COVID-19 Pandemic and Air Quality

Introduction:

Air pollution has become a severe problem in Indian cities due to rapid urbanization and industrialization, causing numerous health-related issues for humans and the environment. Nitrogen Dioxide (NO_2), one of the major pollutants, results from vehicular, industrial, and thermal power plant emissions. During the COVID-19 pandemic, a nationwide lockdown was imposed into four phases from March 25 - May 31, 2020; Phase-I (25/03/2020 - 14/04/2020), Phase-II (15/04/2020 - 03/05/2020), Phase-III (04/05/2020 - 17/05/2020) and Phase-IV (18/05/2020 – 31/05/2020). All major anthropogenic activities contributing to atmospheric pollution (such as industries, vehicles, and other activities) were restricted during the lockdown. The current report examines the impact of the lockdown on tropospheric NO_2 concentrations before and during the different phases of lockdown through satellite (Sentinel 5P) and ground-based (CPCB) measurement across India and two major cities Delhi and Bangalore.

Results:

Long-term Analysis over India:

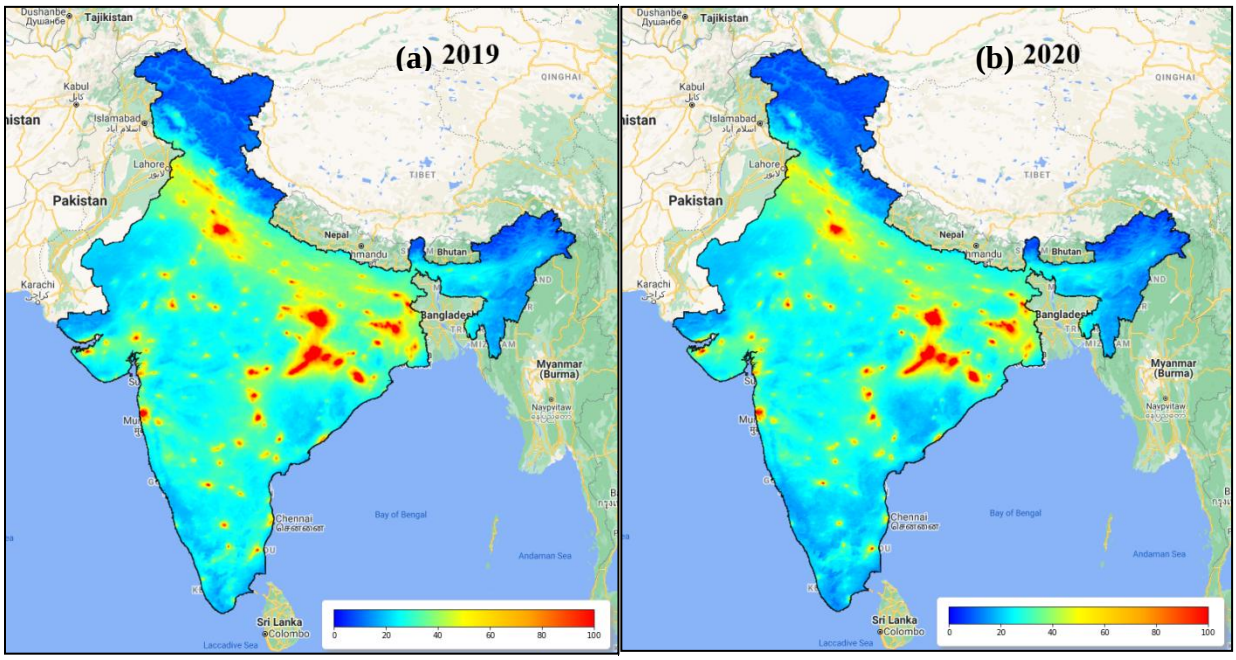
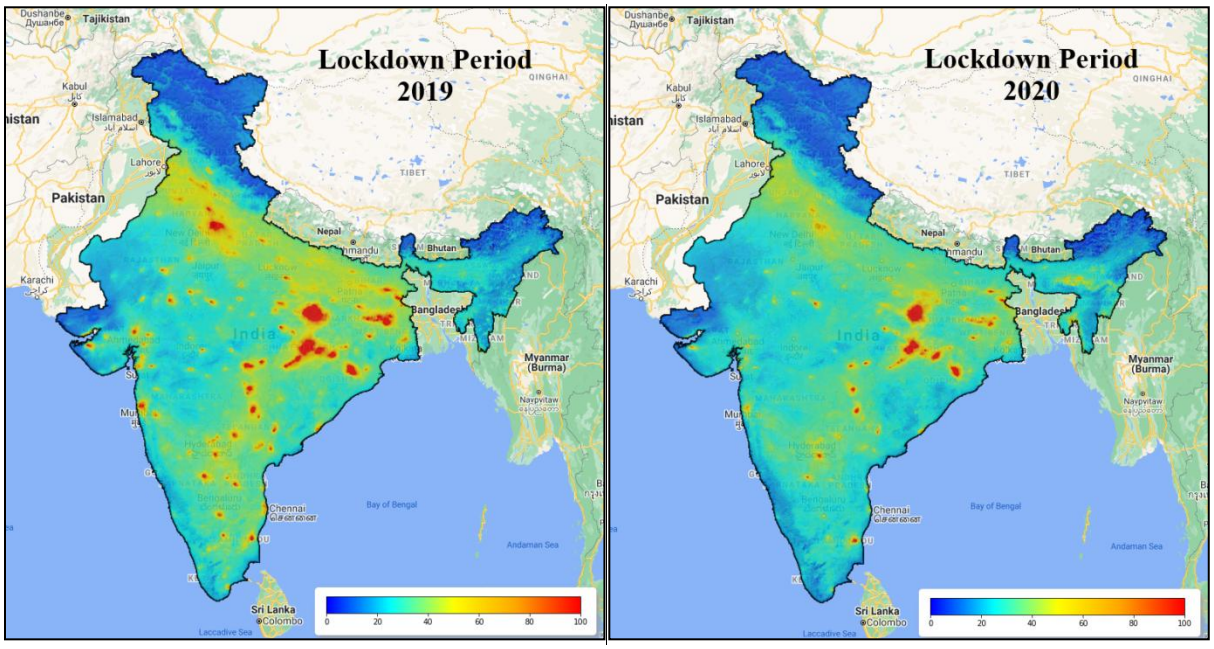


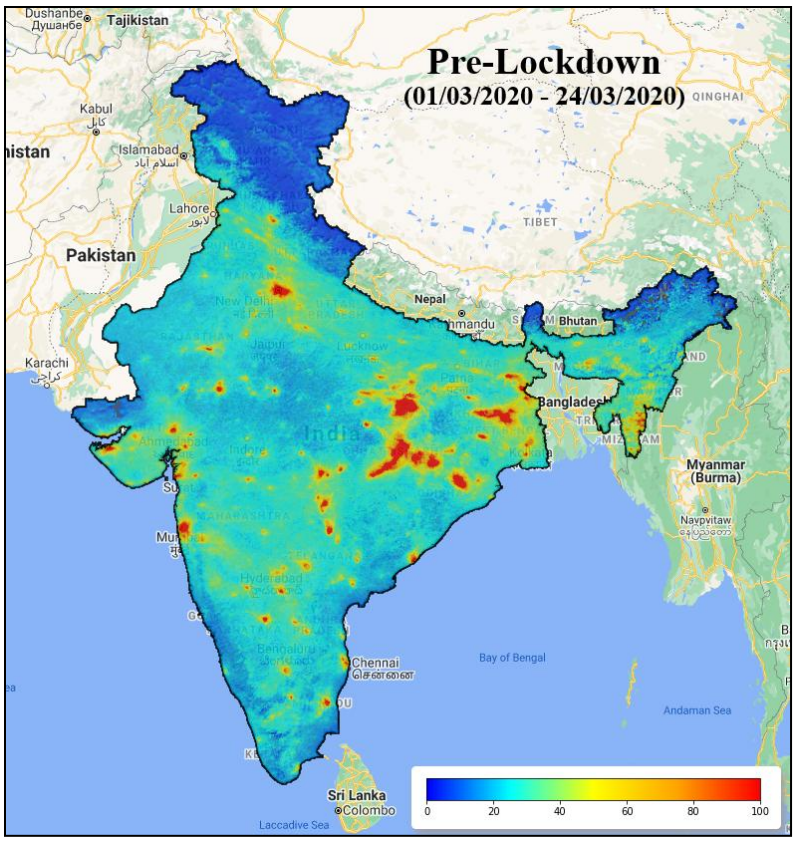
Fig-1. (a) Average tropospheric NO_2 (µmol/m^2) level for the year 2019, (b) Average tropospheric NO_2 (µmol/m^2) level for the year 2020.

In 2020, the lockdown was imposed for a shorter period, but it contributed to a significant reduction in NO_2 concentration throughout the year compared to the previous year (Fig-1). For a more detailed study, the average NO_2 concentration is also compared for the lockdown period

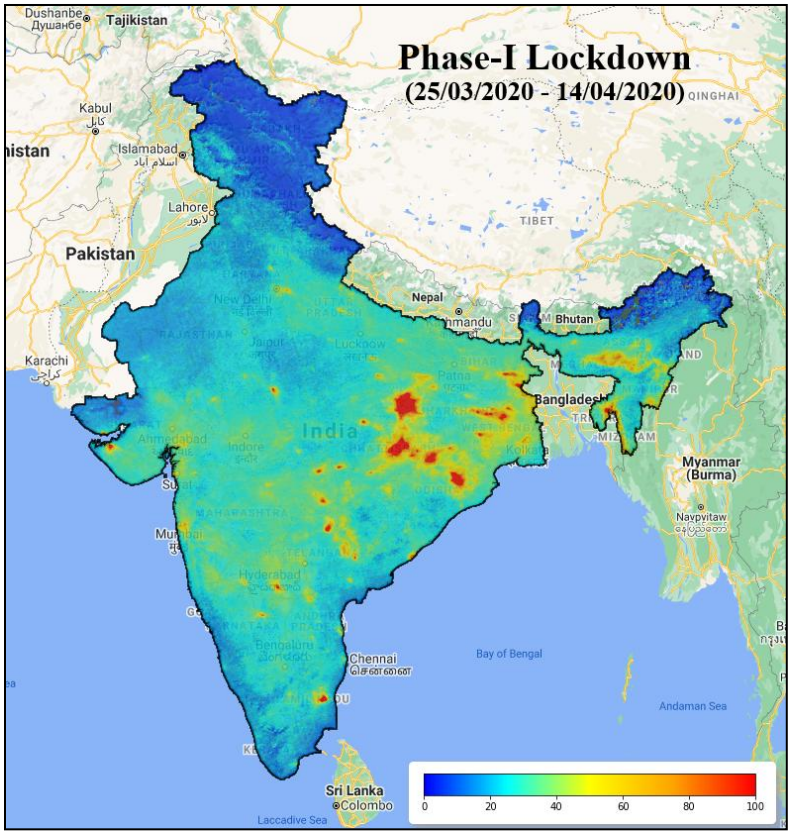
(March 25 to May 31) for 2019 and 2020. A huge reduction in tropospheric NO_2 level is observed during the lockdown period in 2020 compared to 2019.



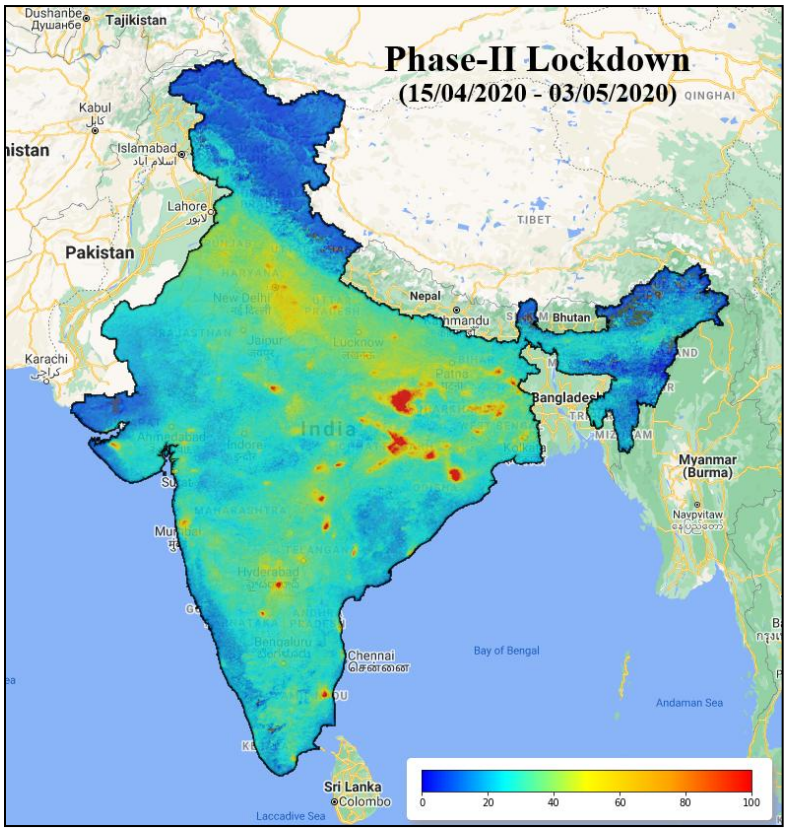
Lockdown Impact on tropospheric NO_2:



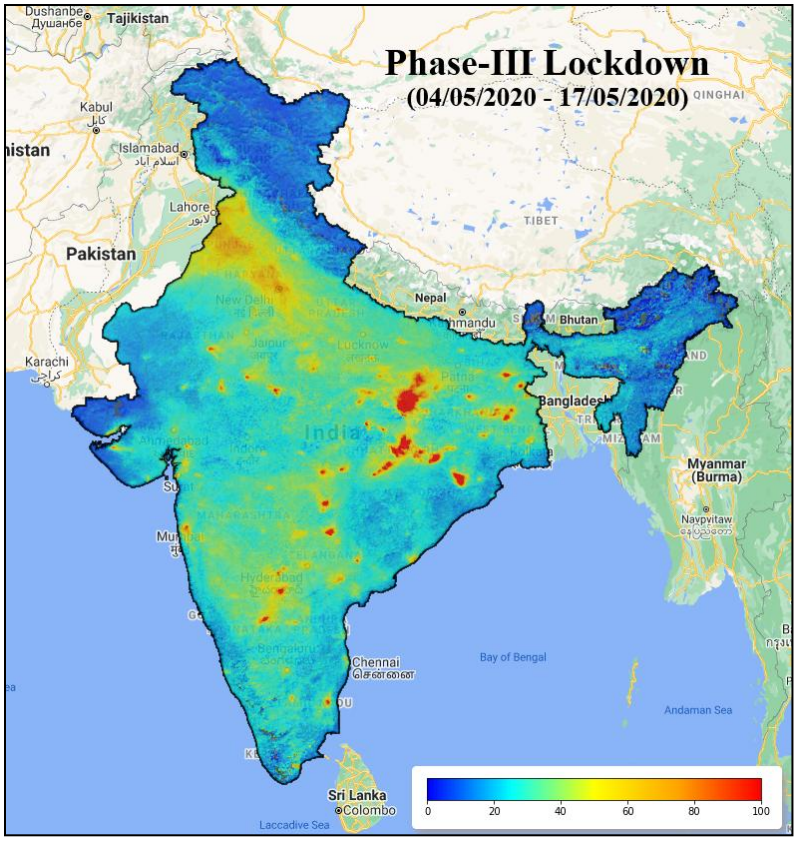
During the pre-lockdown period, tropospheric NO_2 analysis over India depicted that the hotspots are observed from the most urbanized locations (megacities) or the locations dominated by the presence of thermal power plants and other industries. At the urbanized locations, the high NO_2 concentration can be attributed to vehicular emission, domestic combustion, industrial emission and many other anthropogenic activities.

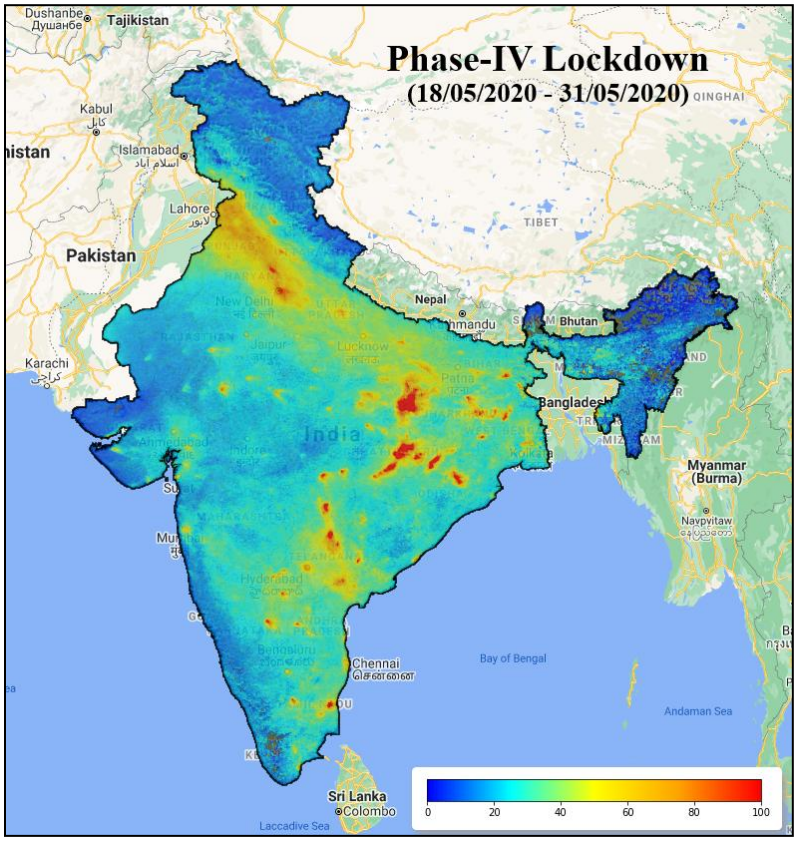


During the first phase of lockdown, most of the urbanized locations (cities) shows a huge reduction in NO_2 level that may be associated with a strict restriction in transportation activities. Another major reason is the closure of industrial activities around the major cities, which is also a major source of air pollution, particularly NO2. However, some locations still show higher NO_2 level. That were identifiesd as thermal power plant emissions in Jharkhand, Chhattisgarh, West-Bengal, Orisa and south-eastern of UP, which were operational to accomplish the electricity demand of the country.



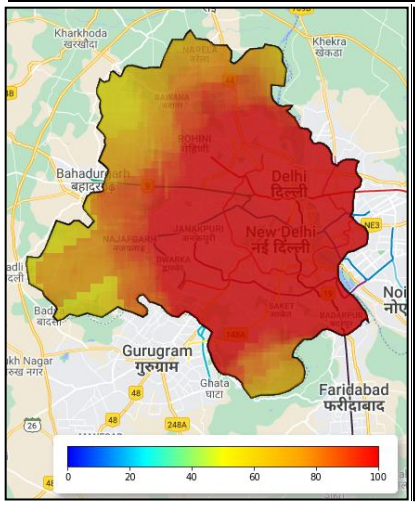
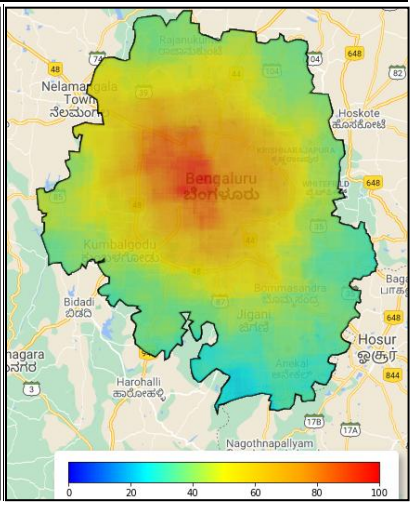
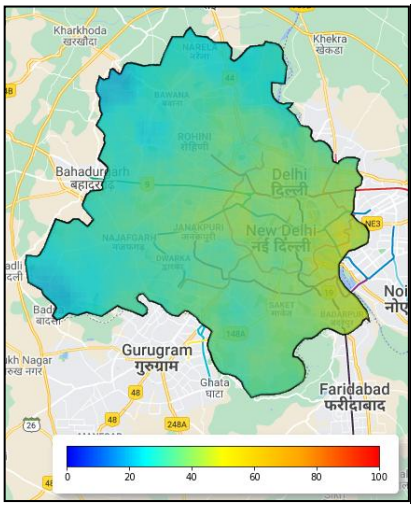
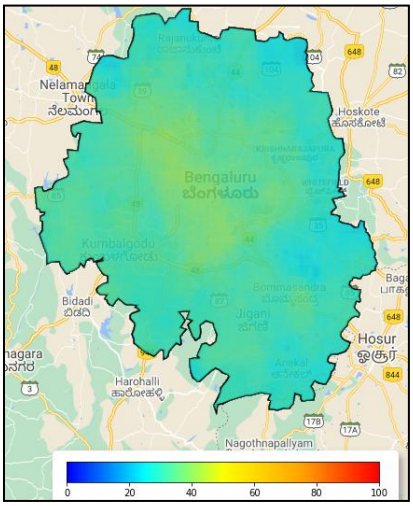
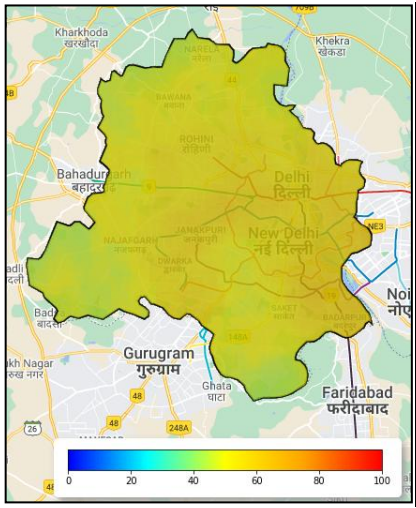
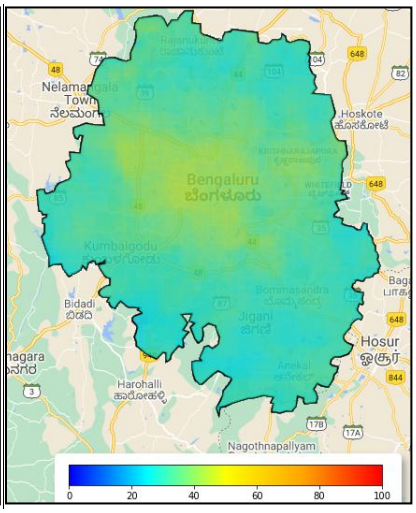
After the first phase lockdown, NO_2 level gradually increases from second phase to fourth phase lockdown because an ease in the upcoming lockdown phases compared to first phase lockdown.



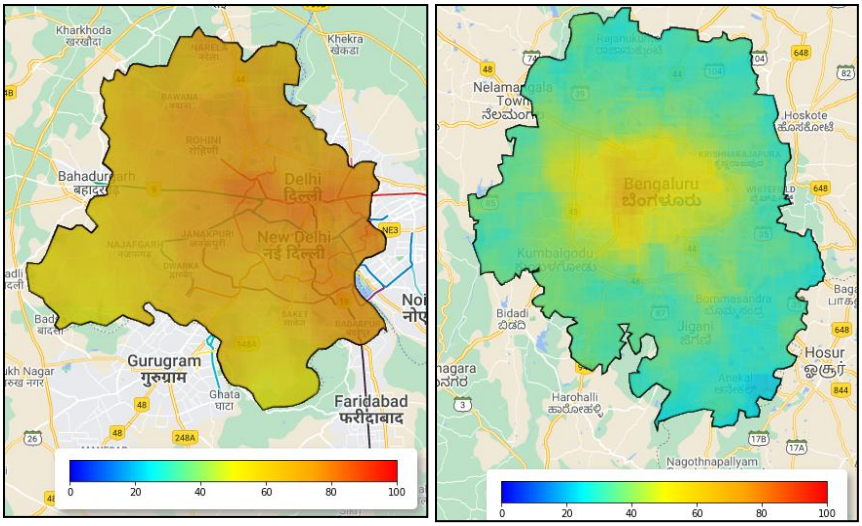


In the third and fourth phase of lockdown, higher NO_2 level is observed over the Western UP, Punjab and Haryana states. These higher NO_2 levels culd be attributed to the crop residue burning activities in the respected states.

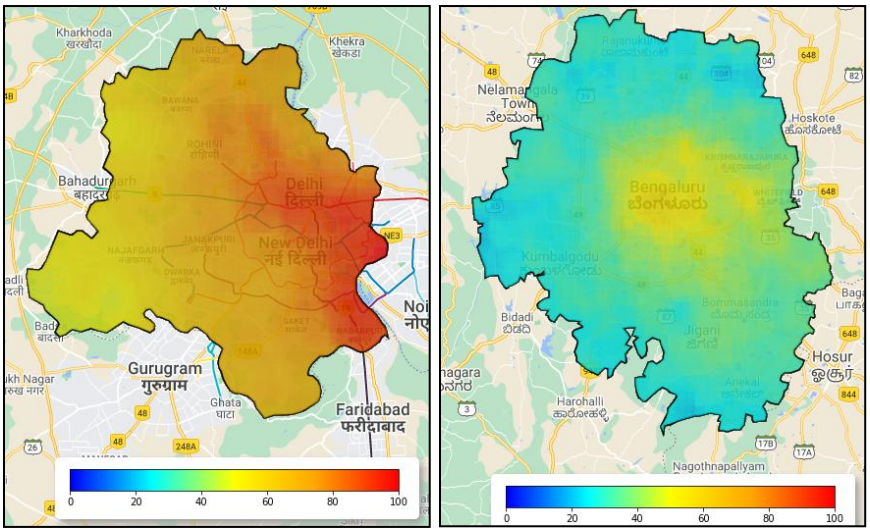
NO_2 analysis over the megacities Delhi and Bangalore:

	Delhi	Bangalore
Pre-Lockdown (01/03/2020 – 24/03/2020)		
Phase-I Lockdown (25/03/2020 – 14/04/2020)		
Phase-II Lockdown (15/04/2020 – 03/05/2020)		

Phase-III Lockdown
(04/05/2020 – 17/05/2020)



Phase-IV Lockdown
(18/05/2020 – 31/05/2020)

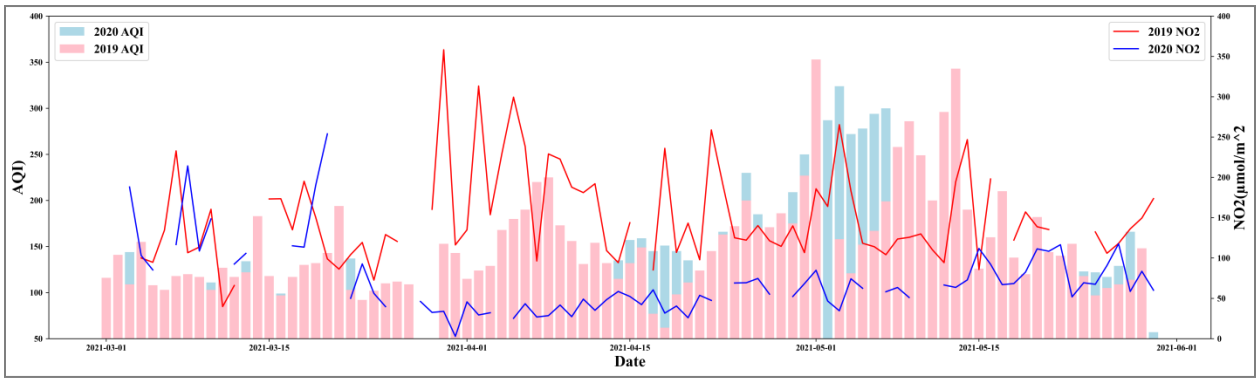


From the above spatial plots, It is observed that both the cities have the same trend in NO_2 level during the study period. Both Delhi and Bangalore show the highest NO_2 in the pre-lockdown phase while the lowest in the first phase of lockdown. It is also experienced that Delhi shows a continuous increase in NO2 level with a higher rate than Bangalore from the second phase to the fourth phase of lockdown.

Time-Series Analysis

Delhi

For the time series analysis, Satellite NO_2 values have been extracted at the Lodhi Road IMD (CPCB station;[28.70, 77.10]) location for the lockdown duration (March 1 – May 31) for the years 2019 and 2020. Kaggle Air Quality Index(AQI) data has also been analyzed with the NO_2 level at the respective locations and durations. It has been observed that the NO_2 level remains much lower in 2020 compared to 2019. Throughout the lockdown duration, 2020 shows significantly improved Air Quality compared to 2019.



**breaks in plots are due to the missing data

Bangalore

A similar analysis has been performed for Bangalore, India. At BTM Layout, Banglore-CPCB station [12.91, 77.59] location. A large data gap has been observed in satellite observation at the Bangalore location during the study period, But it shows better air quality.