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Prayagraj: Air Pollution Profile and Policy Recommendations

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Abstract

Air pollution is the fifth leading risk factor behind the world – wide mortality. Ever growing population size feeding industrial activity through demand channel, vehicular pollution accompanied by rapid urbanization and burning of fossil fuels pose a serious threat to clean air. Some major air pollutants under study in the city of Prayagraj are Nitrogen Dioxide (NO₂), Particulate Matter (PM₁₀) and Sulphur Dioxide (SO₂). Pollution profile of the city locality i.e. Rambagh, Johnstonganj, Alopibagh, Crossing Mahalakshmi talkies and Bharat Yantra Nigam are studied. PM₁₀ level of exposure is serious in Crossing Mahalakshmi talkies and Alopibagh area as exposure to very high level in the range of 250 - 400 µg/m³ occurs for the longest duration of time. Alopibagh, Johnstonganj and Rambagh shows critical level of Nitrogen Dioxide indicating higher vehicular movement in these areas. Trend wise, SO₂ component has spiked above 12 µg/m³ at Rambagh, Johnstonganj and Alopibagh during the onset of winters season in 2016. Similar phenomenon was seen at Bharat Yantra Nigam and Crossing Mahalakshmi talkies during winter season of 2019. Arrival of monsoon tend to lower pollutants content in the outdoor ambient air quality. Overall air quality is in critical zone at Alopibagh for 45 percent of the time period followed by Johnstongani. Crossing Mahalakshmi talkies and Bharat Yantra Nigamshows critical air quality for more than 60 percent of the time period which calls for urgent action to prevent them from entering the critical zone. Overall air quality of Prayagraj is range bound with air pollutants improve during the monsoon season. However, improvement in air quality has reduced in the last two years as fall in air pollutants is less in 2018 and 2019 monsoon compared to previous two years. The findings of the paper will help the administration, municipal corporation and various stake holders of the city to take targeted measures locality wise towards pollution control depending upon pollutants concentration and exposure area - wise. It will also raise public awareness about pollutant levels in their area.



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Introduction

Air pollution affects each one of us irrespective of gender, age income status and geographical location. Cardiovascular and respiratory disease fuels death from lung cancer¹, ischemic stroke², asthma³ causing erosion of quality of life. Air pollutants move deep into our respiratory system and gets absorbed into our blood circulation impairing our brain, heart and lungs.As per WHO's newsletter⁴, 9 out of 10 people breath air loaded with high pollutant level."Air pollution threatens us all, but the poorest and most marginalized people bear the brunt of the burden," says Dr Tedros Adhanom Ghebreyesus, Director-General of WHO. As per global ranking of risk -factors causing deaths, Air pollution is the fifth leading risk factor for world - wide mortality. Air pollution is a direct threat to human health as it caused 4.9 million deaths in the year 2017 approximately 147 million years of healthy life lost.⁵ Recent studies have also established that there is a clear link between air pollution and central nervous system diseases.6 As per WHO, South -East Asia and Eastern Mediterranean Region has the highest ambient air pollution level. Ambient air pollution in this region is five times more polluted than WHO limits. Given the severity of air pollution and its colossal impact on health, this paper studies major air pollutants such as Nitrogen Dioxide (NO₂), Particulate Matter (PM₁₀) and Sulphur Dioxide (SO₂) in Prayagraj. Nitrogen dioxide is emitted from fuel burning and when nitrogen reacts with oxygen at high temperature. PM₁₀ is coarse particle formed from construction and road dust. Sulphur dioxide is emitted from burning of coal or oil in power plants. It also comes from factories that make chemicals, papersor fuel.

An inherent relation to nature is what we all enjoy, cherish and it is the most essential aspect of every living being. People above 65 years of age exposed to greenery and clean environment face lower risk of hypertension by 13 percent and 14 per cent less risk from diabetes.⁷ However unchecked deforestation has led to loss of green cover and destruction of global sink. Growing urbanization and rapid industrialization has led to concretization of cities. Associated investment in road infrastructure has facilitated mobile emitters such as cars and trucks compounding the problem of air pollution. Infants and children are more exposed to respiratory infections and increase their susceptibility to air pollution.8 Moreover, children inhale more polluted air than adults as they remain outside for longer preiods.9 Ever growing population feeding industrial activity through demand channel, vehicular pollution accompanied by rapid urbanization and burning of fossil fuels pose a serious threat to clean air. Air pollution is ranked among top five risk factors causing deaths for all ages across gender in 2017.10 As per estimates, more than 6 million deaths were caused by air pollution in 2012¹¹ and has emerged as a major health concern. Primary pollutants react with anthropogenic emissions forming secondary pollutants in the atmosphere with climate altering and health damaging effects.¹² Ambient air pollution is the fifth biggest cause of mortality in India.13

As per report,¹⁴ increased temperatures due to climatic change and rising level of air pollutants will cause increase in airborne allergens. The report is highly confident that such increased airborne allergens will cause increased respiratory illness, asthma cases other allergic illness. Particulate emissions and ozone traces causes deterioration in health outcomes. Health deterioration due to emissions of pollutants causes premature deaths, lung cancer fall in labour productivity. As per the report air pollution affects different people differently. Women and elderly face the greatest baseline risk due to exposure to pollution. In the U.S. as per an estimate. 6.8 million children shows symptoms of asthma, making it the main cause behind reduced attendance of school going kids.

Air pollution has high mortality rates and disease burden in India being highest in the low Socio – Demographic Index (SDI) states of north India like Uttar Pradesh and Bihar.¹⁵ State wise all round customised approach to tackle the air pollution and related avoidable deaths is need of the hour.

Air pollution is a national problem, killing 1.2 million Indians every year. It has resulted in loss to the national GDP by around 3 percent.¹⁶ According to the report, barring few cities in the southern India, no Indian city comply with NAAQ standards. Air pollution is a critical problem to mankind and straight jacket approach at the central level will only curb pollution to some degree. Customised approach area wise is needed to address major source of air pollutants. As per a study in New Zealand in Auckland city, PM_{10} particles in the atmosphere are negatively corelated. However, during the daytime, PM_{10} particles are positively correlated to temperature due to thermally – induced convection. Overall correlation is moderately negative as the Spearman's co-efficient stands at -0.45. Relative humidity impacts PM_{10} particles in a positive way up to a threshold level of 75% of relative humidity. This positive correlation ceases to exists beyond threshold level. This finding is in line with the findings of Barmpadimos. According to study¹⁷, PM_{10} and relative humidity increases up to a level, then PM_{10} drops suddenly for a period while relative humidity continues to rise.

As per study, out of top 10 cities with worse air quality, seven are from India with Delhi being the world's most polluted city.¹⁸ Air – pollution emergency is not restricted to metros but has rapidly penetrated into tier – II cities. Prayagraj recently witnessed largest human gathering with around 120 million pilgrims visiting the city over a period of 48 days.

Air pollutants were studied by Srivastava and Vaishya¹⁹ (2009) with two monitoring stations in the city. Pollutants exposure were collected using dust samplers. Other than this particular work, no known exhaustive work is done in the city on air pollutants. Dearth of any pollution related city specific study is surprising given the religious importance of the city. The objective of this paper is to fill this gap and present a comprehensive study of air pollution in Prayagraj. Given that the city comes under the list of Smart city, the study becomes more important to guide the district administration and policy makers to take necessary steps towards curbing air pollution. The paper studies air pollutants at five monitoring stations from January, 2016 to January, 2020 (monthly data from Uttar Pradesh Pollution Control Board²⁰). The paper gives a composite air quality index at five monitoring stations after studying air pollutants, namely, Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂) and PM₁₀ particles and highlights the seasonal impacton air quality. The paper studies best global practices to curb airpollution and recommends customised policy measures to check degrading air quality. It also identifies areas with high exposure to pollutants and gives a representative series of overall air quality in the city. Accordingly the paper is divided into four sub sections. Section 2 gives the overall geographical features of the city and its monitoring stations, section 3 studies individual pollutants i.e. PM_{10} , NO_2 and SO_2 , section 4 studies the composite air quality of Prayagraj and section 5 presents detailed conclusion of the paper.

Prayagraj

Pollution Profile and Geographical Features

The city of Prayagraj, the judicial capital of the state, is among the largest cities of Uttar Pradesh with an area of 5,482 sq. km is situated at the confluence of three rivers – the Ganga, the Yamuna and the invisible Saraswati. Prayagraj is the seventh most populated city in the state with the urban population of 11.43 lakh.²¹ Prayagraj is located at 25.45°N 81.84°E.

Prayagraj witnessed the third highest concentration of PM 2.5 (Annual mean, ug/m³) in the ambient air after Zabol (Iran) and Gwalior out of 2975 cities in the year 2012.²² The city was ranked twelfth in terms of exposure to PM₁₀. The residents of Allahabad often face stormy pollutants. Coal-burning power plants, automobile emissions and deforestation accompanied with unchecked construction, all leave the holy city, literally, in the dust. Prayagraj is one among thirteen smart cities identified in the state. As per an estimate, total population of the city is projected to cross 2 million by the year 2031. Smart city requires smart planning and providing clean air to its residents is one the most important aspect of development.

The paper studies pollution level w.r.t. PM₁₀, Nitrogen Dioxide and Sulphur Dioxide at five important locations in the city – Rambagh, Crossing Mahalakshmi Talkiez (CMT, near District Court), Johnstonganj, Alopibagh and Bharat Yantra Nigam (BYN, popularly known as Civil Line). Let us know about these areas brief (figure 1 to 3).

Rambagh

The area is close to city railway station and has open spaces like park, schools and colleges thatare airy and spacious as can be seen in the image below. The area sees heavy traffic.

Johnstonganj

Johnstonganj is a highly dense and congested area with negligible green cover. Heavy traffic and vehicle

movement is a daily event in the area. It is highly commercialized and pavements are encroached with vehicle parking and small shops. Three to four story buildings withvery few tree is a common sight in the area.



Fig. 1: Rambagh (Left) Johnstonganj (Right) source: google map



Fig. 2: Alopibagh (Left) Crossing Mahalakshmi Talkiez (Right) source: google map

Alopibagh

Due to its proximity to Old Grand Trunk road, Alopibagh sees high vehicular movement. Thearea is near to river bed and breeze can be experienced in the morning. Wide open space in the vicinity with greenery in patches is evident from the map. It should be noted that three areas – Rambagh, Johnstonganj and Alopibagh – is served by single artery road as these locations lie adjacent to eachother. Heavy vehicular movement crosses through these areas all the time. Congestion and high density are regular feature in all the three areas.

Crossing Mahalakshmi Talkies

The area is popularly known as Civil Line and mostly traders and government employees live here. It has

wide roads with low density compared to other three areas discussed earlier. Normal traffic with less congestion can be seen.

Bharat Yantra Nigam High Court

The area has wide roads and is less densely



Fig. 3: Bharat Yantra Nigam (High Court) source: google map

Pollutant analysis

PM₁₀

Particulate matter (PM_{10}) is 10 micrometers or less in diameter. Finely divided solid particles or liquid droplets such as soot, smoke, fly ash, mists, aerosols and dust particles from construction activity form major components of PM_{10} . These particulate matters are so small that it can easily be absorbed into lungs and causes health issues like asthama, irregular heart – beat, heart attacks, reduced lung function and other potentially serious health problems.

It is clear from the graph (Fig 4a) that CMT shows the highest number of peaks indicating higher level of PM_{10} exposure. It reaches global maxima of $370 \ \mu g/m^3$ in August 2019. Exposure to PM_{10} remains at elevated level until monsoon. Seasonal effects can be seen as exposure to PM_{10} gradually declines with the arrival of monsoon between July to September. PM_{10} level rises during summer and winter season. Fig 4b shows that PM_{10} median value is the highest for CMT. Outliers can be seen in Bharat Yantra Nigam and Crossing Mahalakshmi Talkiez but they have been included in the study to maintain realism.

There is very high correlation between PM₁₀ particles for Rambagh, Johnstonganj and Alopibagh. It should be noted that these three locations fall on a single feeder artery road. High degree of correlation can

populated featuring parks and open spaces with greenery in patches. However, construction activity in this area has accelerated in the last two – three years.

also be seen in particulate matter between CMT and BYN as these two areas are close by (Table 1).

Rambagh, Alopibagh and Johnstonganj in that order has PM_{10} close to normal distribution. PM_{10} at Bharti

Yantra Nigam and Crossing Mahalakshmi Talkiez is negatively skewed. It should be noted that Alopibagh shows the highest minimum point of 57. Mean PM_{10} pollutant is the highest mean for CMT followed by Alopibagh.



PM₁₀ trend

Box plot with outliers



Table 1: Correlation of PM₁₀ Area Wise

Corr.	byn	cmt	johnstonganj	alopibagh	rambagh
byn	1				
cmt	0.93	1			
johnstonganj	0.36	0.25	1		
alopibagh	0.41	0.27	0.90	1	
rambagh	0.44	0.32	0.86	0.93	1

Table 2: Descriptive Statistics of PM₁₀ Area Wise

 Area	Mean	Std. Dev.	skewness	kurtosis	Min	Мах
byn	189	51	-1.37	4.81	39	255
cmt	235	67	-0.74	3.99	53	370
johnstonganj	182	74	0.25	2.00	52	344
alopibagh	207	84	-0.22	1.68	57	337
rambagh	182	78	-0.14	1.73	45	310

Considering three benchmarks of air quality in terms of PM_{10} : Clean (30 – 100 µg/m³), Moderate (100 – 250 µg/m³) and Polluted (250 – 400 µg/m³), Alopibagh has the highest percentage distribution of PM_{10} pollutant lying in the polluted categoryfollowed

by Crossing Mahalakshmi Talkiez. Rambagh has relatively lower PM₁₀ pollutant in comparison to other locations though it is only 20 per cent of the entire period under study (Figure 5). Overall, Bharat Yantra Nigam area falls under the category of moderate level of air quality (88 percent) in terms of PM_{10} that needs to be watchful. If proper remedial is not

undertaken at the earliest, the area is highly likely to attain "Polluted" category.





Pollutant analysis Nitrogen Dioxide (NO₂)

Nitrogen dioxide mostly emitted from motor vehicle exhaust, burning of fossil fuels, manufacturing industries and food processing. It is critical pollutant in air as it chemically reacts with other pollutants in the air forming photochemical smog having adverse impacts on public health. Continuous exposure to NO₂ causes inflammation in lungs thereby reducing its immunity to lung infection. Reduced immunity may cause frequent and more intense asthama attacks.

Nitrogen dioxide component of air pollution is the lowest in BYN area compared to other locations in the city as evident from Fig 6a. Seasonal impact is clearly visible in the trend line at almost all locations. NO₂ content rises during winter season and slight fall is visible during monsoon and summer. Average exposure to NO₂ level is the highest in Alopibagh, followed by Johnstonganj and Rambagh.Outliers can be seen in Fig. 6b for Crossing Mahalakshmi Talkiez but they have been included in the study to maintain realism.



Fig. 6(a) Seasonal impact can be seen with fall in NO₂ level during monsoon period (b) Alopibagh has the highest NO₂ median level

Close to 90% correlation can be seen between NO₂ level at Alopibagh and Rambagh. Alopibagh, Johnstonganj and Rambagh shows high degree of correlation in NO₂ level. However, CMT and BYN

exhibits 81% correlation implying that NO_2 level between the two location is affected by similar geographical and seasonal factors (Table 3).

Corr.	byn	cmt	johnstonganj	alopibagh	rambagh
bvn	1				
cmt	0.81	1			
johnstonganj	0.32	0.46	1		
alopibagh	0.45	0.49	0.83	1	
rambagh	0.48	0.43	0.77	0.88	1

Table 3: Correlation of NO, Area Wise

NO₂ distribution is approximately symmetric at all the locations except CMT. Positive excess Kurtosis at CMT reveals that it has more in the tails than normal distribution (Table 4). Minimum NO₂ level is maximum for Alopibagh, Johnstonganj and Rambagh (above 27) highlighting narrow feeder line through which most of automobile passes through.

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Area	Mean	Std. Dev.	skewness	kurtosis	Min	Мах
byn	28.73	9.71	0.49	3.17	14.00	59.50
cmt	36.39	10.89	0.71	4.21	17.30	73.40
johnstonganj	47.25	12.52	0.36	1.88	27.10	74.98
alopibagh	48.84	11.59	0.22	2.45	27.50	78.80
rambagh	44.32	9.02	0.12	2.55	27.10	64.31

Considering three benchmarks of air quality in terms of NO₂: clean (10 – 30 μ g/m³), moderate (30 – 50 μ g/m³) and critical (50 – 80 μ g/m³), BYN has least NO₂ content in its air followed by CMT. It shows that the area either has wider roads and/or lower vehicular traffic compared to other areas. NO₂ content is at critical level for 47 percent of the time period under study at Alopibagh. This severity of NO₂ content of air is followed by Johnstonganj and Rambagh. Urgent steps must be taken at CMT as above 60 per cent of the time period shows itsair content to have moderate level of NO₂, which if unchecked might come under "Polluted" category (Figure 7).

Pollutant analysis

Sulphur Dioxide (SO,)

Sulphur dioxide is a gaseous air pollutant which reacts with other compounds forming acid (sulfuric acid, sulfurous acid) and sulfate particles. Sulphur dioxide is emitted from vehicle combustion process, thermal power plants and industrial activities. When inhaled, sulphur dioxide causes breathlessness, irritation in eyes, nose and airways causing coughing and wheezing. Those suffering from asthama are at high risk of getting affected.

Trend shows that SO_2 component has spiked above 12 µg/m³ at Rambagh, Johnstonganj and Alopibagh during the onset of winters season in 2016. Similar phenomenon can be witnessed at BYN and CMT during winter season of 2019. It has thereafter remained at higher level throughout the year. Arrival of monsoon does tend to lower SO_2 content in the outdoor ambient air quality. SO_2 content in air tends to moderate during summer but winters shows clear spike at CMT and BYN during winters of 2019 (Figure 8a).



Fig. 7 a. Alopibagh has the highest percentage of NO₂ in the "Polluted" category followed by Johnstonganj.

b. Crossing Mahalakshmi Talkiez area needs immediate attention to prevent its transition from "Moderate" to "Polluted" category.



SO₂ trend



Fig. 8(a) General trend of increase in SO₂ level with fall in temperature can be seen (b) CMT has the highest SO₂ median level

We can infer from Table 5 that areas closer to each other i.e. Rambagh, Alopibagh and Johnstonganj exhibits very high degree of correlation. Similar observation can be made for SO_2 at BYN and CMT as they show higher correlation with each other. CMT and BYN shows slight negative correlation with the rest of other locations (Table 5).

Mean level of SO_2 is the highest at CMT followed by BYN. At Rambagh, SO_2 is on the lower side. SO_2 distribution in air is positively skewed at all the locations. Positive skewness is very high at Rambagh and Alopibagh. Positive excess Kurtosis at all location reveals that it has more in the tails than normal distribution. CMT exhibits higher variance than the rest of the locations (Table 6).

Considering three benchmarks of air quality in terms of SO₂: less $(0 - 3 \mu g/m^3)$, moderate $(3 - 8 \mu g/m^3)$ and critical $(8 - 16 \mu g/m^3)$, Rambagh has air components relatively free from SO₂ for 59 percent of the entire duration followed by Johnstonganj. SO₂ level in air is moderate to critical at CMT and BYN for most of the time period (Figure 13).

Corr.	byn	cmt	johnstonganj	alopibagh	rambagh	
byn cmt johnstongar alopibagh rambagh	1 0.98 nj -0.20 -0.09 -0.05	1 -0.16 -0.06	1 0.94 0.92	1	1	

Table 5 Correlation of SO, Area Wise

Table 6 Descriptive statistics of SO₂ Area Wise

Area	Mean	Std. Dev.	skewness	kurtosis	Min	Мах
byn cmt johnstonganj alopibagh	4.72 5.40 3.63 3.87	2.94 3.11 2.60 2.72	1.50 1.45 2.65 3.24	4.63 4.65 11.38 14.20	1.60 2.00 1.58 1.70	13.50 15.10 15.50 15.80
rambagh	3.25	2.09	3.56	16.19	1.60	12.80





b. Crossing Mahalakshmi Talkiez area needs immediate attention to prevent its transition from "Moderate" to "Polluted" category for SO, content of air.

Composite Air Quality at Each Station

PM₁₀ sits in our lungs causing upper respiratory problems. Higher exposure to particulate matter can impair development of brain in children.²⁴ PM₁₀ causes serious effects on the cardiovascular system.²⁵ Exposure to NO₂ causes swelling in the inner linings of our lungs resulting in mild shortness of breath and cough²⁶. People suffering from asthma must avoid exposure to NO₂ as it causes frequent and sever attacks. An increase in SO₂ by 0.005

ppm can cause an increase of emergency room visits for wheezing episodes in children by $12\%^{27}$. Exposure to SO₂ causes shortness of breath and congestion feeling in chest²⁸. Individual pollutants make a cocktail of harmful air quality. To arrive at composite air quality at each station, weights have been allotted to individual pollutants according to Principal Component Analysis, as indicated in the table below.

Table 7: PCA weights

Principal Component Weights for pollutants at each location

Area	PM ₁₀	NO ₂	SO ₂
byn	0.5564	0.3099	0.1337
cmt	0.4925	0.3215	0.1861
johnstonganj	0.5419	0.3512	0.1069
alopibagh	0.5297	0.3733	0.097
rambagh	0.465	0.3643	0.1707

Air quality at each station is calculated by multiplying pollutants with corresponding weights. Below equation represents the methodology for arriving at air quality.

AQ(i)=W1×PM10+W2×NO2+W3×SO2

AQ(i)=Air Quality at individual locations/station

Composite air quality at each station is further studied for frequency distribution under four categories i.e. Clean $(20 - 50 \ \mu g/m^3)$, Moderate $(50 - 90 \ \mu g/m^3)$, Satisfactory $(90 - 150 \ \mu g/m^3)$ and Critical $(10 - 50 \ \mu g/m^3)$. Based on these categories, air quality percentage distribution chart is formed for all locations in the city (Figure 10). Below chart indicates that air quality at Alopibagh is at critical level for around 45 percent of the period followed by Johnstonganj for 29 percent of the duration. Air quality at BYN is of gretar significance as above 85 percent of time, air quality is satisfactory. It may soon experience greater proportion of time under critical category if proper steps for air pollutants control is not taken.





b. Bharat Yantra Nigam and Crossing Mahalakshmi Talkiez area needs immediate attention to prevent itstransition from "Satisfactory" to "Critical" category.

Figure 11 is clearly indicative of improvement in the air quality during monsoon season as air pollution falls with the arrival of rainy season. However it must be noted that the magnitude of improvement has slowly reduced during the last two years. Post monsoon, air pollutants content return their normal level of $100 - 150 \ \mu\text{g/m}^3$ which is a worrisome scenario.



Fig. 11 a. Overall air quality improves during monsoon as is evident from the trend line b. improvement in air quality has reduced in the last two years as fall in air pollutants is less in 2018 and 2019 monsoon compared to previous two

Conclusion and Suggestions

The study is purposive as Prayagraj is neither a metro nor a town, neither industrial nor rural. It is more traditional, historical and cultural town surrounded by many semi – rural and semi – urban settlements. Pollution level is measured at five places which although are different in settlements, density and traffic but contagious and so clear-cut demarcation cannot be made between them for the level of pollutants. So, the conclusions drawn cannot be generalized, yet provide important lessons for the policy makers and administrators. The main conclusions can be summarized as following:

- Seasonal impact can be seen on PM₁₀, NO₂ and SO₂ level during monsoon period. The general trend has been that air becomes more cleaner during monsoon. NO₂ and SO₂ picks up during winter while PM₁₀ content of air rises during summer.
- CMT area has the highest PM₁₀ median level followed by Alopibagh. Dust particles due to construction activity needs to be regulated stringently. General direction by the authority should be issued to pause construction during summer season and stocking of sands, cements and pebbles should be allowed in closed space away from roadside. Covering

of construction site can check PM₁₀.

- Bharat Yantra Nigam (BYN) and Crossing Mahalakshmi Talkiez area needs immediate attention to prevent its transition from "Moderate" to "Polluted" category in terms of NO₂ and SO₂ respectively. Roadside eateries and food joints should be forced to have smokeless bhatties. Traffic management is the key to curb nitrogen dioxide and sulphur dioxide. Diesel vehicles like autos and Vikrams should be replaced by E – rickshaws or original manual rickshaws. Urban alleviated viaducts can be used to reduce the impact of pollutants.²⁹
- Based on the composite air pollution, we conclude that Alopibagh has the highest percentage of air quality in the "Critical" categoryfollowed by Johnstonganj. Bharat Yantra Nigam and Crossing Mahalakshmi Talkiez area needs immediateattention to prevent its transition from "Satisfactory" to "Critical" category. Studies related to air pollution tolerance of plants in Prayagraj³⁰ suggests that plant species named *Magnifera Indica* has the highest tolerance to air pollutants followed by Aegle Marmelos. These plants must be widely grown along the roadsides.

 Overall air quality improves during monsoon as is evident from the trend line. However, improvement in air quality has reduced in the last two years as fall in air pollutants is lessin 2018 and 2019 monsoon compared to previous two years.

Environmental degradation and increased pollution (air, sound, water) are probably the most discussed, negotiated and diluted issues of 21st century. Seriousness of such environmental threat should be understood well. Time lag between implementation of regulation and introduction of technology is significant in Asian countries compared to European environments.³¹ There is a lot of scope to reduce this time lag for quick redressal towards air pollution. GIS based pollution studies is widely gaining traction. It will be interesting to see what conclusions are arrived at on the basis of GIS study. It will provide holistic study of air pollution in Prayagraj given the lack of coverage of ground based air monitoring stations.

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