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POLICY BRIEF - 50

Learning from Covid-19 led lockdown to improve Bengaluru's ambient air quality: An assessment based on Sentinel-5P satellite data

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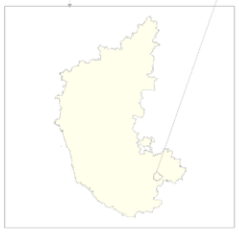

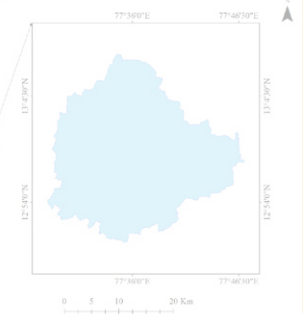

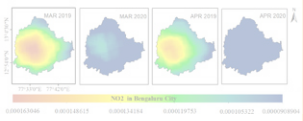

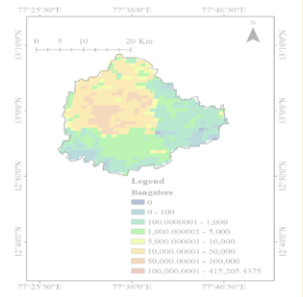

Introduction

The world has been shuddered by the recent pandemic making the economy, environment and society experience a lot of drifts and transformations. The outbreak of Novel Coronavirus disease (COVID-19) was first detected in Wuhan, China in late 2019 and has since spread throughout China and the entire world (Lu et al., 2020; Xu et al., 2020; Zhu et al., 2020). The World Health Organization (WHO) declared a public health emergency on 30th January, 2020. The COVID-19 pandemic affected the entire world's economy as well as claiming the lives of millions of human beings. To counter the spread of the disease, a nation-wide lockdown was imposed in India on 24th March, 2020. During the pandemic, various mandatory actions such as lockdowns, restriction of travel, virus tracing, quarantining and the issue of proper guidelines to the public, were taken by the municipal and provincial governments which were supported by the central government and the World Health Organization. Although the major impacts were negative, the economic disruption and restricted movement of vehicles provided a boost to the environment, decreasing vehicular and industrial emissions. With air pollution being the leading risk factor for public health contributing to adverse health conditions, the imposition and restrictions caused the reduction of anthropogenic activities which drastically reduced the emission of pollutants leading to visible improvement in the ambient air quality.

Scientific evidences are available which state that the spread of pollutants such as nitrogen dioxide, Sulphur dioxide, carbon monoxide and particulate matter in the atmosphere cause direct harm to the human respiratory system (Dominici et al., 2006; Hansel et al., 2016). Severe acute respiratory syndrome (SARS) and air pollutants have a positive relationship, where higher levels of pollutants increase the risk of fatality. It also leads to cardiovascular disorders, hypertension and lung cancer in humans. Air pollutants also contribute to global warming which leads to prolonged heat waves, temperature variability, forest fires, droughts, floods, melting of icebergs and glaciers along with depletion of the stratospheric ozone layer (Manisalidis et al., 2020). Air pollutants also affect plant growth by inducing changes in soil pH, decrease in photosynthesis rate and retarded growth. Many studies have revealed that air pollution increases the COVID-19 mortality rate (positive relationship), whereas COVID-19 lockdown induced by rise in COVID-19 cases could reduce air pollution level and short-term global temperature at the same time (negative relationship) (Sangkham et al., 2021). Megacities like Mumbai, Delhi, Bengaluru, Chennai and Kolkata are highly susceptible to human health problems as compared to towns and villages because of their high population density, large number of industries and automobiles. The emissions in these cities are contributed by a variety of factors (Ravindra et al., 2016) such as emissions due to household consumption, industrial and construction activities, vehicular emission, road dust, waste burning, commercial setups etc. (Guttikunda et al., 2014). Reports confirm an increasing trend in air pollution over the years due to rapid urbanization, traffic, industry and related economic and developmental activities in Bangalore (CPCB, 2012, 2014). Earlier studies revealed that the air quality of the city is within acceptable limits set by the CPCB but there is an increasing trend in NO_2 and SPM over Bangalore (CPCB, 2010).

As economic activities came to a halt all over the country during the pandemic, air quality improved in Indian cities. Delhi had the highest decrease in pollutant level as compared to other Indian cities (Navinya et al., 2020; Sharma et al., 2020). There are a few studies which have assessed urban air quality during the COVID-19 lockdown and documented significant reductions in air pollutants concentrations. The CPCB (Central Pollution Control Board) stated that the NO_2 (Nitrogen Dioxide) levels decreased all over the country during the lockdown period. NO_2 emissions decreased by %17 and aerosol optical depth decreased by nearly %45 during the lockdown (Goel et al., 2020). The imposition of a lockdown also led to remarkable improvement in water

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quality of lakes and rivers as industrial activity came to a standstill. A large number of migratory birds were also observed to have returned during this period. Although it was a short-term improvement, nature and the environment rejuvenated.

During the lockdown, Bengaluru had witnessed a drop in motorized transportation, industrial operations, construction activity and power generation operation, which drastically reduced the emission of pollutants and consequent improvement in air quality. The results of various studies show a significant decrease in environmental and related health risk during the lockdown. An analysis of air quality data carried out by the Centre for Research on Energy and Clean Air (CREA) in Bangalore revealed that air pollution reduced by 28% in the city during the COVID 19 lockdown. During this period, there was a significant drop in respiratory symptoms in children and decline in asthma and other respiratory ailments. The Healthy Air Coalition set up a network of 30 air quality monitors across the city in order to assess the impact of air pollution in Bengaluru and drive measures for improving air quality. This indicates the emergency to take traffic and industrial regulation more seriously and implement strategies to control emission levels.

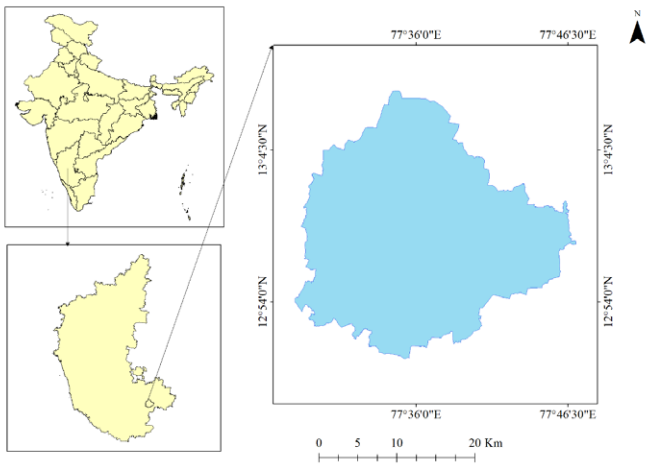
Objectives

- To analyze the impact of COVID-19 Outbreak on Tropospheric NO_2 Pollutant over Bengaluru city, India
- To analyze the association between Tropospheric NO_2 pollution and population density during lockdown period and business-as-usual condition.

Study Area

Bengaluru is the capital of Karnataka state, India which is situated in South-Deccan plateau in Peninsular India to the South-East corner of Karnataka. It is sixth largest metropolitan cities in the country which has a population of 12.76 million. Geographically it is situated in $77^0$37'19.54'' E and $12^0$59'09.76'', with an elevation of 900 m above sea level. Bangalore is the center of India's high-tech industry, popularly known as the Silicon Valley of India. The city is home to 12.34 million people with a population density of 4000/km^2 making it the 24th most populous city in the world.

Fig 1: Study area map of Bengaluru city



Methodology

TROPOMI (TROPOspheric Monitoring Instrument) based Sentinel 5P data are used to analyze the NO_2 concentration over Bengaluru city. Spatio-temporal characteristics of NO_2 were analyzed for Bengaluru city to assess the level of NO_2 pollutants in air. Sentinel 5P data is used for monitoring of the atmosphere. Sentinel 5P is a new remote sensing data whose measurements are made by TROPOMI. In this analysis, tropospheric NO_2 was used to understand the pollution level in Bengaluru. Further, population density data has been collected from the European Commission Global Human Settlement to understand the distribution of population density across Bengaluru city. Moreover, population density data was correlated with Sentinel 5P based NO_2 data for April 2019 and April 2020 to understand their relationship.

Data used	Year	Resolution	Source
Nitrogen Dioxide (NO_2)	2019 & 2020	0.01^0	Sentinel 5P
Population density (GHS-POP)	2015	1Km	European Commission Global Human Settlement

Results

We examined the status of ambient NO_2 in Bengaluru city during the lockdown and business as usual situation. It is observed that during pandemic- led lockdown, the air quality has significantly improved because of the shutdown of industrial activities and drastically reduced vehicular movement. NO_2 in Bengaluru city depicted a significant decrease in 2020 as compared to 2019. Mean NO_2in Bengaluru city was found to be 0.0001292 mol/m2 in March and 0.0001201 mol/m2 in April 2019, in comparison to 2020, and a significant reduction in $NO_2$was observed in both the months March 2020 (0.0000884 mol/m2) and April 2020 (0.0000703 mol/m2) as shown in fig 2.

The population density map of Bengaluru city was derived from GHSL data. The unit of data is person per sq. km. The population density of Bengaluru city is 4378 per sq km as shown in fig 3. Further the coefficient of determination analysis between NO_2 and population density during the lockdown period was conducted taking into account the same month last year for consistency in influence of meteorological parameters (April 2019 and April 2020). The results demonstrate that during BAU (2019) the coefficient of determination is 0.62 whereas during lockdown (2020), the coefficient of determination is 0.37. Hence the analysis shows that the high emission is mainly associated with high population density. Decrease in coefficient of determination between NO_2 and population density directly represents the decrease in the effect of anthropogenic activities on air quality.

Fig 2: NO_2 in Bengaluru city

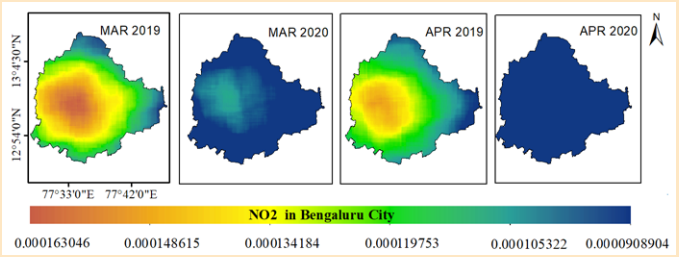
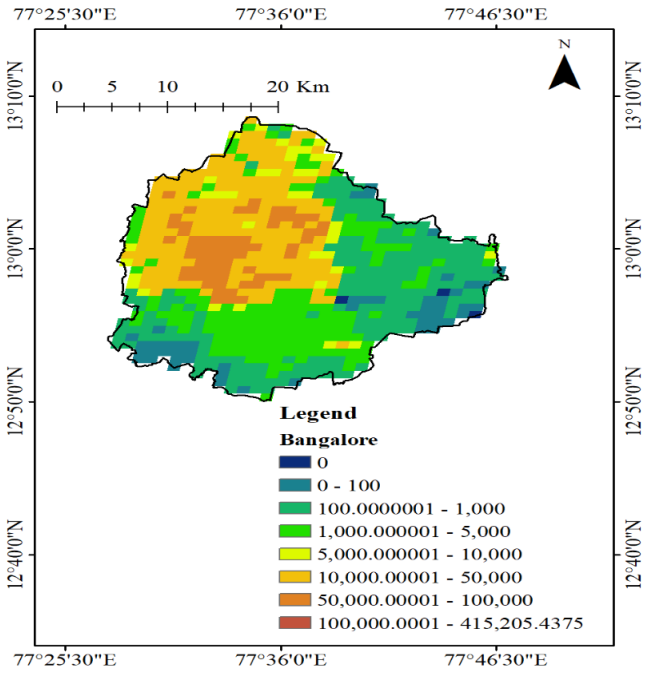


Fig 3: Population density of Bengaluru city 2015



Policy Suggestions

Air pollution poses a grave threat to public health with increased mortality and morbidity rates as well as contribution to climate change. The COVID-19 pandemic has highlighted the urgency to address India's chronic problem of air pollution. The government needs to focus on mitigating air pollution along with an emphasis on climate change control. The impact of the lockdown on the relationship between air pollutants and COVID-19 pandemic suggests the immediate need to build a better environment. Policies must include a pledge to continually measure and improve environmental performance for improvement in environmental sustainability. A few recommendations to be considered under policy formulation and/or reorientation are discussed below.

- Development of a comprehensive air quality assessment and monitoring strategy with a focus on more detailed source apportionment is the first step in establishing the present scenario and planning effective strategies to move forward.
- Policies are needed to shift towards a low emission economy with a transition towards cleaner energy for the betterment of human health and lives. Appropriate and adequate financial and technological innovation is necessary to tackle the issue at hand. A low emission economy would be helpful to deal with climate change and significantly reduce air pollutants. It is also necessary for policies in this regard to impose strict regulations on low emission rates for people who belong to the upper strata of society, i.e. high emission category.
- Industries and business establishments can also make a significant impact in improving air quality by aligning their own practices and supply chains with the clean air agenda by adopting sustainable practices which can reduce their environmental footprint. Monetary charges and fines can be imposed for excess emissions while policies could include raising awareness and providing incentives to establishments that have adopted cleaner and greener technology with sustainable practices.
- Construction and demolition activities are major sources of pollutants and dust. The government must ensure the use of more environment-friendly construction techniques and recycling drives to repurpose the waste produced.
- The emissions and toxins produced from waste burning could be reduced by establishing stringent responsibilities for waste management, improving coordination among agencies and providing guidance from the central level to municipalities on waste management and disposal. Revising fees and charges for waste management services and fines for polluters while also considering waste as a resource and improving reuse and recycle systems.
- A close collaboration between the public and the government is essential to overcome challenges as environmental rules should not be ignored on behalf of economic recovery plans. Government policies should incorporate community-based solutions to mitigate the impacts of air pollution.
- Policy implementation is also hampered by widespread violation of the law and weak coordination. Violation of these laws should be taken seriously, with the imposition of fines on offenders. Since the private sector also plays an important role in collaborating with the public sector and stakeholders to build awareness, generating appropriate funding is necessary to support them. It is also imperative to create policies to mobilize private finance for clean-air solutions in India. Funding is also required to support private start-ups focusing on combating the air pollution crisis for tangible solutions.
- Policies that address the problem of ambiguity in a number of air quality monitoring stations in the states. It is essential to analyze trends and patterns of ambient air quality, where useful policy actions are required to generate adequate information which will be used for developing emission control and mitigation solutions. The government can utilize air pollution data to guide transportation planning and expand public transport with better interconnectivity providing comfortable and accessible transport facilities which would be beneficial to the mass.
- Offices and workplaces should promote and organize carpooling practices for their employees as an initial measure to reduce emissions. Investing in public transport would promote public health as well as inclusive growth.
- The shift towards electric vehicles is imperative in the long run to counter the ongoing pollution crisis. Promoting the use of electric vehicles is an important step toward an emission-free society. Reforming taxes on imported vehicles and fines for polluters is also crucial.
- Frequently updating emission standards with technical inspections and fuel testing is also necessary to maintain the performance of a vehicle and minimize emission rates. There is an immediate

need for policies with a strict timeline for the retirement of old vehicles which would greatly maximize reductions in emissions. Policies could include penalties and higher taxes for older vehicles as a way to obligate people to dispose old vehicles.

- The major barrier that exists is the lack of demand for environmental information from policymakers. Working on better understanding the demand and use of information in order to make environmental information systems more demand-driven and user-relevant so that they can meet policy and operational needs.
- Public awareness campaigns and programs should be organized to educate people to use public transport systems, energy-efficient appliances and fuel-efficient automobiles, renewable sources of energy and to avoid burning trash, leaves and other discarded materials. Policy makers should also consider public requests as well as inform citizens of their rights to bring in more effective outcomes through a consultative manner.
- Identification of and extending support to NGOs and other organizations working on the same cause and collaborating will be effective in improving public awareness and participation. It is also crucial to develop awareness and organize training programs for public officials in environmental decision-making to enforce the public's rights and remove the barriers to justice. Creating awareness about the health impacts of indoor pollution among the marginalized and vulnerable communities should be emphasized.
- Policies for combating air pollution should also ensure the active participation of vulnerable communities in decision-making and in creating a balance between clean technologies and preserving their natural lifestyle. Planting trees is also a critical solution to air pollution as trees filter pollutants and absorb carbon dioxide while also being a source of oxygen. Ground-level ozone formation is also reduced in areas that are abundant in tree cover.
- Despite the solutions presented above, the most basic and immediately effective solution for air pollution would be replacing fossil fuels with alternative clean sources of energy, reducing industrial emissions through strict regulation, and creating awareness and educating the public. It is also important to set stringent future goals and standards to conserve energy, water, and other resources with promoting efficient use. However, short-term lockdowns may be useful in extreme situations when ambient air quality deteriorated, as an intervention strategy to control and curb air pollution.

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