Original Research Paper

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CHANGING AIR QUALITY AND ITS IMPACT: A CASE STUDY OF MUMBAI

Social Science

KEYWORDS:

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ABSTRACT

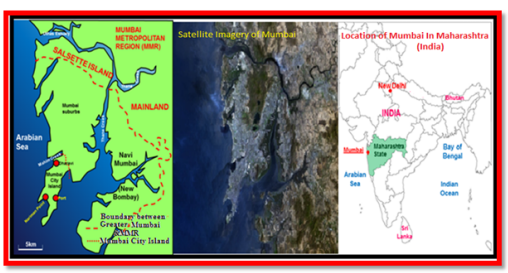
Air pollution is always present in the cities. The rapid population growth along with urban and industrial developments has posed a threat to the human existence. Air pollution has now become a worldwide phenomenon and every individual in one way or the other is facing problems caused by it. Any changes in the physical, chemical and biological characteristics of the environment can cause harmful effects on humans. It is evident that pollution causes disruption of life resulting in spread of various diseases and genetic disorders among humans. Some environmental poisons can cause acute illness and even death. This present study is an attempt to highlight the increasing air pollution in Mumbai and its impact on the human health and to suggest recommendations to reduce health impact from air pollution. This information will be used to develop policies and strategies to control air pollution, now and in the future.

INTRODUCTION:

Today healthy physical environment is the basic requirement for our economic and social development. The refreshing atmosphere will improve the standard of health of people and build sound mind and body. As urbanization and industrialization has spread around, so the problem of pollution has spread with it. Increasing burden of health issue due to pollution has prompted many decision makers to take a close look at the changing environment due to many sources. Urban areas are the worst affected by increasing pollution. Therefore, an integrated approach is needed to formulate strategies and embark upon the action plan. The present study has shown an increase in the level of contaminated air in the city of Mumbai. The quality of the air we breathe is significant, because air pollution can affect our health. Therefore, balanced strategies focused on sustainable development that cause minimal damage to natural resources and environment are required. Based upon the analysis of available data and information, conclusions are drawn and recommendations are made.

THE STUDY AREA

Mumbai the capital city of Maharashtra and the commercial capital of India is located along the western coast of India in Konkan Division **(Map 1.)** It is one of the most populous urban regions in the world and the second most populous metropolitan area in India, with a population of 20.7 million as per census of 2011. Along with the neighboring urban areas, including the cities of Navi Mumbai and Thane, it is one of the most populous urban regions in the world. Mumbai lies on the west coast of India and has a deep natural harbor. Mumbai consists of two distinct regions: Mumbai City district and Mumbai Suburban district, which form two separate revenue districts of Maharashtra. The city district region is also commonly referred to as the Island City or South Mumbai. The total area of Mumbai is 603.4 km2. Mumbai is made from the group of seven islands and is thus referred to as the Island city. These islands are Isle of Bombay, Mazagaon, Colaba, Old Woman's Island, Parel, Worli, and Salsette Island. This city extracted its name from Mumba Devi, said to be a local Hindu Goddess. It extends between 18° 55' North latitudes and 72° 54' East longitudes. Mumbai has a humid tropical climate. The temperature varies from a low temperature of 15C in January to a high temperature of 35C in May and receives an average rainfall about 180 cm.



Map 1: The Study Area

OBJECTIVES

1. To highlight the industrial and urban scenario of Mumbai.
2. To identify the common air pollutants of the city.
3. To highlight the changing trend of air quality in the city
4. To reveal the impact of air pollution on human health.
5. To suggest solutions and remedial measures.

DATA BASE:

The Environmental Status Report of Mumbai, Maharashtra Pollution Control Board (MPCB), National Environmental Engineering Research Institute (NEERI), National Ambient Air Quality Monitoring Programme (NAAQM), BMC's Annual Environmental Status Report (ESR), Environmental Pollution Research Centre (EPRC).

I. INDUSTRIAL AND URBAN SCENARIO OF MUMBAI CITY

Mumbai and Mumbai suburban areas are highly urbanized. Most of the industries are located in mix area. Mainly Textiles, Dyes, Fertilizer, Thermal power, Oil refineries and Pharmaceuticals large & medium scale unit are operational in Mumbai. On the other hand Engineering, Chemical, Pharmaceutical, Electronic, Electrical etc are also located in industrial estates & other area in the jurisdiction. The causes of urbanization are multiple, but involve a high level of natural increase within Mumbai itself and in-migration principally from the surrounding district of Maharashtra but also from neighboring states. Mumbai booming economy means that migrants come for job opportunities in the expanding industries, financial institutions and administration. According to The Environmental Status Report there are about 7850 industries in Mumbai region which are categorized into red, orange and green as shown in Table 1.

Table 1. Categories of Industries

DISTRICT	CATEGORIES	*LSI	*MSI	*SSI	TOTAL
MUMBAI & MUMBAI (SUB- URB)	RED	97	14	898	1009
	ORANGE	21	26	2581	2628
	GREEN	3	15	4195	4213
	TOTAL	121	55	7674	7850

* LSI: Large Scale Industries
* MSI: Medium Scale Industries
* SSI: Small Scale Industries

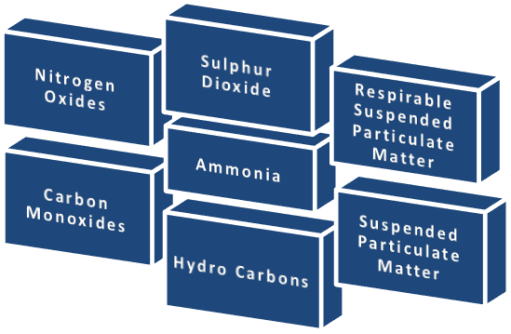
It is an established fact that development of industries coupled with urbanization has made the Mumbai city national & international business centre. Industrial development in Mumbai started in the year 1854 with the establishment of the cotton textile industrial belt extending from Parel and Naigaum to Worli and Prabhadevi. Today, this industry is characterized by sick mills and also known as sunset industry. On the other hand, industries like chemical, computer software, petrochemical etc., are located in the suburbs of Chembur, Andheri, Kurla, Ghatkopar, Mulund, and Bhandup and are known as sunrise industries.

Hence the overall scenario states that the people living in Mumbai have been breathing polluted air which falls under the "poor to severe" category, a report on the air quality status of Maharashtra, published by the Maharashtra Pollution Control Board (MPCB) in the year 2013-14. The report was prepared by "The Energy and Resources Institute" (TERI) based on air quality data monitored by MPCB.

II. COMMON AIR POLLUTANTS OF THE STUDY AREA

Generally the common air pollutants in the city are generated from transportation, fuel combustion, burning of fossil fuels, etc. A very high level of motor vehicles produces high levels of carbon monoxide (co), hydrocarbons (hc) and nitrogen oxides (no). Besides these the construction activities, bad roads and burning of fossil fuels are responsible for dust (particulate matter) pollution and increase in Sulphur Dioxide. Residential and commercial activities also contribute to air pollution **(Fig.1.).**

(Fig 1.) Common Air Pollutants in the City



Source: Maharashtra Pollution Control Board

The quality of air in an area determines the health of living being. In other words, it refers to the nature of the air that we breathe and the affect of this on us. This study concentrates on the pollution of the air and in particular examines the common air pollutants that are known to affect human health.

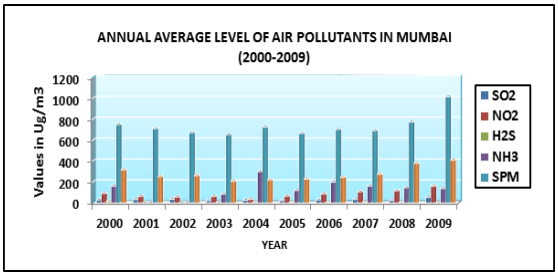
Table 2. Major Sources of Air Pollutants in Mumbai

S.NO	AIR POLLUTANTS	MAJOR SOURCES
1.	Sulphur Dioxide (SO2)	Fuel combustion, industrial processes, chemical processes, diesel vehicles, solid waste disposal, and smelters.
2.	Nitrogen Oxide (NO2)	Transport (road, rail, passenger and commercial), fuel combustion, industrial boilers, chemical processes, smelters.
3.	Particulate Matter (SPM & RSPM)	Fuel combustion, power station, construction activities, industrial processes, diesel vehicle exhaust, resuspended road dust, domestic refuse burning, domestic wood etc.
4.	Carbon Monoxide (CO)	Transports, combustion, industrial processes, solid waste disposal, refuse burning.
5.	Hydrocarbons	Transport, oil based fuel combustion sources, chemical processes, solvent use, vaporization of fuel.
6.	Other metals like Lead and Cadmium	Lead additives in gasoline, soil originated particles. Fuel combustion, metal production process, transport

III. THE CHANGING TREND OF AIR QUALITY:

More than 20 years National Environmental Engineering Research Institute (NEERI) is monitoring the air quality of Mumbai at three locations of Kalbadevi, Parel and Worli under National Ambient Air Quality Monitoring Programme (NAAQM). Maharashtra Pollution Control Board (MPCB) also carries out air quality monitoring at three stations of Mumbai Sion, Mulund and Bandra. On the basis of the available data it has been observed that there is continuous increase in the air pollutants in the city.

Table 3. Annual Average Air Pollutants



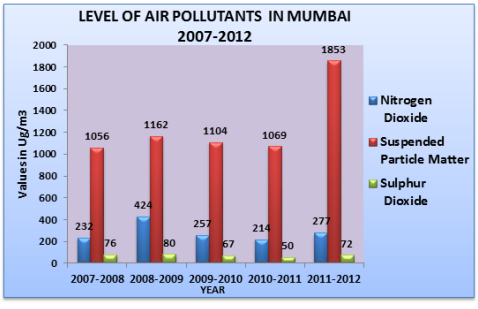
Source: Neeri Zonal Laboratory (Mumbai)

Table 3. shows trend in the annual average air quality levels in Mumbai between 2000 and 2009. In order to give an overview of the level of pollutants in the air, the focus is on the trend analysis of annual average concentrations.

It is clear from the table that-

- Average annual Sulfur Dioxide (SO2) concentration has increased.
- Average annual Nitrogen Dioxide (NO2) concentration has increased.
- Average annual Hydrogen Sulphide (H2S) concentration were extremely low and show no clear trend
- Average annual Ammonia (NH3) concentration shows a decrease after 2004.
- Average annual Suspended Particulate Matter concentration has outnumbered every pollutant since 2000 and shows a tremendous increase after 2006.
- Average annual Respirable Suspended Particulate Matter concentration has also increased between 2000 and 2009.

Table 4. Levels of Increased Air Pollutants (2008-2012)



Source: BMC's Annual Environmental Status Report (ESR)

Table 5. Nitrogen Dioxide Levels at Six Locations of Mumbai

LOCATION	2012 – 2011	2011 – 2010	2010 – 2009	2009 – 2008	2008 – 2007
Worli	44	32	41	67	31
Khar	57	44	47	84	47
Andheri	56	40	53	86	47
Bhandup	40	34	29	67	34
Borivali	20	14	22	31	19
Maravli (Chembur)	60	50	65	89	54

(All figures are in µg/m^3 – micrograms per cubic meter of air)

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Table 6. SPM Levels at Six Locations of Mumbai

LOCATION	2012 – 2011	2011 – 2010	2010 – 2009	2009 – 2008	2008 – 2007
Worli	205	197	201	183	185
Khar	219	221	250	252	258
Andheri	238	203	227	263	281
Bhandup	273	198	200	206	268
Borivali	158	125	113	129	32
Maravli (Chembur)	760	642	603	389	439

(All figures are in µg/m^3 – micrograms per cubic meter of air)

Table 7. Sulphur Dioxide Levels at Six Locations of Mumbai

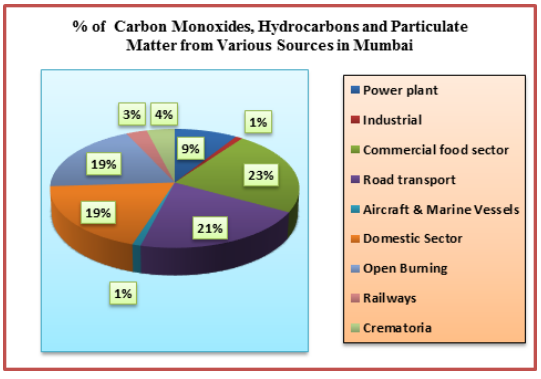
LOCATION	2012 – 2011	2011 – 2010	2010 – 2009	2009 – 2008	2008 – 2007
Worli	14	8	9	13	14
Khar	10	7	9	12	11
Andheri	11	8	12	13	11
Bhandup	12	10	14	18	14
Borivali	9	7	7	8	8
Maravli (Chembur)	16	10	16	16	18

(All figures are in µg/m^3 – micrograms per cubic meter of air)

It has also been observed that between 2007 and 2012 there is continuous increase in air pollution specifically the levels of Nitrogen Dioxides, Suspended Particulates and Sulphur dioxides **(Table 4.).** According to the Annual Environmental Status Report of Mumbai at all the six observation locations of Mumbai there is increase in air pollution as shown in **Tables 5, 6 &7.**

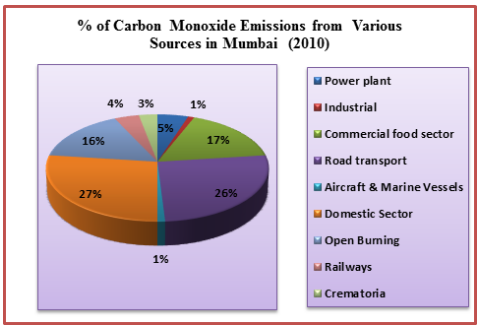
Another study by NEERI (2010) has stated that in Mumbai open burning and landfill fires are also one of the major sources of air pollution in Mumbai. The study found that about 2% of the total solid waste generated in Mumbai is openly burnt on the streets and 10% of the total solid waste generated is burnt in landfills by humans or due to landfill fires. Open burning contributes to 19% of air pollution due to emissions of CO, PM and HC in Mumbai **(Figure 2.)** More than twice as much particulate matter is emitted by open burning of Mumbai Solid Waste as compared to emissions from road transportation in Mumbai. Also, a quarter of volatile hydrocarbons entering the atmosphere in Mumbai are a result of such activity. MSW is combusted on the streets, exposing millions of urban Indians directly to these emissions every day. MSW burning emits pollutants into the lower atmosphere, where the dispersion of pollutants is very low, increasing the risk of exposure to these harmful emissions.

Fig 2.



Source: Neeri Zonal Laboratory (Mumbai)

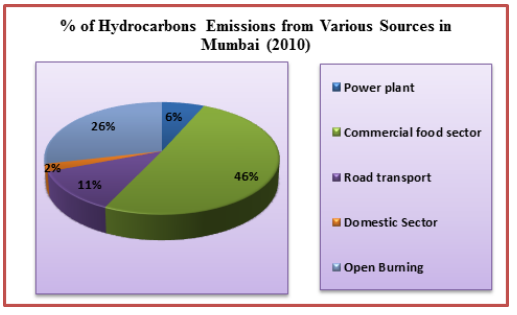
Fig. 3.



Source: Neeri Zonal Laboratory (Mumbai)

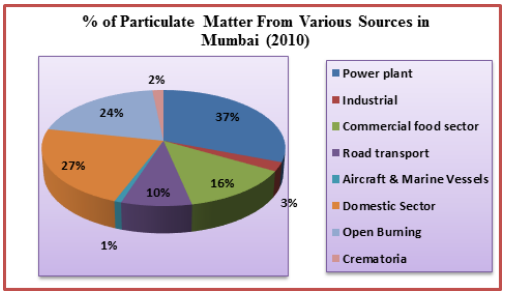
Fig 3 depicts the % of carbon monoxide emission from various sources. It is clear from the figure that open burning is a major contributor to carbon monoxide pollution in Mumbai after domestic, transport and commercial food sector. Similarly 26% of hydrocarbon emissions in the air are due to open burning after commercial food sector (46%) as shown in **Fig 4.** About 37% of particulate matter in the air of Mumbai is generated from power plant followed by domestic sector (27%) and open burning of waste (24%) respectively **(Fig 5.)**

Fig 4.



Source: Neeri Zonal Laboratory (Mumbai)

Fig 5.



Source: Neeri Zonal Laboratory (Mumbai)

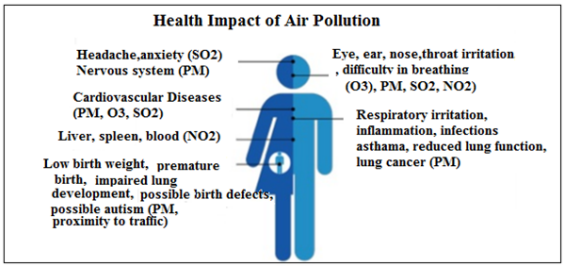
Hence, it is evident that air pollution is threatening the study area. Industrial emissions, burning of refuse and vehicle exhausts are combining to produce unacceptably high levels of nitrogen oxides and Particulate Matter (PM) in Mumbai's air. Mumbai's air pollution has grown dramatically in recent years, and has now reached 18 million – the fourth highest in the world and the most densely populated. 451 new vehicles are registered in Mumbai every day. These motor vehicles are deteriorating the quality of air. Also, slow moving traffic jams lead to increased air pollution as compared to smooth flowing traffic. Increased construction (housing, Metro, bridges, roads, etc) is also responsible for an increase in dust and Suspended Particulate Matter (SPM). In addition several toxic gases such as nitrogen dioxide are emitted during traffic congestions

because vehicles do not move and burn more fuel for less distances (National Environmental Engineering Research Institute, Mumbai.). In addition due to massive construction work, including infrastructural projects and buildings, the levels of substances emitted in the air are also higher.

IV. IMPACT OF AIR POLLUTION ON HUMAN HEALTH IN MUMBAI

It is the fact that air pollutants have serious adverse effect on human health. People living in cities are particularly prone to varied types of diseases due to air pollution and have no choice but to breathe the air around them. When it is polluted, they breathe in harmful gases and particles that can hurt their lungs, heart, and overall health and can cause coughing, burning eyes, breathing problems etc. **(Fig 6).** Mumbai is in the middle of a huge transition as new towers, new modes of transport (Monorail and the Metro) are being laid, mills and chawls are being brought down for multi-storied complexes. Sulphur dioxide, ammonia and suspended particulates in the air are higher and posing serious health concerns

Fig 6.



The Brihanmumbai Municipal Corporation's (BMC) Environment Status Report (ESR) for 2009-2010, released on September 3, 2010 showed an increased amount of cancer-causing particulate matter in the air. The report shows that the presence of benzo (a) pyrene, a highly carcinogenic chemical released in the air, in the city has risen eight times from its minimum level of 0.13 µg/1000m3 in 2008-2009 to 1.09. Similarly the report of International Institute for Population Sciences (IIPS) states that about 89.6 per cent of people living in Mumbai die of respiratory diseases followed by digestive problems (41.6 per cent) and aches and pains (37.8 per cent).

- **Impact of Sulphur Dioxide and Nitrogen Dioxide:**

Mumbai has a very high incidence of chronic respiratory problems, arising from extreme air pollution. The causes of pollution are mainly industries in the eastern suburbs, garbage burning by the BMC, and insufficient control over emission levels from vehicles. A recent study by the Environmental Pollution Research Centre (EPRC) found that about 10% of the population of Chembur area suffers from bronchitis and respiratory distress caused by pollution. Excess Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2) in the air are causing respiratory illness, breathing problems, reduced functioning of lungs, cardiovascular problems, etc. Mumbai residents who suffer from heart disease or asthma or other respiratory problems are most at risk to exposure to Sulphur Dioxide and Nitrogen dioxide.

- **Impact of Suspended Particulate Matter**

Increased exposure to Suspended Particulate Matter (SPM) in Mumbai is resulting in various respiratory diseases such as lung cancer, asthmatic attacks, bronchitis, pneumonia, etc and heart disease. Even young childrens are being affected by this as there are cases of birth defects, lower IQ and premature deaths (IARC Report). International Agency for Research on Cancer (IARC), which is a part of the UN World Health Organization (WHO) have declared in October 2013 that Air Pollution is carcinogenic which increases the risk of lung and bladder cancer. The air in Mumbai is laden with toxic substances and is found to be more polluted than the air in Beijing. But nobody seems to bother, least of all the government.

- **Impact of Ammonia and Lead**

The Brihanmumbai Municipal Corporation's annual Environment Status Report (ESR) 2012 Data shows that the city's air contains high levels of toxic pollutants such as ammonia, lead, nickel and nitrogen dioxide whose ill-effects can range from sinusitis to respiratory illnesses such as bronchitis and even cancer, while the noise pollution can lead to high blood pressure and even heart disorders.

- **Impact of Chlorine Gas Leakage**

On 14th July, 2010 chlorine gas leak from the Sewri industrial area on land owned by the Mumbai Port Trust. Nearly 76 people were treated in hospital and 10 people were in intensive care after the gas leak Mumbai was poisoned by Chlorine gas leak from the Sewri industrial area.

Therefore it is evident from the available data that continuous increase in the levels of air pollutants since last decades in Mumbai has posed a serious threat to the human health. For instance doctors in Mumbai said over a period of five years, the number of patients with allergic bronchitis have increased by 30-40%. According to Dr Shahid Barmare, physician, Kohinoor Hospital, Kurla "Many times, I have asked my patients to leave the city as a treatment. They go to their village for a few days and their cough disappears. Such cases are a result of increased pollution levels," Dr Barmare said people who travel in open vehicles such as autos and motorcycles have a higher exposure to pollutants and develop allergic bronchitis because they inhale more particulate matter. People who have existing lung conditions such as asthma and chronic obstructive pulmonary disorder are the worst affected. Higher pollutant levels in the city can trigger allergic rhinitis – which causes a burning sensation in the eyes and increases the risk of heart conditions and cancer (Hindustan Times Report, 2015)

What is more worrying is the rise in number of people complaining of respiratory infections that rarely respond to common medicines. "While their lung function test results are normal, their condition does not seem to improve with regular medication. Such respiratory distress could be related to higher exposure to toxic gases inhaled," said Dr Samir Garde, pulmonologist, Global Hospital, Parel. Dr Pratit Samdani, physician, Breach Candy Hospital, said, "Particulate matter (PM10 and PM2.5) also carries virus and bacteria, which infect the lungs and cause lung infections." Doctors said people should avoid walking in polluted areas. They should also avoid taking early morning and evening walks, as the pollutants are closer to the ground.

CONCLUSION

Continuous emissions of harmful pollutants such as SO2, NO2, (SPM) etc, are responsible for rising discomfort, and increasing airborne diseases in the study area. The research identifies that open burning of MSW on streets and landfill sites need to be stopped immediately to increase air quality in Mumbai and points out the need for credible solutions to this problem. The city is also facing another serious and emerging health hazard — asthma. Besides the known reasons causing the illness, Aspergillus fungus from pigeon droppings is the latest addition.

The transport sector followed by industrial sector is the major contributor of air pollution in the city. Mumbai has registered 1,80,441 vehicles between 2012 and 2013, contributing the highest amount of carbon monoxide, suspended particulates, lead, sulphur dioxide, hydrocarbons and oxides of nitrogen, among other pollutants. Suspended particulates from vehicle emissions lead to respiratory problems. CNG and LPG are regarded as clean fuels and used by over 93% of metered taxis and all auto rickshaws. A report from BMC in May 2010 showed that deaths due to respiratory tract infections have increased by 20.17 per cent, pushing even heart disease and cancer aside. The new killer diseases are bronchial asthma and chronic obstructive pulmonary disorders (COPD). Also, WHO ranks Mumbai among the top 10 polluted cities in the world? "General Asthma levels in the city are anywhere between three to five per cent whereas in polluted areas, that increases to 10 per cent," says

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Dr Amita Athavale, head of (EPRC) at KEM Hospital (Indian Express, 2014)

Mumbai have been breathing polluted air which falls under the poor to severe category therefore Mumbai & its surrounding needs special care and this action demands strong technical & resource back-up so as to stream line & strengthen the regional set-up of Mumbai.

RECOMMENDATIONS:

1. Effective policies to control air pollution in the city to achieve environmentally acceptable of ambient air quality.
2. More efficient use of energy for instance use of less polluting fossil fuels.
3. Look for regular updates on air quality in your city and report polluting activity such as burning of waste, to pollution control agencies. Check daily air quality forecasts provided by Mumbai US Consulate Air Quality Index (AQI).
4. Check the data provided by The Maharashtra Pollution Control Board website (http://mpcb.gov.in/) on major pollutants in the city.
5. Avoid travelling during peak traffic hours.
6. Use masks whenever there is excessive dust in the air.
7. Close windows if construction work is underway nearby.
8. Report smoking vehicles in your vicinity
9. Undergo lung function tests on a regular basis
10. Turn off electrical and electronic appliances when they are not in use.
11. Plant trees, as they improve the air quality.
12. Don't burn waste, leaves, paper and plastic.
13. Avoid using insect and mosquito repellents
14. Air purifiers remove pollutants from the air. These instruments are said to be beneficial to those suffering from allergy and asthma.
15. Buy energy efficient appliances
16. Choose efficient, low-polluting models of vehicles
17. Choose products with less packaging, or packaging that is reusable
18. A sensor based monitoring system can be used to calculate the air quality at different areas, within a radius of three kilometers around the sensor.

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