

## A STUDY ON AIR QUALITY MANAGEMENT AND CONTROL MEASURES TO REDUCE AIR POLLUTION IN BANGALORE

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### **Abstract**

Because of the high levels of air pollution in the surrounding region, Air Quality Management is absolutely necessary in Bangalore. The city is one of the urban centers in India that is expanding at the quickest rate, and the rapid pace at which it is both industrializing and urbanizing has resulted in a considerable rise in the levels of air pollution. Vehicle traffic, industrial activity, construction, the open burning of waste, and dust from unpaved roads are the primary contributors to air pollution in Bangalore City. Other sources include construction dust, open burning of waste, and construction dust. Particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds are only some of the pollutants released into the air by these sources. The very high levels of air pollution that are present in Bangalore City have been linked to a wide range of health problems, including cancer, cardiovascular disease, and respiratory illnesses. Children, older people, and those who already struggle with their health are at a larger risk of suffering poor health outcomes due to exposure to air pollution. This is especially true for people who already have health problems. The administration of Bangalore City, in conjunction with many other stakeholders in the city, has worked together to implement a range of air quality control measures to combat the air pollution issue plaguing the city. Among these are improving public transportation networks, promoting cleaner fuels and vehicles, enforcing more rigorous emission standards for industrial sites, and executing measures to avoid dust and the open burning of waste. The present research discusses various aspects of air quality management in Bangalore.

**Keywords:** Air Quality Management; Air Pollution, Bangalore City, Bangalore Air Quality Management System(BAQMS); Karnataka State Pollution Control Board (KSPCB)

### **Introduction**

Air pollution has emerged as a primary issue of concern in many cities throughout the globe, including Bangalore City in India. The fast expansion in the city's population, along with its expanding urbanization and industrialization, has resulted in a notable rise in the levels of air pollution. Vehicle traffic, industrial activity, construction, the open burning of waste, and dust from unpaved roads are the primary contributors to air pollution in Bangalore City. Other sources include construction dust, open burning of waste, and construction dust. "Particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds" are only some of the pollutants released into the air by these sources.

In light of the magnitude of the issue, there is an urgent need to conduct research on air quality administration in Bangalore City. This kind of research may help identify the pollution sources and quantify the air pollution levels in the city. Researchers can establish whether or not the aims of present policies and interventions are being met by studying data on pollution levels and health

consequences. Additionally, they can assess the efficacy of the measures already in place and identify new approaches and technology that might help reduce pollution levels.

The current research on air quality management may also help create awareness about the significance of clean air and its influence on the health of the general people. Researchers may help to develop support for policies and interventions that promote cleaner air by sharing research results with the public, policymakers, and other stakeholders. This may lead to a heightened feeling of urgency surrounding the problem of air pollution, which in turn can push people and organizations to take action to reduce their emissions.

Finally, the present research on air quality management is critical for ensuring sustainable development in Bangalore City. By reducing air pollution levels, the city can promote a healthier and more livable environment for its residents. This, in turn, can help attract investment and spur economic growth while ensuring that the city remains a desirable place to live and work.

### **Air Quality Status of Bangalore**

Because Bangalore has been facing considerable levels of air pollution over the last several years, the city's current situation in terms of its air quality is a cause for worry. Emissions from vehicles, industries, building sites, and open waste burning are the primary contributors to air pollution in Bangalore. Other sources include construction and demolition work.

The Central Pollution Control Board (CPCB) has released statistics indicating that Bangalore's air quality has been persistently bad. On most days of the year, PM10 and PM2.5 levels were found to be higher than the National Ambient Air Quality Standards (NAAQS). Bangalore has been identified by the World Health Organization (WHO) as one of the most polluted cities in the world due to the high levels of particulate matter and other hazardous pollutants present there.

The Air Quality Index (AQI) measures air quality and related health hazards with varying levels of pollution. The Air Quality Index (AQI) levels in Bangalore have regularly been in the "Unhealthy" and "Very Unhealthy" categories, which pose a significant threat to the people of the city's overall health. There is a correlation between high levels of air pollution and various health issues, including cancer, cardiovascular disease, and respiratory ailments.

The government of Bangalore, together with other organizations, has taken several measures to reduce the amount of air pollution in the city. These measures include the implementation of the odd-even rule for automobiles, promoting public transit, encouraging the use of electric vehicles, and expanding the amount of green space in the city. Despite this, the efforts made so far have not been sufficient to improve Bangalore's air quality significantly.

### **Pollutants present in Air in Bangalore**

The air in Bangalore contains a variety of pollutants, including both primary and secondary pollutants. Some of the major pollutants present in the air of Bangalore include:

#### **a) Particulate Matter (PM):**

PM is a complex combination of very small particles that may enter the respiratory system and cause various health problems, including those related to the cardiovascular system and the lungs. Various sources, including vehicular emissions, industrial processes, construction processes, and

the open burning of waste, generate PM. PM10 and PM2.5 comprise the majority of the several forms of particulate matter that may be found in the air in Bangalore.

**b) Nitrogen oxides (NO<sub>x</sub>):**

Combustion processes, including vehicular emissions and industrial operations, generate NO<sub>x</sub>. NO<sub>x</sub> may cause respiratory problems in humans and contributes to smog formation.

**c) Sulfur dioxide (SO<sub>2</sub>):**

Combustion activities, including burning fossil fuels, generate SO<sub>2</sub>. In addition to contributing to acid rain, SO<sub>2</sub> may cause respiratory problems in humans.

**d) Carbon monoxide (CO):**

CO is generated by incomplete combustion of fossil fuels and may cause headaches, dizziness, and nausea. In Bangalore, most of the city's CO comes from the emissions of vehicles.

**e) Ozone (O<sub>3</sub>):**

O<sub>3</sub> is a secondary pollutant produced as a byproduct of the interaction between volatile organic compounds (VOCs) and nitrogen oxides (NO<sub>x</sub>) in the presence of sunlight. In addition to harming crops and other plants, O<sub>3</sub> may also cause respiratory problems in humans.

**f) Volatile organic compounds (VOCs):**

Various sources generate VOCs, including vehicular emissions, industrial activity, and solvents. VOCs are known to be a contributor to the formation of smog and are known to cause respiratory problems in humans.

These pollutants can potentially significantly affect the health of humans and the environment. It is important to understand the sources of these pollutants and implement targeted air pollution strategies to reduce emissions in Bangalore to combat air pollution.

**Airshed in Bangalore City**

An airshed is a geographic area that shares a common air mass and is impacted by the same air pollution sources. Essentially, an airshed is a region where the air quality is influenced by the movement and distribution of pollutants within that region. Airsheds are often defined based on topography, meteorological conditions, and the distribution of pollution sources.

Airsheds can vary in size, ranging from local airsheds that cover a small area, such as a neighborhood or industrial park, to regional airsheds that cover large geographic regions, such as a city or even an entire country. Airsheds can also cross international borders, leading to the need for international cooperation to address air pollution issues.

Understanding airsheds is important for effective air quality management, as it allows policymakers to identify the pollution sources contributing to poor air quality in a given area. Policymakers may implement targeted strategies to reduce emissions and enhance air quality by identifying the sources of pollution.

For instance, if a city is suffering excessive levels of air pollution due to vehicular emissions, the city's policymakers may decide to implement measures such as encouraging the use of electric

vehicles, strengthening the city's public transportation systems, and enforcing stricter emission regulations for vehicles. Similarly, suppose a region is experiencing high levels of air pollution due to industrial activities. In that case, policymakers may implement measures such as setting up pollution control boards and enforcing stricter emission standards for industries.

The airshed of Bangalore City is a complex and dynamic region impacted by various pollution sources. Bangalore is located in the southern part of India and is surrounded by hills on all sides, which creates a basin-like topography that can trap pollutants in the city. The city's airshed covers an area of about 2,200 square kilometers, encompassing the urban areas of Bangalore and the surrounding peri-urban and rural areas.

In Bangalore, vehicular traffic is one of the main sources of air pollution. The city's roads are filled with many vehicles, including automobiles, buses, trucks, and motorcyclists, all of which contribute to the city's high levels of air pollution. The city's industrial activities, including building and manufacturing, are also a significant contributor to the city's overall pollution levels. Another significant contributor to Bangalore's air pollution is burning waste in the open, especially in the city's rural regions.

The topography of Bangalore's airshed can exacerbate pollution levels, as the city is surrounded by hills that can trap pollutants within the city. In addition, meteorological conditions such as temperature inversions can cause pollutants to accumulate in certain areas, leading to localized pollution hotspots.

The city has implemented various measures to address air pollution in Bangalore's airshed. These include promoting the use of cleaner fuels and vehicles, enforcing stricter emission standards for industries, implementing measures to reduce dust and open burning of waste, and improving public transportation systems. The city is also working to promote sustainable urban planning, including developing green spaces and pedestrian-friendly infrastructure, to reduce the need for vehicular travel.

### **Air Quality Assurance and Quality Control in Bangalore**

Protecting Bangalore's residents and the city's natural resources' health and well-being depend on effective air quality assurance and control. There are several reasons why it is important to emphasize Bangalore's air quality assurance and quality control:

#### **a) Health impacts:**

Poor air quality has been linked to several major health issues, including respiratory problems, cardiovascular illness, and cancer. We can reduce the likelihood of these health problems occurring and enhance the general well-being of Bangalore's residents by ensuring clean air.

#### **b) Repercussions on the environment:**

Air pollution may have a range of repercussions on the ecosystem, including harm to agriculture, forests, and rivers, among other things. Limiting air pollution can help preserve the area's ecology and natural balance.

#### **c) Economic implications:**

Poor air quality may also have economic consequences, including lost productivity and higher expenditures associated with healthcare. We will be able to develop a healthier and more productive workforce, reduce healthcare expenses, and increase the general economic health of the city if we improve the air quality.

**d) Compliance with regulations:**

There are several laws and regulations in place in India to control air pollution, including the “National Clean Air Programme (NCAP) and the Air (Prevention and Control of Pollution) Act.” The city can comply with these regulations and avoid fines if it emphasizes air quality assurance and quality control.

**Data Archiving and Retrieval Relating to the Prevention of Air Pollution in Bangalore City**

Data archiving and retrieval are critical in preventing air pollution in Bangalore city. The city has been experiencing a significant increase in air pollution due to various sources such as vehicular emissions, industrial activities, and construction. It is important to archive and retrieve air quality and pollution levels data to address this issue.

By archiving data on air quality, we can identify the sources of pollution in the city and develop targeted strategies to reduce emissions from these sources. For instance, the city may implement laws to reduce vehicular emissions on the road or encourage the use of electric vehicles if data reveals that vehicular emissions are a significant cause of pollution in the city.

In addition, we can monitor our success in lowering pollution levels in the city by retrieving data on changes in air quality over time. This may help us establish whether or not the measures made to reduce pollution are effective and identify locations in which extra action is required. Additionally, collecting and retrieving data on air quality may help increase public awareness about the effects of air pollution and the significance of taking action to avoid it. This is important since air pollution can negatively influence human health. We can encourage people and communities to take action to reduce their contributions to air pollution if we make this data publicly available and make it easily accessible to them.

Data archiving and retrieval are also important for complying with regulations related to air pollution. By maintaining accurate records of pollution levels and the measures taken to reduce them, the city can demonstrate its compliance with regulations and avoid penalties.

In conclusion, data archiving and retrieval are crucial in preventing air pollution in Bangalore. By maintaining accurate and up-to-date air quality records, the city can identify sources of pollution, track progress, raise public awareness, and comply with regulations. These steps are all necessary to create a healthier and more sustainable environment for the residents of Bangalore City.

**Targeted strategies to reduce emissions to control air pollution in Bangalore**

To implement targeted strategies to reduce emissions, the city can take various actions. These may include:

**a) Vehicular emissions**

Vehicular emissions are one of Bangalore’s primary sources of air pollution. The city’s roads are clogged with outdated and poorly maintained vehicles, which contributes to the city’s elevated

levels of air pollution. The city has taken measures to solve this problem, including encouraging the use of electric vehicles, enforcing stricter pollution rules, and enhancing public transportation systems.

**b) Industrial activities:**

Bangalore has many industries, including IT, electronics, and manufacturing. While these industries contribute to the city's economy, they also generate significant levels of air pollution. The city has implemented measures such as setting up pollution control boards and enforcing stricter industry emission standards.

**c) Construction activities:**

Bangalore is also experiencing rapid growth in the construction sector, leading to an increase in dust and other pollutants. To address this issue, the city has implemented measures such as requiring builders to use dust control measures and enforcing penalties for non-compliance.

**d) Open burning of waste:**

Open waste burning is common in Bangalore, particularly on the city's outskirts. This practice leads to the release of harmful pollutants into the air. The city has implemented measures such as promoting composting and recycling and enforcing penalties for open waste burning.

**e) Climate change:**

Climate change is also becoming an important issue in Bangalore, as rising temperatures and changing weather patterns can lead to increased air pollution levels. To address this issue, the city is implementing measures such as promoting renewable energy sources and encouraging sustainable urban planning.

Bangalore's air quality management is a difficult and multidimensional problem that calls for various strategies and interventions. Even though the city has made strides in reducing air pollution in recent years, there is still a lot of work to be done before residents can breathe in air that is free of contaminants and beneficial to their health.

**Control Measures to Reduce Air Pollution in Bangalore**

**A. Bangalore Air Quality Management System(BAQMS)**

The Bangalore Air Quality Management System, sometimes abbreviated as BAQMS, is an all-encompassing system built to monitor, analyze, and regulate Bangalore's air quality. The system is meant to offer real-time air quality data and help city officials take preventative measures to enhance air quality.

The Building Air Quality Monitoring System (BAQMS) is a network of air quality monitoring stations built all around the city. These monitoring stations are outfitted with sophisticated sensors and devices that detect the amounts of various air pollutants, including particulate matter, nitrogen oxides, sulfur dioxide, and carbon monoxide, among others.

Real-time air quality index (AQI) values are generated from the data these monitoring stations gather and then sent to a centralized data center to examine and process it. The Air Quality Index

(AQI) is a scale with a color-coded system that offers information on the potential dangers to one's health connected with various levels of air pollution. It helps the public and the government understand the severity of the pollution levels and take suitable measures to safeguard their health. The BAQMS system also has a thorough Air Quality Management Plan, which delineates several measures that may be performed to enhance the air quality in the city. The plan contains strategies to reduce emissions from various sources, including vehicular traffic, industrial processes, and practices about waste management. The plan also includes measures to expand the usage of cleaner technology, such as electric vehicles and renewable energy sources, by increasing the number of times they are used.

Stakeholder involvement is another component of BAQMS, including public awareness campaigns, training programs, and partnerships with private, governmental, and civil society groups. These partnerships contribute to developing a culture of shared responsibility for the betterment of Bangalore's air quality, which in turn helps cultivate a feeling of ownership among the many stakeholders.

## **B. Karnataka State Pollution Control Board (KSPCB)**

Karnataka State Pollution Control Board (KSPCB) is a statutory authority that was created by the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981. Both of these pieces of legislation were passed in India. The KSPCB is primarily responsible for these tasks to reduce and control pollution in Karnataka.

The KSPCB monitors and enforces regulations on various pollution sources across the state, including industries, autos, and household waste. To guarantee that industries and other types of establishments conform to the standards for pollution control, the board offers a variety of licenses and permits. To verify that these establishments are upholding the standards that have been established, it also performs routine inspections of them.

To monitor air quality across the state, the KSPCB has established a network of air quality monitoring stations. An Air Quality Index (AQI) is prepared for several cities in Karnataka, including Bangalore, using the data gathered from these stations. This information is made accessible to the general public by the KSPCB, which regularly publishes the data on its website and other social media platforms.

In addition, the KSPCB organizes several different awareness initiatives and training programs to educate the general public and various industries on the negative consequences of pollution and the means by which it might be reduced. In addition, the board collaborates closely with a wide range of stakeholders to design and implement pollution control measures, including industry groups, non-governmental organizations, and government agencies.

In addition to its typical duties, the KSPCB also takes on various individual projects and initiatives to solve various unique pollution-related problems. For instance, the KSPCB is implementing a project to deploy "Continuous Ambient Air Quality Monitoring Systems (CAAQMS)" across Bangalore to give real-time data on the city's air quality.

## **C. Task Force for Control of Pollution in Bangalore City (Task Force)**

The state government of Karnataka established a committee called the Task Force for Control of Pollution in Bangalore City to address the problem of air pollution in Bangalore. In 1998, the committee was established, and its members include representatives from a wide range of government departments and agencies, representatives from non-governmental organizations, and specialists in environmental research.

The major purpose of the Task Force is to create and implement strategies to reduce the amount of air pollution in Bangalore. The committee has actively monitored and evaluated the city's air quality, identified pollution sources, and adopted control measures. In addition, it has played a role in the organization of awareness campaigns and the education of the general public about the negative impacts of air pollution.

The Task Force has implemented several measures to control air pollution in Bangalore, including introducing cleaner fuel and vehicle emission norms, promoting public and non-motorized transport, and implementing green initiatives such as tree planting and park development. These are just a few of the measures that have been implemented. In addition, the committee has been very active in monitoring and regulating industrial emissions, waste management, and building activities to reduce the negative effect of these activities on the environment.

In addition to these measures, the Task Force has been engaged in establishing long-term plans and policies for the sustainable development of Bangalore. These initiatives include the development of green infrastructure, the promotion of renewable energy sources, and the deployment of greener technology.

The Task Force for Control of Pollution in Bangalore City has been an important part of the solution to the city's air pollution problem. This has been the case throughout. Its efforts have greatly helped improve air quality in Bangalore, which has served as an example for other cities in India to follow in its footsteps.

### **Bangalore's action plan for air pollution**

The Government of Karnataka has developed an action plan for air pollution control in Bangalore. The plan, titled "Comprehensive Action Plan for Air Pollution Abatement in Bangalore City," was launched in 2018 and is aimed at improving the air quality in the city through a multi-pronged approach.

The action plan focuses on the following key areas:

**Reduction of emissions from vehicular traffic:** The plan proposes measures such as introducing electric buses and promoting non-motorized transport, as well as implementing measures to control emissions from existing vehicles.

**Control of industrial emissions:** The plan proposes measures to regulate industrial emissions, including installing pollution control equipment and adopting cleaner production technologies.

**Improvement of solid waste management practices:** The plan recommends several measures to be taken to enhance the current procedures for the management of solid waste in the city. These measures include the separation and processing of waste at the point of generation as well as the construction of waste-to-energy facilities.



Promotion of green initiatives: The plan recommends measures to alleviate the effects of air pollution, such as promoting tree planting, green buildings, and green infrastructure. One of these measures is the encouragement of green projects.

Awareness and education: Awareness and education are two goals that will be pursued via implementing this plan. The first goal is to increase public awareness of the negative effects of air pollution, and the second goal is to educate the public on how to reduce their exposure to air pollutants.

The action plan also includes a detailed monitoring and evaluation mechanism to track the progress of the measures being implemented and to ensure that they are having the desired impact on air quality.

Overall, the Comprehensive Action Plan for Air Pollution Abatement in Bangalore City is a comprehensive and integrated strategy for tackle the city's air pollution problem. This plan was developed to reduce the amount of pollution in the city's air. The plan intends to enhance the quality of life of Bangalore's residents and reduce the levels of pollutants in the air.

### **Conclusion**

In conclusion, the state of the air quality in Bangalore is a cause for worry, and immediate action is required to reduce the levels of pollution and enhance the health and well-being of the city's residents. It is vital to confront the sources of pollution head-on to attain clean air for everyone, and this requires a strategy that is both comprehensive and multi-pronged, including both policies and measures. The ongoing research on air quality management in Bangalore City is crucial for maintaining sustainable growth, boosting public health, and guiding policy choices. These kinds of research may help to quantify the levels of air pollution, identify the sources of pollution, assess the efficiency of current measures, and identify new solutions and technology. Current research work has the potential to encourage people and organizations to reduce their own emissions and support policies and interventions that promote cleaner air by increasing awareness about the significance of clean air and educating them about its value.

Overall, Bangalore's air quality management is a complicated and multidimensional problem that calls for various air quality and interventions. Even though the city has made strides in reducing air pollution over the last several years, there is still a lot of work to be done before the air in the city can be considered clean and healthy for its residents.

The city of Bangalore has adopted a range of measures to address the issue of air pollution in its airshed. Among them are implementing measures to reduce dust and open burning of waste, promoting cleaner fuels and vehicles, enforcing stricter emission limits for industries, and improving public transportation systems. In order to reduce the need for vehicular transport, the city is also aiming to promote sustainable urban design, including creating green areas and infrastructure favorable to pedestrians.

In addition to this, the Karnataka State Pollution Control Board (KSPCB) is an essential component of the state's efforts to reduce and control pollution. To foster a clean and healthy environment, it monitors and controls numerous sources of pollution, coordinates awareness campaigns and training programs, and works closely with diverse stakeholders.

To summarize, the Bangalore Air Quality Management System is an essential instrument for maintaining a healthy level of air quality in Bangalore. It enables authorities to take preventative measures to enhance air quality by providing real-time data and analysis on air pollution levels. To guarantee that the city of Bangalore continues to have a healthy and sustainable environment for its residents, this all-encompassing system includes monitoring, analysis, planning, and participation from many stakeholders.

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