

Air Pollution Causes, Trends and Mitigative Measures to Improve Air Quality with Respect to Bangalore City

Najeebunnisa

Abstract

Author Affiliation
Principal, BES LAW College,
Bengaluru, Karnataka 560011,
India & Research scholar,
Gulbarga University,
Kalaburagi, Karnataka 585106,
India.

Reprint Request
Najeebunnisa,
Principal, BES LAW College,
Bengaluru, Karnataka 560011,
India & Research scholar,
Gulbarga University,
Kalaburagi, Karnataka 585106,
India.
E-mail:
naazneen2002@gmail.com

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Cities in India have witnessed a phenomenal growth in the last 2 decades both in population and number of vehicles. Population growth in cities is mainly attributed to migration of people in search of better employment, opportunities, whereas the increase in vehicular population is attributed to absence of efficient, comfortable and reliable public transport system. Bangalore is no exception to such phenomena.

“The level of urbanization in Karnataka as per the census has increased from 33.99% in 2001 to 38.57% in 2011, this population growth coupled with increase in household income and increase in commercial and industrial activities has placed heavy demands on urban transport system of the State, a demand that many cities have not been able to meet. As per Wikipedia, in 2011-12 Karnataka had 182 registered motor vehicles per 1000 population which is about 1 per 5 persons. Such huge number of vehicles in the cities cause increased traffic jams, congestions and air pollution. The average speed of the vehicles in Bengaluru city is less than 10 KMs per hour. As on 2016, the vehicle number has increased to 67 lakhs “

Keywords: Air Pollution Issues in Bengaluru City; Current Status and Trends.

Introduction

Air quality is an important component of overall quality of life enjoyed by a citizen. There are large number of studies and programs which have measured impact of quality of air that we breathe and live in. The quality impacts not only humans but entire ecosystem comprising plants, animals of this planet and building structures. Citizens are seriously concerned about deteriorating air quality especially in the urban areas in general.

Air pollution is emerging as an important concern in India. Levels of particulate matter

(PM) are above the prescribed national standards in about 80% of Indian cities. Other than PM, gaseous pollutants like NO₂ and SO₂ are found to be high at specific locations. There is adequate evidence that air pollution has adverse effect on human health and agriculture in India.

Air pollution occurs when harmful substances including particulates and biological molecules are introduced into Earth's atmosphere. It may cause diseases, allergies or death in humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. Air pollution is by far the most harmful form of pollution in our environment. Air pollution is caused by the injurious smoke containing pollutants

namely Sulphur di oxide, carbon monoxide, oxides of nitrogen, particulate matter emitted by cars, buses, trucks, trains and factories e.g. asbestos, wood industries, construction industries etc.

Even smoke from burning leaves and cigarettes are harmful to the environment causing a lot of damage to man and the atmosphere.

Evidence of increasing air pollution is seen in lung cancer, asthma, allergies, and various breathing problems along with severe and irreparable damage to flora and fauna.

Even the most natural phenomenon of migratory birds has been hampered, with severe air pollution preventing them from reaching their seasonal metropolitan destinations of centuries.

Particle pollution, also called particulate matter or **PM**, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form in complicated chemical reactions in the atmosphere. Particles come in a wide range of sizes. Particles less than or equal to 10 micrometers in diameter are so small that they can get into the lungs, potentially causing serious health problems. Ten micrometers is less than the width of a single human hair. Coarse dust particles (PM_{10}) are 2.5 to 10 micrometers in diameter. Sources include crushing or grinding operations and dust stirred up by vehicles on roads. Fine particles ($PM_{2.5}$) are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes.

Acid rain is a result of air pollution. When any type of fuel is burnt, lots of different chemicals are produced. The smoke that comes from a fire or the fumes that come out of a car exhaust don't just contain the sooty grey particles that one can see - they also contains lots of invisible gases that can be even more harmful to our environment.

Power stations, factories and cars all burn fuels and therefore they all produce polluting gases. Some of these gases (especially nitrogen oxides and sulphur dioxide) react with the tiny droplets of water in clouds to form sulphuric and nitric acids. The rain from these clouds then falls as very weak acid - which is why it is known as "**acid rain**".

During recent past, Bengaluru has achieved overall development due to establishment of IT, BT companies, Industries and increase of Construction activities. Due to this, there is an increase in population of the city, vehicles, which has impacted

on Ambient Air Quality (AAQ) of the city. The Karnataka State Pollution Control Board (KSPCB) is regularly monitoring the Ambient Air Quality of the city at different locations. The monitoring results reveals that Particulate Matter concentration is exceeding the standard stipulated under National Ambient Air Quality Standards.

The level of urbanization in Karnataka as per the census has increased from 33.99% in 2001 to 38.57% in 2011, this population growth coupled with increase in household income and increase in commercial and industrial activities has placed heavy demands on urban transport system of the State, a demand that many cities have not been able to meet. As per Wikipedia, in 2011-12 Karnataka had 182 registered motor vehicles per 1000 population which is about 1 per 5 persons. Such huge number of vehicles in the cities cause increased traffic jams, congestions and air pollution. The average speed of the vehicles in Bengaluru city is less than 10 KMs per hour. As on 2016, the vehicle number has increased to 67 lakhs.

Status of Ambient Air Quality Monitoring Programme (NAAQM) in Bengaluru city:

The Board is monitoring the ambient air quality of Bengaluru city at 21 locations including seven Continuous Ambient Air Quality Monitoring Stations and using manual equipments under National Ambient Air Quality Monitoring Programme (NAMP) covering Industrial Area, Mixed Urban Area and Sensitive Area. Seven continuous ambient air quality monitoring stations (CAAQMS) installed at City Railway station, Regional Office complex at S.G Halli (Modi Hospital), KAVIKA on Mysore Road, Veterinary, College Hebbal, Silk Board, NIMHANS, Shalini Grounds, Jayanagar.

Ambient air quality monitoring is being carried out on 24 hourly basis for PM_{10} , $PM_{2.5}$, SO_2 , NO_2 , Ammonia, Lead and CO and the data is sent to CPCB, New Delhi electronically and also the data is displayed in the Board Web Site.

The Central Pollution Control Board has declared Bengaluru as one of the non-attainment cities with respect to particulate matter pollution based on the air quality data during 2009 to 2011.

Trends Of Ambient Air Quality In Different Zones In Bengaluru Is As Under:

- **Industrial Zone:** Four ambient air quality monitoring stations have been set up in the industrial zones of Bangalore city viz.

1. Export Promotional Park , ITPL ,White Field Industrial Area
2. KHB Industrial Area, Yelahanka
3. Peenya Industrial area (Gymkhana)
4. Peenya Industrial area, RO, Urban Ecopark

2012-2017. Higher levels of PM₁₀ may be due to the construction activities and vehicular movement and road dust.

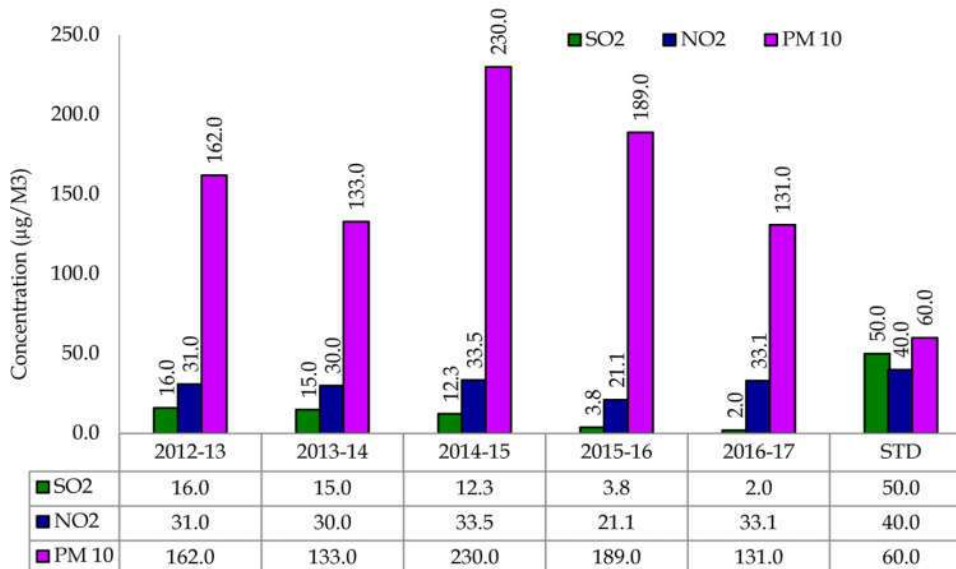
KHB Industrial Area, Bengaluru

PM₁₀ values are exceeded the national ambient air quality standard (60.0 µg/M³) in all measured years. During 2012-2017, PM₁₀ values are around 3 fold higher than national limit, may be due to construction of International Air Port Road, whereas SO₂ and NO₂ are within the national limit during all the measured years 2012-17.

1. ITPL, White field road (Export Promotional Park), Bengaluru

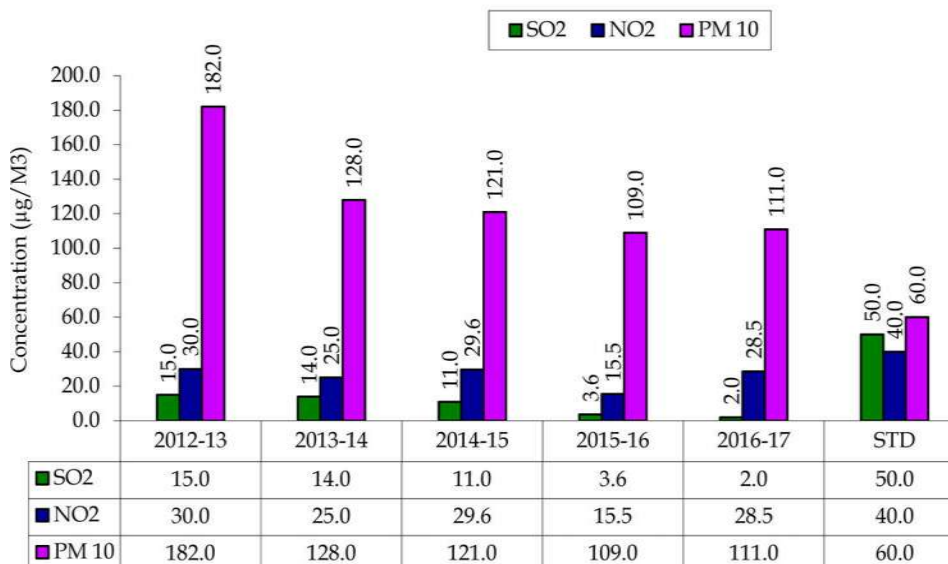
PM₁₀ values have exceeded the national limit (60.0 µg/M³) in all measured years, whereas SO₂ and NO₂ values are within the national limit during the period

Annual average values of air pollutants at ITPL, Whitefield road during the year 2016-17



Graph 1:

Annual average values of air pollutants at KHB Indl Area, during the years 2012-17



Graph 2:

Peenya Industrial area (Urban Eco Park Peenya), Bengaluru

PM₁₀ values are exceeded the national ambient air quality standard (60.0 µg/M3) in all the measured years due to the construction activities and vehicular movement and road dust whereas SO₂ and NO₂ are within the national limit in all the measured years 2012-17.

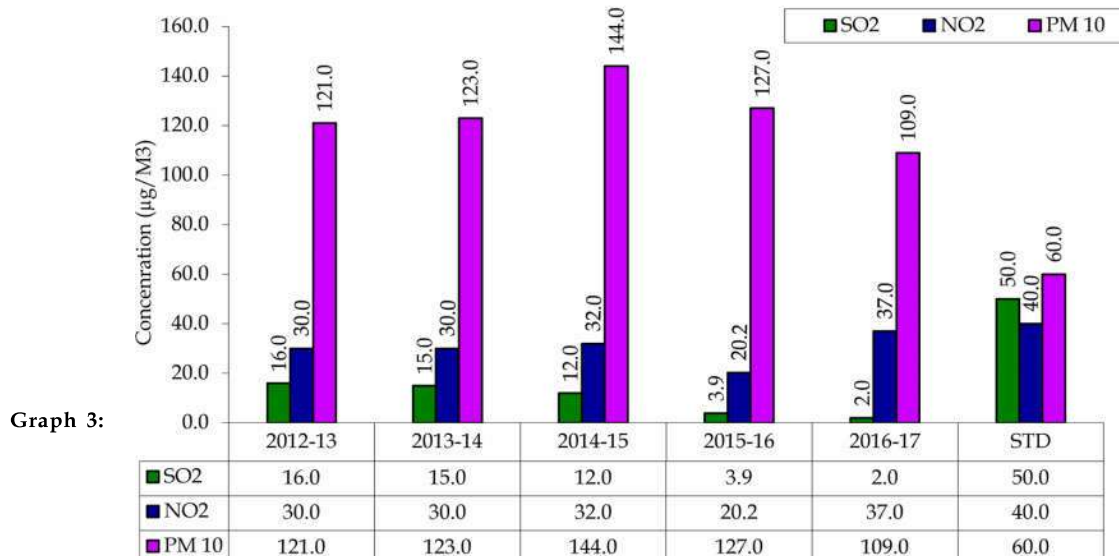
IMTA/Swan Silk Industry, Peenya, Bengaluru

PM₁₀ values are exceeded the national ambient air quality standard (60.0 µg/M3) in all the measured

years , due to the construction activities and vehicular movement and road dust , Whereas SO₂ and NO₂ are within the national limit in all the measured years 2013-17.

Mixed urban zone: Eight ambient air quality monitoring stations have been set up in the mixed zone (Residential, Rural & Other areas) of Bangalore city viz. 1. AMCO Batteries, Mysore Road. 2. Yeshwanthpur Police Station, 3. Central Silk Board, Hosur Road, 4. DTDC office, Victoria Road, 5. Teri Office, Domlur, 6. Banaswadi Police Station, 7. Kazisummanahalli, White Field, 8. UVCE, KR Circle, Bangalore.

Annual average values of air pollutants at Peenya Industrial Area, during the years 2012-17



Graph 3:

Annual average values of air pollutants at IMTA/Swan Silk Peenya for 2013-17



Graph 4:

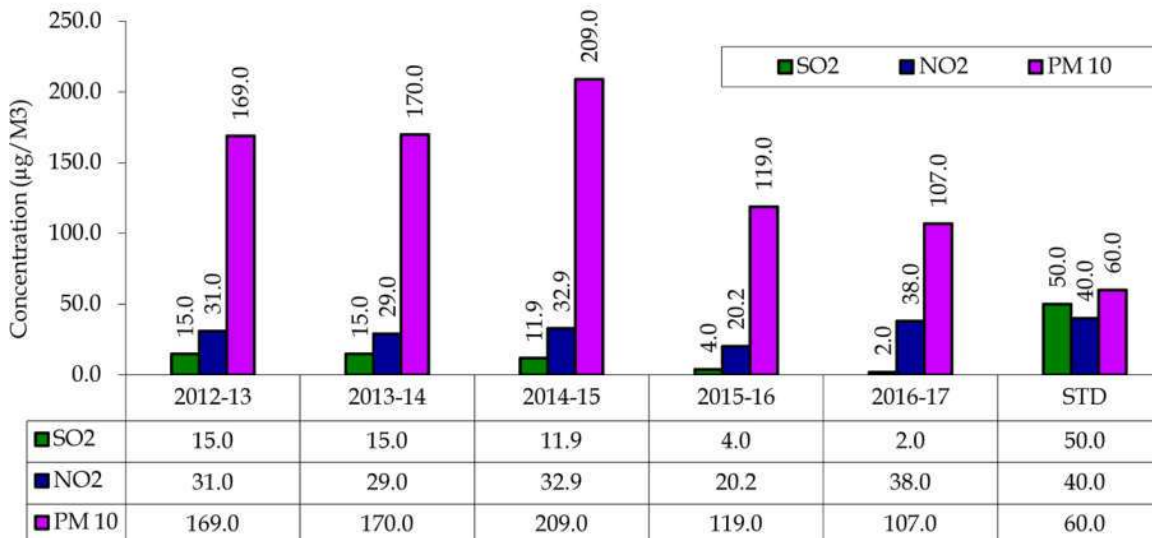
AMCO Batteries Mysore Road, Bengaluru

PM₁₀ values have exceeded the national ambient air quality limit (60.0 µg/m³) during the years 2012-2017, PM₁₀ values are around 3 fold higher than national limit, due to the construction activities and vehicular movement and road dust. Whereas SO₂ and NO₂ are well within the national limit during the years 2012 -2017.

Yeshwanthpur Police Station, Bengaluru

PM10 values have exceeded the national ambient air quality standard (60.0 µg/m³) in all measured years whereas SO₂ and NO₂ are within the national limit during 2012-17. Higher levels PM₁₀ is due to the construction activities and vehicular movement and road dust.

Annual average values of air pollutants at AMCO Batteries, Mysore Road, during the years 2012-17



Graph 5:

Annual average values of air pollutants at Yeshwanthpur Police Station during the year 2012-17



Graph 6:

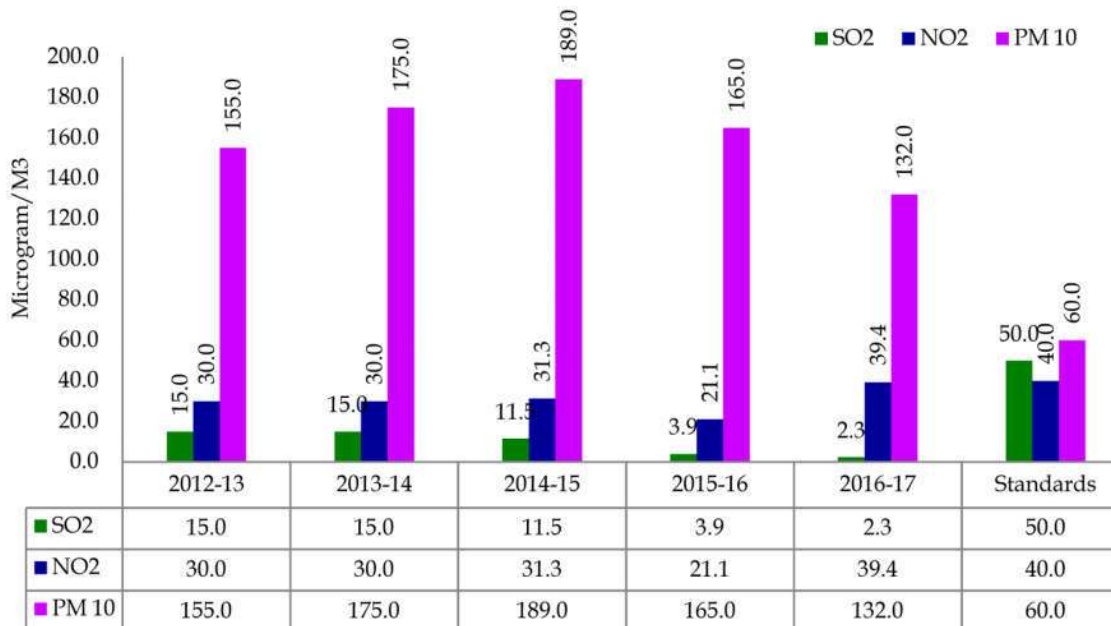
Central Silk Board, Hosur road, Bengaluru

PM₁₀ values have exceeded the national ambient air quality standard (60.0 µg/M³) in all measured years, During 2012-2017 PM₁₀ values are around 3 fold higher than national limit, due to the construction activities and vehicular movement and road dust whereas SO₂ and NO₂ are within the national limit during 2012-17.

Madavachari House, Kajisonnenahalli, Bengaluru

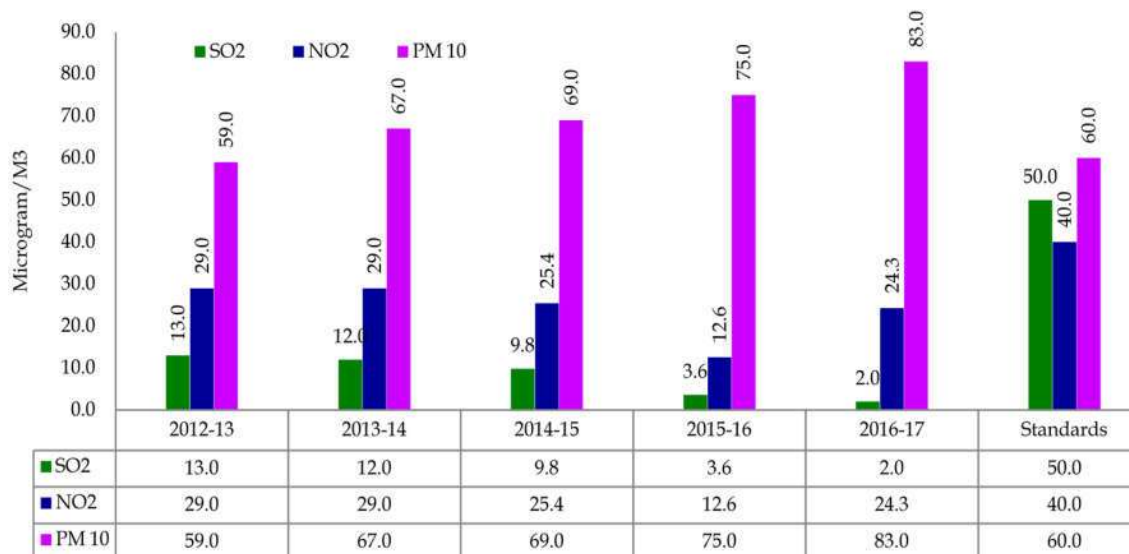
PM₁₀ values have slightly higher than the national ambient air quality standard (60.0 µg/M³) in all measured years except in the year 2012-13, where the PM₁₀ value is 59.0 µg/M³ in the year 2012-13 which is near to the National limits (60.0 µg/M³) whereas SO₂ and NO₂ are within the national limit during 2012 -17.

Annual avg values of air pollutant at Central Silk Board for the year 2012-17



Graph 7:

Annual avg values of air pollutants at Kajisonnenahalli for the year 2012-17



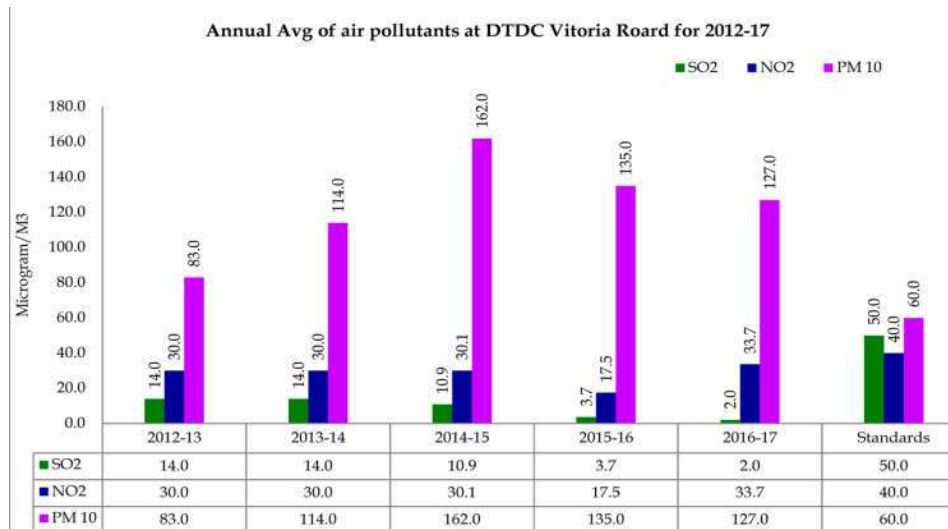
Graph 8:

DTDC, Victoria road, Bengaluru

PM₁₀ values have exceeded the national ambient air quality standard (60.0 µg/M³) in all the measured

years 2013-17, due to the construction activities and vehicular movement and road dust and SO₂ and NO₂ are within the national limit during 2012 -17.

Graph 9:



Banaswadi Police Station, Bengaluru

Annual avarge values of air pollutants at Banaswadi Police station for the year 2013-17

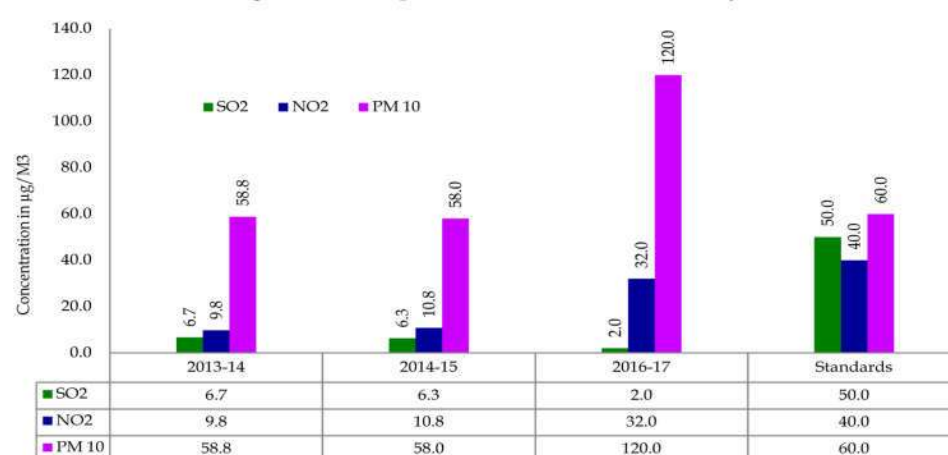
Graph 10:



TERI, Domlur, Bengaluru

Annual average values of air pollutants at TERI, Domlur for the year 2013-17

Graph 11:



City Railway Station, Bengaluru

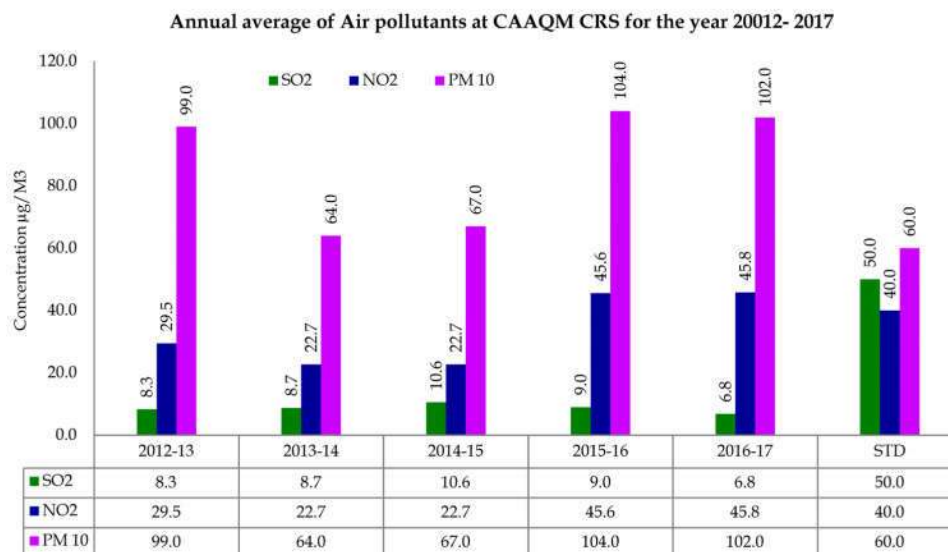
PM10 values are exceeded the national ambient air quality standards 60.0 µg/M³ for the years 2012-2017 and NO₂ values are within the national limit of 40.0 µg/M³ for the year 2012-2015 except for the year 2015-16. SO₂ values are well within the national limit (50.0 µg/M³) in all measured years 2012-2017.

CO values are well within the national limit of (2.0 µg/M³) for all measured year 2012-2017. At City Railway Station Metro work is under progress, hence only PM10 has exceeded and traffic has decreased

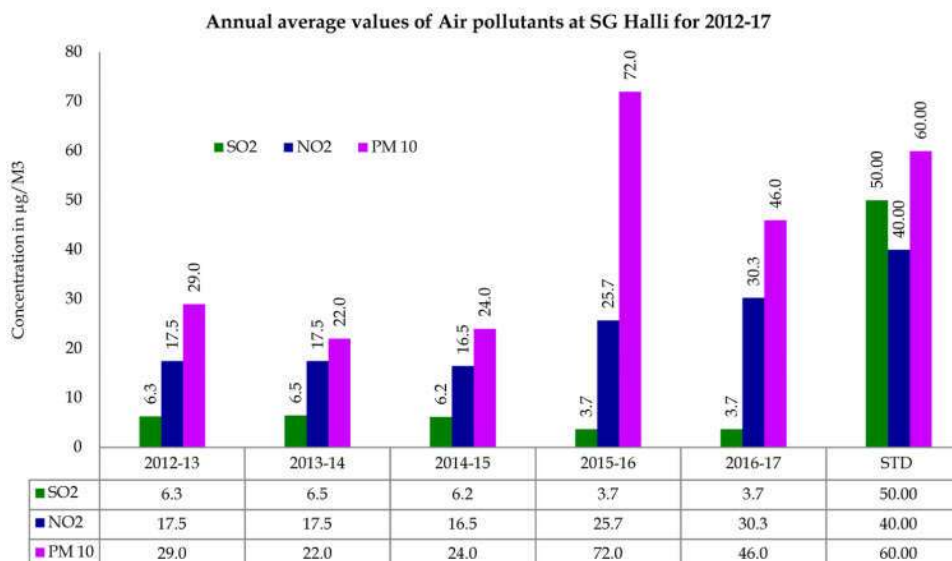
meanwhile pollutants like SO₂, NO₂ showing decreasing trend.

Saneguravanahalli CAAQM, Nisarga Bhavan, Bengaluru

At S.G.Halli SO₂, NO₂ and CO values are within the national limit of (40.0 µg/M³ and 50.0 µg/M³, 2.0 mg/M³) respectively for the period of 2012 - 17, where as PM10 values are within the national limit (60.0 µg/M³) for the year 2012-17 but increased for the year 2015-16. This is due to the construction activities and vehicular movement and road dust.



Graph 12:



Graph 13:

UVCE, KR Circle, Bengaluru

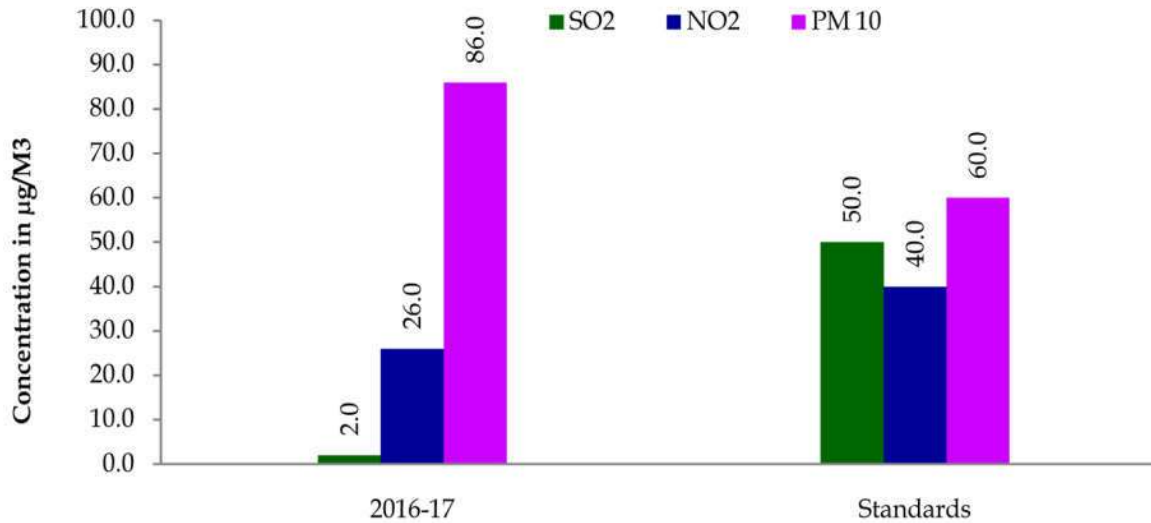
Sensitive zone: Ambient air quality monitoring stations are at sensitive zone of Bangalore city.

1. Ambient Air Quality at Victoria Hospital Bangalore
2. Indira Gandhi Child Care Centre, NIHMANS

Victoria Hospital

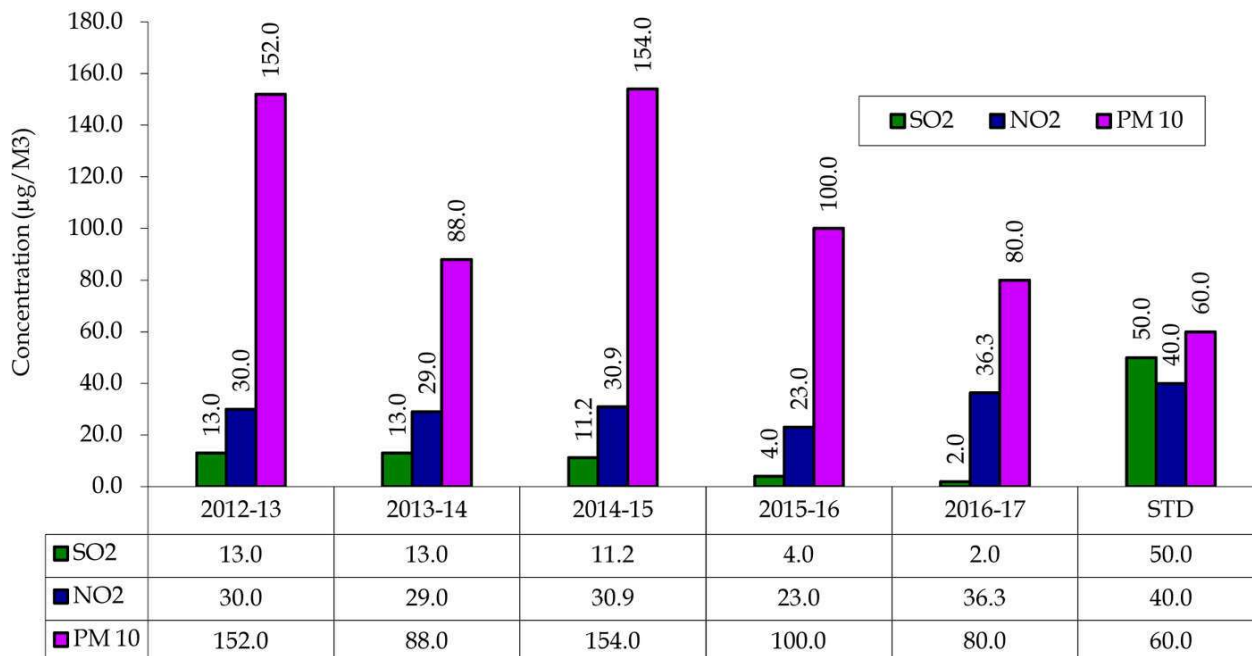
PM₁₀ values are exceeded the national ambient air quality standard (60.0µg/M³) in all the measured years 2012-2016. This is due to the construction activities and **vehicular movement and road dust** and SO₂ and NO₂ are within the national limit during the years 2012 -17.

Annual average of air pollutants at UVCE, K.R.Circle, for the year 2016-17



Graph 14:

Annual average values of air pollutants at Victoria Hospital during the years 2012-17

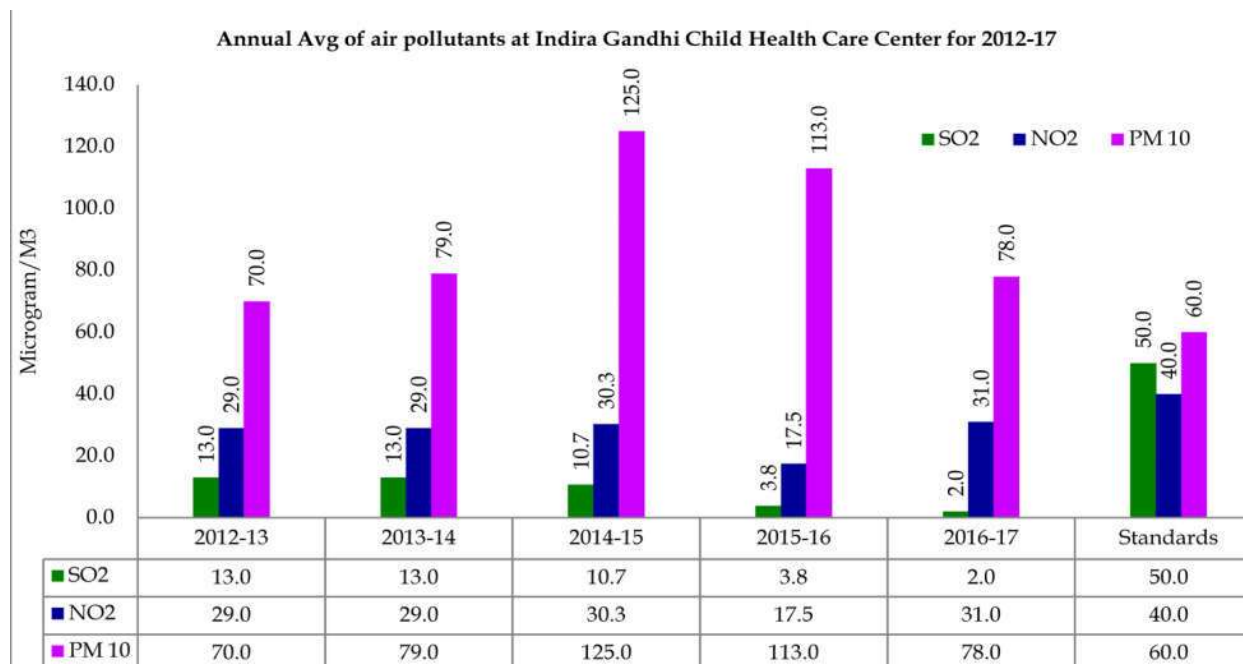


Graph 15:

Indira Gandhi Child Health Care Centre (NIMHANS)

PM₁₀ values have exceeded the national ambient air quality standard (60.0µg/M³) in the year 2012-17 which is raised 2 fold higher than the national ambient air quality standard (60.0µg/M³) this is due to the construction activities and vehicular movement and road dust and SO₂ and NO₂ values are within the national limit during 2012 -17.

The monitoring data during the year 2012-2017 of ambient air quality stations at 16 locations reveals that, ambient air quality levels at White Field, Peenya Industrial Area, AMCO Batteries, Yeshwanthpur, Central Silk Board, Victoria Road, Banasavadi police station, Victoria Hospital and Indira Gandhi Child Health Care Centre (NIMHANS) have decreased since 2015 onwards may be due to the following measures under taken by the Government.



Graph 16:

- Metro rail work completed near AMCO batteries Mysore Road, Yeshwanthpur, and Peenya
- In East West and North South Corridors majority of publics are using the metro rail for commuting and same numbers of usage of vehicles are dropped
- Flyovers at major traffic intersection are completed.
- Under pass at major traffic intersection are completed.
- Developmental work at outer ring road, white Filed, Central Silk Board, and Mysore Road are completed and Filling of pot holes
- Traffic management including conversion of two ways into one way and B- Track.

Past Studies on Air Quality of Bengaluru

The CPCB had taken up Source Apportionment Study to identify the contributing sources for deteriorating air quality in Bangalore City through Tata Energy Research Institute during the year 2007-2009. As per the study, the sector wise contribution

Sl. No.	Sectors	% wise contribution
1	Transport sector	42.0 %
2	Road dust	20.0 %,
3	Construction activity	14.0 %
4	Industries	14.0 %
5	D.G. Set	7.0 %.
6	Domestic	3.0 %

of PM₁₀ is as given below;

Action taken by the Government & KSPCB to control air pollution in Bengaluru city

- As per the direction of Hon'ble Supreme Court, W, P No 13029/1985 (Civil- PIL), 14 points action

plans were drawn to reduce air pollution in Bangalore city and same has been implemented by concerned State Government Department. The implementation of the action plan is monitored by Task Force headed by Additional Chief Secretary to Govt. and the status of impleme-

Sl. No.	Air quality improvement action plan for Bangalore City within Outer Ring Road limits of Bangalore	Implementing Agency	Status
1	Mandatory conversion of <u>in-use</u> 3-wheelers registered after 1.04.1991 onwards to bi-fuel mode (such as LPG and petrol) in a phased manner from 1.12.2003 onwards with authorized LPG kits and fixed LPG cylinders.	Transport Department	Complied
2	Register only new 3-wheelers having bi-fuel mode (such as LPG and petrol) only from 1.12.2003 onwards.	Transport Department	Complied
3	To take action for conversion of nearly 35,000 auto rickshaws which are running with unauthorized LPG kits and detachable cylinders by October 2004.	Transport Department	Complied
4	Introduction of "No Pollution Under Control Certificate- No Fuel" Scheme in petrol/diesel dispensing stations by October 2004.	Karnataka State Pollution Control Board in coordination with Transport Department	The Transport and Road safety department to follow up with Ecology and Environment, Govt of Karnataka
5	Setting up of electronic Emission Testing Centers (ETCs) in each petrol bunk to be introduced from 1.12.2003 onwards wherever feasible.	Transport Department	Complied
6	Increase sales tax and to impose entry tax on white kerosene (Superior Kerosene Oil) to curb adulteration with petrol.	Food and Civil Supplies	Now, Bangalore is Kerosene Free
7	Strengthening strict vigilance and surveillance actions in order to check adulteration of fuel.	Food and Civil Supplies	Complied
8	To make mandatory for kerosene whole sellers to register themselves and produce end use certificates before Civil Supplies Department.	Food and Civil Supplies Department	Complied
9	To establish 5 Auto LPG Dispensing Stations (ALDS) in Bangalore city by March 2004.	Food and Civil Supplies Department and State Level Oil Coordinator.	Complied
10	To convert 5 roads into one way by Home Department by March 2004.	Home Department	Complied
11	To construct 2 flyovers and one railway under pass by March 2004 as proposed by the concerned Departments.	Urban Development Department.	Complied
12	To increase fleet size of Bangalore Metropolitan Transport Corporation from 3106 at present buses to around 4330 buses by the end of October 2005.	Bangalore Metropolitan Transport Corporation.	Complied
13	Karnataka State Pollution Control Board to install one On-line Ambient Air Quality Monitoring Station by June 5, 2004.	Karnataka State Pollution Control Board.	Complied
14	Karnataka State Pollution Control Board to take action to promote use of cleaner fuels used by major industries in DG sets and boilers.	Karnataka State Pollution Control Board.	Complied

ntation is as under:

- Govt of India has introduced Green fuel policy during 1997 wherein the Sulphur content in fuel

is reduced from 0.25 % to 0.005% in Phases. From 2010 onwards low sulphur content fuels is being supplied to Bangalore city. Use of unleaded petrol and

low sulphur fuel in Industrial sector is made compulsory.

- Further, as per the directions of Hon'ble High Court of Karnataka in the Suo-Moto Writ Petition No. 39432/2013, the Karnataka State Pollution Control Board has issued directions under Sec.31 (A) of the Air (Prevention and control of Pollution) Act 1981 to reduce air and noise pollution in Bangalore to a) The Commissioner, Transport and Safety Department b) Bhruhat Bangalore Mahanagar Palike (BBMP) and c) Police Department, d) BDA. The directions are as under:
- To restrict registration of new vehicles in Bangalore city.
- To ban the entry of heavy motor vehicles within the outer ring road of Bangalore City
- To ban the use of two stroke vehicles in Bangalore city.
- To ban plying of more than 15 years old vehicles in Bangalore city.
- To ban the entry of Auto rickshaw in central business district of Bangalore
- To initiate action to remove the dust/slit accumulated on the road side/ median using mechanical means on regular basis.
- To initiate action plan to fill up potholes and road cuttings to facilitate smooth flow of vehicles.
- To remove encroachment of footpath by hawkers in market place.
- To construct more number of multilevel vehicle parking
- To conduct a comprehensive study for regulating

the traffic.

- To issue directions to BMTC to follow the lane discipline rules by stopping /parking vehicles at designated bus stops.
- To take action to notify boundaries of residential area, commercial area and silent zones in co-ordination with BDA and Police department.
- To increase the green cover by planting more number of trees in Bangalore city on road sides, industries premises, public parks, etc.

The Hon'ble High Court of Karnataka disposed Suo-Moto Writ Petition No. 39432/2013 on increased noise and air pollution of Bangalore City during 2015 by directing the concerned departments to implement the directions issued by the Karnataka State Pollution Control Board as Practicable as possible.

Further, to review and implement the action points the Board has constituted a Co-Ordination Committee with the line Departments viz. BBMP, BWSSB, BDA, BMTC, KSRTC, Transport and Road Safety Department, Food and civil supplies Department, Police Department and CPCB.

In order to strengthen the vehicular emission checks, the Board has procured 12 Mobile Vans equipped with Vehicular emission monitoring equipments (Smoke density Meter- for Diesel Vehicles and Gas-analyser for petrol vehicles) during November 2016. Out of 12 vehicles, 6 vehicles are being used for the Joint Monitoring of Vehicular emission with Transport and Police Departments in Bangalore and remaining 6 vehicles are deployed in 6 major cities viz Mysore, Mangalore, Bellary,

Table 1: Vehicular emission monitoring in Bangalore city (Nov 2016 to Nov 2017)

Type of vehicles	Total	Pass	Pass (%)	Fail	Fail (%)
Petrol Vehicle	8852	7282	82.0	1570	18.0
Diesel Vehicle	6583	4979	75.6	1604	24.4
Total Vehicle	15435	12267	78.8	3174	21.2

Chitradurga, Dharwad and Kalburgi.

The Author thanks the department of Karnataka State Pollution Control Board, Scientific officer for necessary help and encouragement during this study.

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