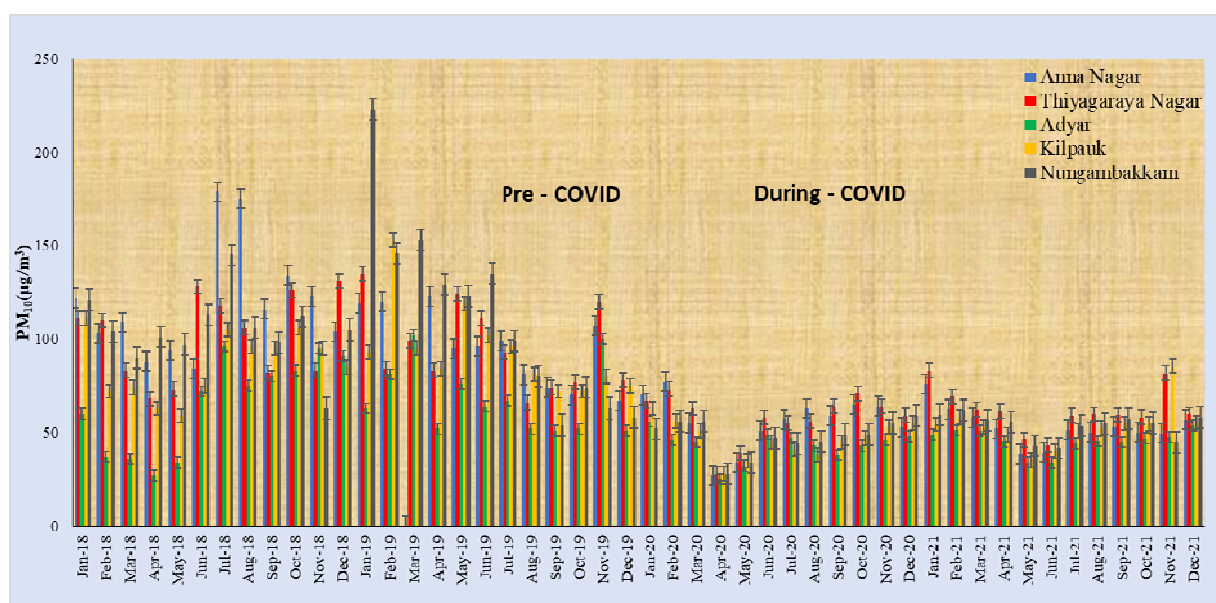


Fig. 5 PM_{10} concentration of Anna Nagar, T-Nagar, Adyar, Kilpauk and Nungambakkam from Jan 2018 to Dec 2021.

Table 3 Mean value of the PM_{10} concentration from Jan 2018 to Dec 2021 for five different stations in Chennai City.

Study Year	PM_{10} (Anna Nagar) [Mean]	PM_{10} (T-Nagar) [Mean]	PM_{10} (Adyar) [Mean]	PM_{10} (Kilpauk) [Mean]	PM_{10} (Nungambakkam) [Mean]
Jan 2018 – Dec 2018	119.25	101.58	65.50	86.33	104.58
Jan 2019 – Dec 2019	87.58	95.33	67.58	93.50	111.42
Jan 2020 – Dec 2020	56.25	58.08	43.17	46.42	47.83
Jan 2021 – Dec 2021	53.09	61.94	45.59	53.63	53.47

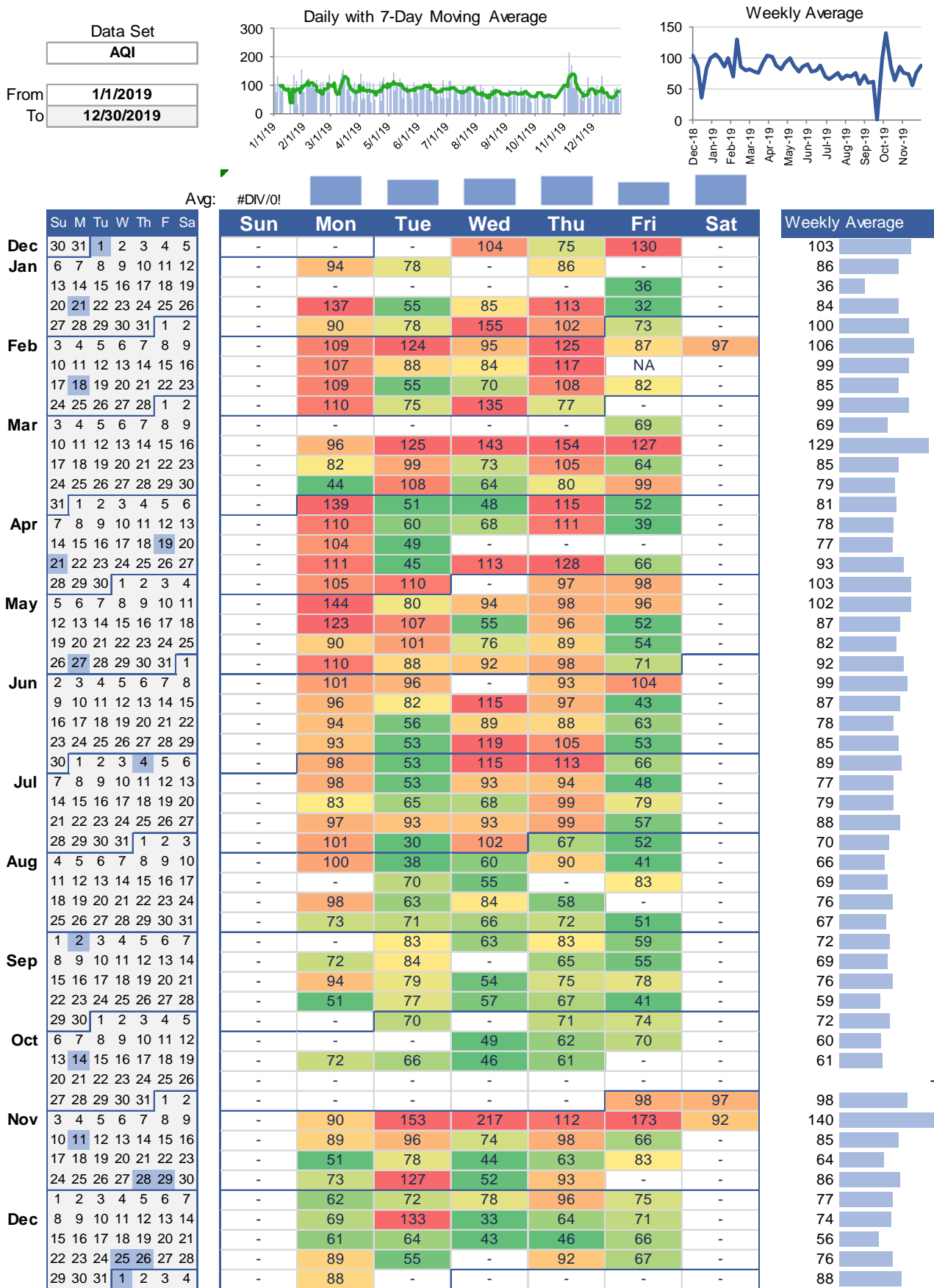


Fig.6 Daily assessment of AQI in Chennai during 2019.

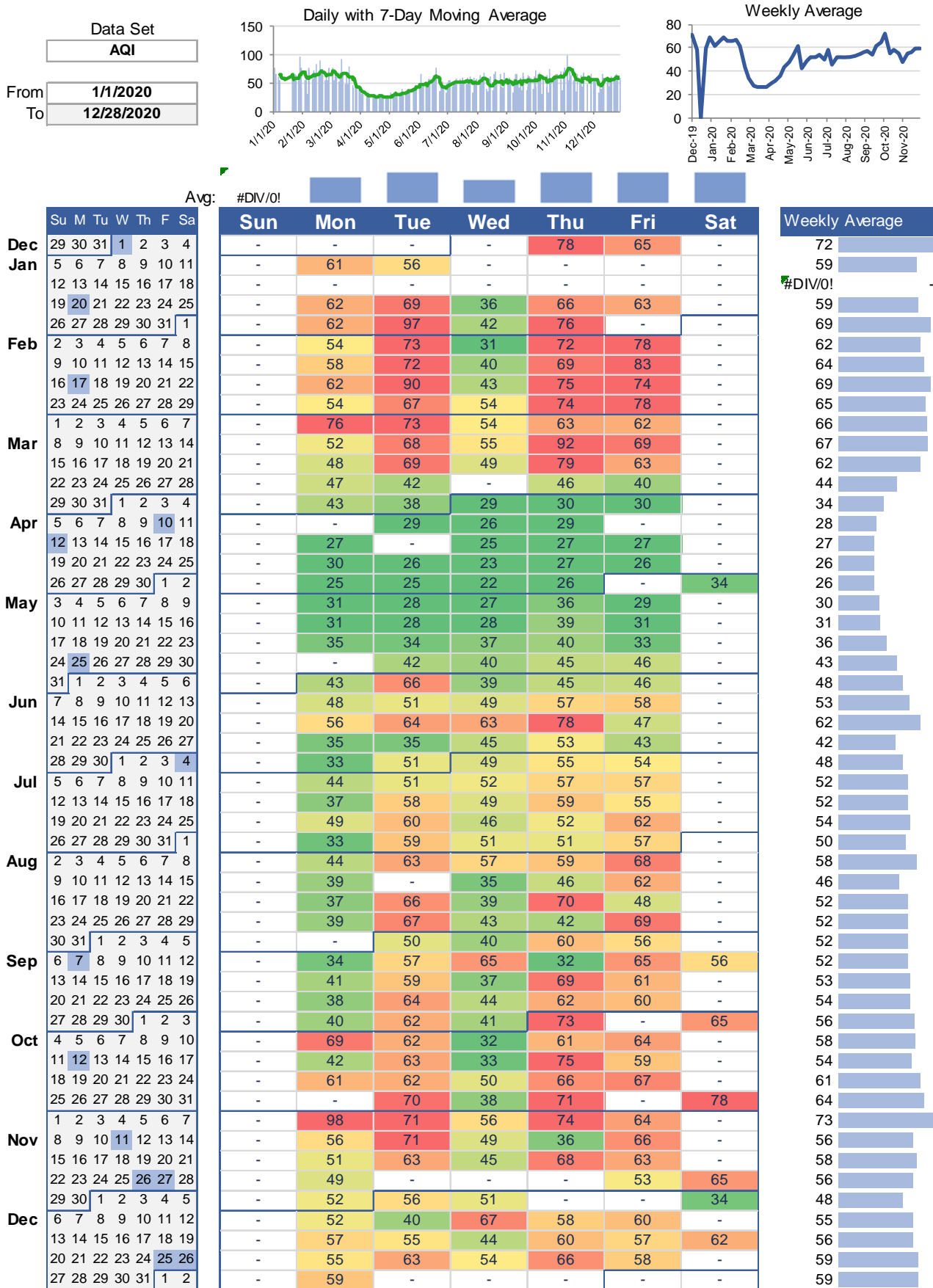


Fig.7 Daily assessment of AQI in Chennai during 2020.

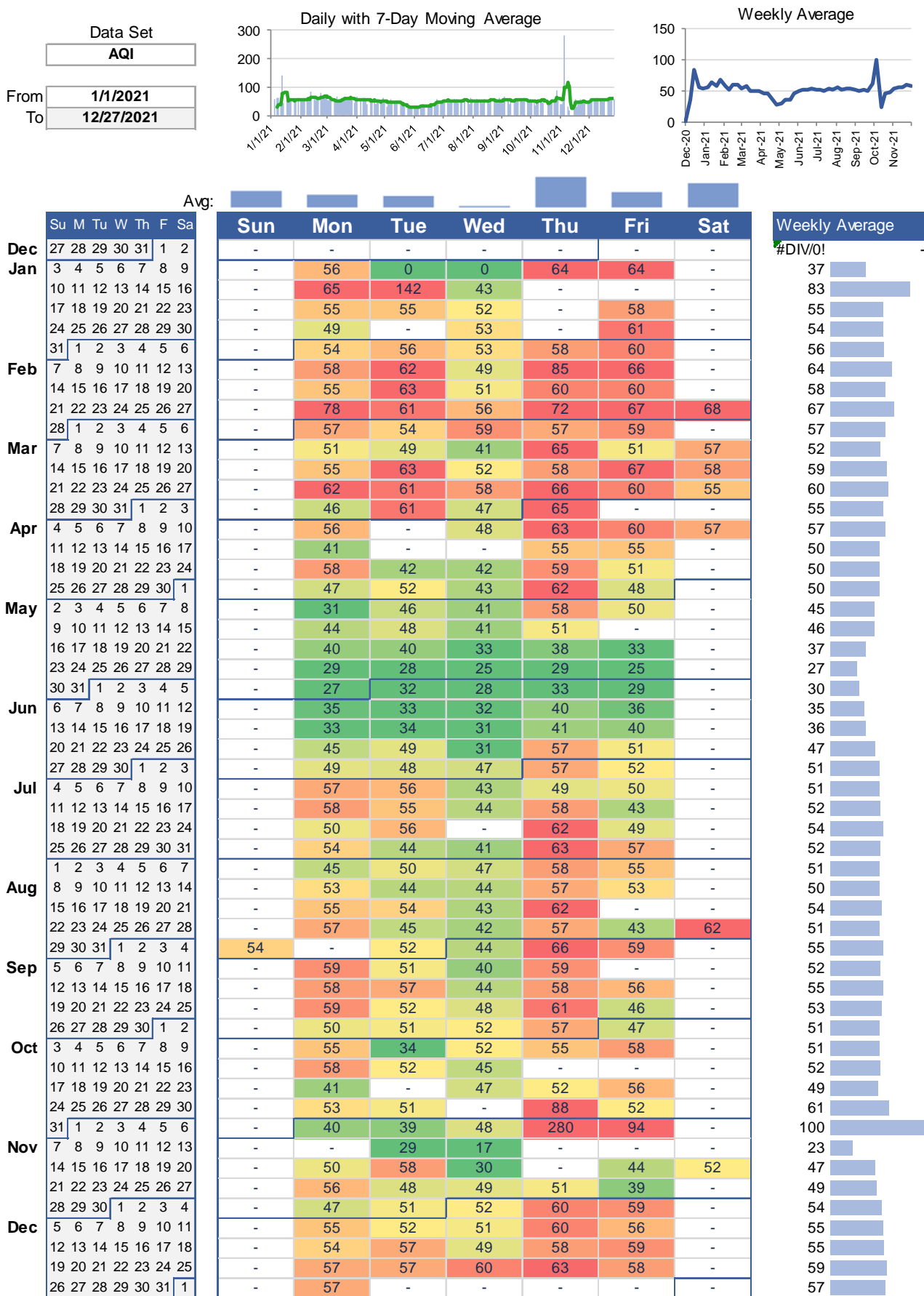


Fig. 8 Daily assessment of AQI in Chennai during 2021.

4 Conclusions

The detailed analysis of air quality data in the Chennai city, Tamilnadu for the period of four years from 2018 to 2021 was studied. Further comparison between the concentration of AQI and various pollutants for pre-Covid and post-Covid period was presented. The study presents that concentration of the pollutants were reduced about 50% as compared to previous years. The strict measures and lockdown due to Covid-19 by limiting the transports, closing industrial and commercial centres reduces the pollutants like PM₁₀, PM_{2.5}, NO₂ and SO₂ significantly. The reduction in the concentration is mainly due to decrease in the emissions from the vehicles and exhaust pollutants from industries. Thus, implementing the regulations and measures in the locations where the AQI level is more can be controlled to maintain ambient air quality. Temporary control of pollutants at the source for a required time interval may protect the environment and ozone layer.

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