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Delhi Air Pollution: A Critical Analysis

RAJ KUMAR GARG¹ AND DHARAMJEET SINGH²

ABSTRACT

India is devoted to a clean environment with clean air and water. Indian constitution also supports environmental protection. India's commitments and obligations to environmental conservation and protection within the scope of the Sustainable Development Goals (SDGs) are manifested in the fact that several administrative and regulatory measures, including a separate statute on air and water pollution, have been enacted. However, with its expanding population and pervasive poverty, India has great problems in reaching its several other key goals related to poverty and hunger elimination. For the past three decades, India has experienced a surge in industrial activity. The concurrent expansion in industrialization and urbanisation has resulted in a significant increase in environmental challenges, particularly air pollution. Delhi the capital city of the country is also facing the problem of Air pollution due to poor infrastructure, extreme urbanisation, dust, industrial pollutants, vehicle emissions, landfills, and open burning. This paper discusses the causes and consequences of air pollution, as well as the actions taken by the Delhi government to address this issue.

Keywords: Delhi, Air Pollution, Causes, Effects, PM 10 Level , PM 2.5 Level , Policies.

I. INTRODUCTION

Pollution is a major source of worry not only in India, but across the world. Since India's independence, technical advances and rapid expansion have come at a high environmental cost. Rapid industrial expansion, uncontrolled emissions, and a variety of other factors all had a role in the rise in air pollution. In certain situations, the intensity of air pollution became so severe that government intervention was required. The Great Smog of London in 1952 was an exceptional example of air pollution that greatly impeded vision. It also resulted in a slew of diseases and the deaths of numerous individuals. In November 2017, Delhi's air pollution levels were ten times higher than the acceptable limit. The healthy air quality index ranges from 0 to 50, yet at that time period, the air quality index exceeded 500. This occurrence is now known as the Great Smog of Delhi. The city's air and water have become very toxic, resulting in a plethora of health problems. Delhi the capital of India is one of the top 10 most polluted cities in the world. The number of people experiencing health problems as a result of air pollution is rising dramatically. Young children, adults, and seniors all have negative effects. Mild colds

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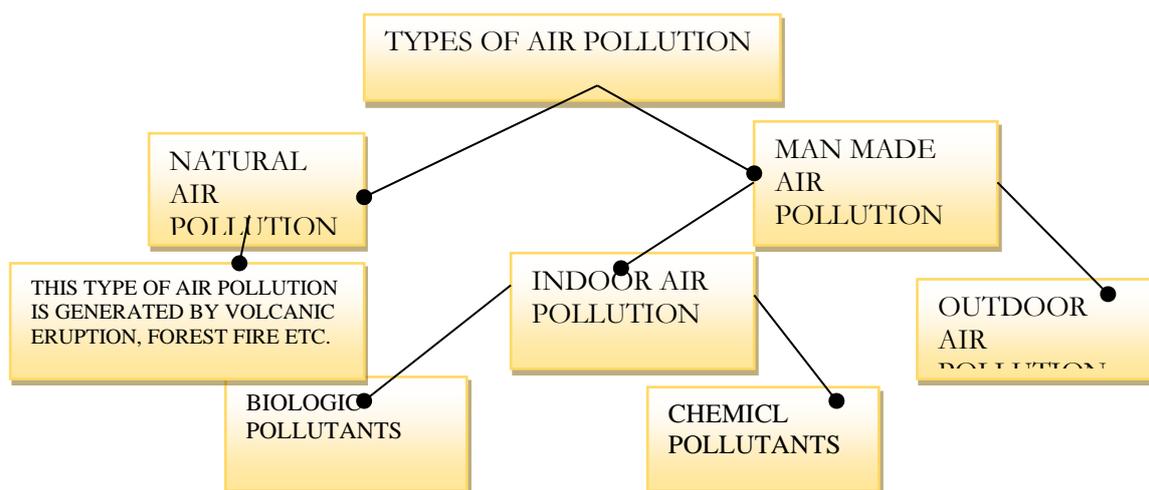
and runny noses to chronic bronchitis, asthma, and lung infections are just a few of the symptoms.

II. WHAT IS AIR POLLUTION

Air pollution is defined as contamination of the indoor or outdoor environment by any chemical, physical, or biological agent that alters the natural properties of the atmosphere. Common sources of air pollution include household combustion devices, motor vehicles, industrial facilities, and forest fires. Particulate matter, carbon monoxide, ozone, nitrogen dioxide, and sulphur dioxide are all major public health concerns. Both outdoor and indoor air pollution cause respiratory and other diseases, as well as significant morbidity and mortality.³

III. TYPES OF AIR POLLUTION

Air pollution can be categorized into two categories 1. Natural Air Pollution and 2. Man-made or Anthropogenic Air Pollution.



(A) Natural air pollution: Natural air pollution is generated by natural phenomena such as volcanic eruptions, forest fires, and so on. Organic chemicals from plants, sea salt, suspended soils and dust, and ozone are examples of natural pollutants. On a worldwide scale, ozone is one of the most frequent natural air pollutants.⁴

(B) Man-made air pollution: Anthropogenic air pollution is generated by human activities such as industrialization, urbanisation, and transportation. Sulfur dioxide, carbon

³ *Air Pollution, World Health Organization.* World Health Organization. Available at: <https://www.who.int/health-topics/air-pollution> (Accessed: December 3, 2022).

⁴ Ahirwar, M. (2020) *Air pollution: Types, sources, causes, effects, controls, Handwritten Notes.* Available at: <https://handwrittennotes.in/2020/09/11/air-pollution-types-sources-causes-effects-controls/> (Accessed: December 3, 2022).

monoxide, benzopyrene, soot, nitrogen oxides, lead, and ammonia are all significant air pollutants caused by human activity.⁵

a. Indoor air pollution

The release of hazardous chemicals within any building or house causes indoor air pollution. Fine particulate matter, carbon monoxide, and a number of other harmful substances are examples of indoor pollution.⁶ Because fuels like wood, charcoal, and animal dung are burnt inside houses for cooking and heating, developing nations are far more affected by indoor air pollution than industrialised nations. Residents of these houses frequently breathe in carbon monoxide and other hazardous chemicals since there is rarely adequate ventilation to allow the pollutants to escape.⁷

In the modern house, a variety of indoor air pollution scenarios are available. If not enough outside air is delivered into the home to dilute emissions from interior sources and to take indoor air pollutants out of the home, air pollutant levels in the home rise.⁸

High temperatures and humidity levels can also make some pollutants more concentrated. Indoor pollutants can be placed into two groups, biologic and chemical.

b. Biologic pollutants

Bacteria, moulds, viruses, cat saliva, dust mites, cockroaches, and pollen are examples of biologic pollutants. These biological contaminants may have detrimental impacts on one's health. Measles, chickenpox, and influenza are examples of biological pollutants that may spread through the air.⁹

c. Chemical pollutants

Solvents and chemicals are the primary sources of volatile organic molecules. Perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, and a variety of other household goods are the primary sources of indoor chemical pollutants. The irritation

⁵ Ibid

⁶ *Indoor Air Pollution: What causes it and how to tackle it* (no date) *World Economic Forum*. Available at: <https://www.weforum.org/agenda/2022/07/what-causes-indoor-air-pollution-sources-how-to-reduce/> (Accessed: December 3, 2022).

⁷ *Take online courses. earn college credit. Research Schools, Degrees & Careers* (no date) *Study.com / Take Online Courses. Earn College Credit. Research Schools, Degrees & Careers*. Available at: <https://study.com/academy/lesson/what-is-indoor-air-pollution-definition-sources-effects.html> (Accessed: December 3, 2022).

⁸ Supra Note 6.

⁹ Pollen, a common contaminant that comes from plants, can cause symptoms including sneezing, watery eyes, coughing, shortness of breath, dizziness, fatigue, fever, and stomach issues. Repeated exposure and immunologic sensitization to certain biologic allergens lead to allergic responses. <https://www.cdc.gov/nceh/publications/books/housing/cha05.htm>

in the eye, nose, and throat is the major health impact of indoor chemical pollutants. Headaches, nausea, and lack of coordination may occur in more severe instances. Some of the contaminants are suspected of causing long-term harm to the liver and other organs.¹⁰

d. Outdoor air pollution

Outdoor air is also known as ambient air. Emissions from motor vehicles, solid fuel burning, and industry are the most frequent sources of outdoor air pollution. Other forms of outdoor pollution include wildfire smoke, windblown dust, and biogenic emissions from plants.¹¹

Outdoor pollution is very dangerous for health, exposure to ground-level ozone and pollutants such as sulphur dioxide and nitrogen oxide can cause a variety of respiratory difficulties, including allergies, asthma episodes, decreased lung function, and an increased risk of respiratory infection. Air pollution is particularly more dangerous for people who already have respiratory disorders like chronic obstructive pulmonary disease (COPD) or emphysema. Children with chronic ozone exposure were more likely to be admitted to hospitals for asthma, according to researchers in New York.¹²

IV. CAUSES OF AIR POLLUTION IN DELHI

Let's look at some data to get a sense of Delhi's air quality - the National Capital saw its first 'good air' day of 2021 in October, owing to a strong rain. In 2016 and 2018, Delhi did not have a single day with "good air." Only two such days were reported in 2017 and 2019. Even last year, when the country was under lockdown with little economic activity, Delhi had only five 'good air' days. As a result, air pollution is a year-round issue in Delhi that is only seen during the winter.¹³

A. Pollution by vehicles.

According to a 2018 research conducted by ARAI and TERI, motor vehicles are the largest source of pollution in Delhi, accounting for around 41% of PM 2.5 emissions. Interestingly, a recent research by the Centre for Science and Environment (CSE) showed that motor vehicles accounted for more than half of the pollutants produced from within Delhi this winter, from

¹⁰ *Indoor air pollution, Indoor Air Pollution.* Edugreen. Available at: <https://edugreen.teri.res.in/explore/air/indoor.htm> (Accessed: December 3, 2022).

¹¹ *Air Quality - Outdoor Air Pollution, Outdoor air pollution - Air quality.* Available at: <https://www.health.nsw.gov.au/environment/air/Pages/outdoor-air-pollution.aspx> (Accessed: December 3, 2022).

¹² *Understanding the effects of outdoor air pollution on Public Health (2021) Regis College Online.* Available at: <https://online.regiscollege.edu/blog/outdoor-air-pollution/> (Accessed: December 3, 2022).

¹³ Amit Bhatt, Half of Delhi pollution caused by vehicles! Here are three ways to clean the city's mobility system, Information available at : <https://www.firstpost.com/india/half-of-delhi-pollution-caused-by-vehicles-here-are-three-ways-to-clean-the-citys-mobility-system-10192511.html>

October 24 to November 8. Other significant sources of pollution in Delhi include stubble burning and smoke from firecrackers during Diwali. However, motor vehicle emissions occur all year, making it the city's most important and constant source of pollution.¹⁴

B. Pollution from power plants and industry

In Delhi, 11 coal-fired power plants produce roughly 11% of total air pollution. Fly ash, PM2.5, nitrates, mercury, and other pollutants are produced by coal-fired power stations. During the winter, several power facilities are shut down because they do not satisfy the needed emission requirements and compliance. With 3,182 industries functioning in the Delhi-National Capital Region, Delhi has the largest cluster of small-scale industries in India (NCR). Factory emissions contributed around 3.6 percent to the bad air quality.¹⁵ Delhi is home to four thermal power plants, two of which run on coal, namely the Badarpur Power Plant, and the other two on gas. Following the shutdown of the Badarpur Power Plant in October 2018, significant progress was made. It was cited as one of Delhi's major sources of air pollution by the Supreme Court-appointed Environment Pollution (Prevention and Control) Authority (EPCA), which called for its shutdown. Since its shutdown, Delhi is presently supplied by all gas-based power facilities in the national capital region.¹⁶

C. Pollution from vehicle

According to a 2018 research conducted by ARAI¹⁷ and TERI¹⁸, motor vehicles are the largest source of pollution in Delhi, accounting for around 40% of PM 2.5 emissions. Surprisingly, a recent research conducted by the Centre for Science and Environment (CSE)¹⁹ revealed that

¹⁴ Ibid: Delhi has over 10.3 million registered vehicles in the city, which are responsible for 41% of the total pollution load on the capital. The number of vehicles has grown four fold in last two decades, explaining how sources of pollution continue to outperform the mitigation measures. Information available at : <https://www.livemint.com>.

¹⁵ Dhariyash, Where Does Delhi's Air Pollution Come From?. Information available at : <https://smartairfilters.com/en/blog/where-delhis-air-pollution-come-from/>.

¹⁶ Information available at <https://timesofindia.indiatimes.com/city/delhi/badarpur-thermal-plant-shut-for-good/articleshow/66228551.cms>

¹⁷ Automotive Research Association of India (ARAI), established in 1966, is the leading automotive R&D organization of the country set up by the Automotive Industry with the Government of India. ARAI is an autonomous body affiliated to the Ministry of Heavy Industries, Government of India. The Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India, has recognized ARAI as a Scientific and Industrial Research Organisation (SIRO). Further, ARAI is a prime Testing and Certification Agency notified by Government of India under Rule 126 of Central Motor Vehicle Rules, 1989. ARAI has been playing crucial roles assuring safe, less polluting, more efficient and reliable vehicles. <https://www.araiindia.com/pages/about-us>

¹⁸ https://en.wikipedia.org/wiki/The_Energy_and_Resources_Institute

¹⁹ The Centre for Science and Environment (CSE) is a non-profit research and advocacy organisation situated in New Delhi, India. CSE, founded in 1980, works as a think tank on environment-development issues in India, such as inadequate planning and climatic shifts that are destroying India's Sundarbans, and promotes policy reforms and improved implementation of current regulations. https://en.wikipedia.org/wiki/Centre_for_Science_and_Environment

motor vehicles accounted for more than half of the pollutants produced from within Delhi.

D. Brick kilns/construction activities

The manufacturing of the raw materials that support the city's building sites, such as bricks and concrete, also makes a significant contribution to the polluted air in Delhi. Some elderly people and those with chronic illnesses are now being advised to leave the city by pulmonologists. People in Delhi would very soon realise that Delhi is not the best place to live and that they will have to search for a more suitable location. An Indian Institute of Technology Kanpur research estimates that the act of mixing concrete alone is responsible for 10% of the coarse particles in the air in Delhi.²⁰

E. Road dust

Road dust accounts for approximately 38% of all pollution. This component is particularly difficult to regulate since it represents both poor road conditions with unpaved pathways and the usage of traditional methods for sweeping the streets (hand-held brooms).²¹

F. Stubble burning

In order to prepare a field for planting wheat from the final week of September to the beginning of November, stubble (parali) is burned. Burning straw stubble is the process of igniting the material that remains after harvesting grains such as rice, wheat, etc. In regions where agricultural residue is left behind during combined harvesting, it is typically necessary.²² People in Delhi and the surrounding areas are experiencing the fatal winter air pollution for many years around the winter months and causes lethal clouds of smog to cover this area. Stubble burning in the nearby states of Punjab, Haryana, and Uttar Pradesh is acknowledged as one of the key contributors for the existence and amplification of air pollution in the area during the winter, accounting for near about 30% of the winter air pollution in Delhi.²³ The Supreme Court acknowledged the problem and has since made declarations and given instructions regarding the dangers of air pollution and stubble burning. In reality, decisions regarding stubble burning and even the usage of firecrackers during Diwali in Delhi have been made by the Supreme Court

²⁰ Michael Safi, Delhi's deadly dust: how construction sites are choking the city, <https://www.theguardian.com/cities/2017/feb/15/delhi-deadly-dust-how-construction-sites-choking-city>.

²¹ Ahluwalia, M.S. (2017) *Delhi's air pollution is both a challenge and an opportunity*, mint. Available at: <https://www.livemint.com/Opinion/cxTMqiyXOBgJRrV7VMra3H/Delhis-air-pollution-is-both-a-challenge-and-an-opportunity.html> (Accessed: December 3, 2022).

²² Business Standard, *What is stubble burning ? impact on air pollution, alternative of Parali Burning*, Business Standard. Available at: <https://www.business-standard.com/about/what-is-stubble-burning> (Accessed: December 3, 2022).

²³ Shukla, S. (2021) *Winter air pollution and stubble burning in North India: A regulatory governance perspective*, ORF. Available at: <https://www.orfonline.org/expert-speak/winter-air-pollution-and-stubble-burning-in-north-india/> (Accessed: December 3, 2022).

and the National Green Tribunal as of 2016. The different state administrations engage in a verbal spat, flagrantly breaking the principles of cooperative federalism and taking a very protectionist and petty posture in which they blame the problem experienced by one state on the entire state.²⁴

G. Topography

Delhi is cursed with poor topography when it comes to air pollution, which makes the problem worse. The capital city is situated south-west of the Himalayas, north-west of the central plains, and northeast of the Thar Desert. Winds from the coastlines come and are "caught" immediately before the Himalayas as they carry contaminants they have picked up along the route. Particulate matter builds up over the northern plains as a result of the air pressure pushing in one direction and making it difficult to swiftly escape in the other. Not only Delhi is affected by this buildup and trapping, but also the entire region between Punjab in the west and West Bengal in the east. In Delhi, the average wind speed in winter ranges between one and three metres per second, which is nearly one-third of the average speeds in the summer months and much lower than the average wind speed in Chennai. A study by Sarath Guttikunda and Bhola Gurjar considering nineteen years of Delhi's meteorological conditions revealed that in Delhi, pollution levels are 40% to 80% higher in the winter months compared to the rest of the year. Even on average, the PM (particulate matter) pollution levels exceed the national ambient standard of 100 micrograms per cubic metre by two to three times. The lack of winds that can carry away pollutants is one of the most important factors impacting air quality.²⁵

H. Municipal solid waste

The city produces more than 9,500 tonnes of trash per day (TPD) Waste is gathered and sent to three dump locations at Bhalswa, Okhla, and Ghazipur at a rate of around 8,000 TPD. Given that the informal sector handles the majority of garbage management, the actual amount of waste generated in the city may be significantly greater. In Delhi, there are reportedly over 150,000 rag pickers. Furthermore, the 2016 Solid Waste Management Rules' criteria were not followed while designing the three dump sites. The Master Plan for Delhi, 2021 indicates that these landfill sites' capacity was surpassed back in 2008. Aquifers and groundwater at and

²⁴ Ibid

²⁵ *How Delhi's location makes its pollution crisis worse* (2018) *Quartz*. Available at: <https://qz.com/india/1448666/delhis-location-is-the-reason-it-suffers-smog-every-winter> (Accessed: December 3, 2022).

around the majority of these sites have been affected.²⁶ In Delhi, around 9600 tonnes of municipal solid trash are produced each day, and solid waste treatment facilities typically burn 3,240 tonnes of the material each day. With a 3.9% contribution to the pollution load, waste management facilities and thermal power plants are among the other strongly emitted zones.²⁷

I. Weather

Delhi's air is unhealthy all year round; in the winter, when the city is shrouded in haze, it merely stands out more. Winter is when things grow worse since there are less breezes and lower mixing heights of pollutants, which result in haze. Sometimes the monsoon's delayed departure contributed to an increase in pollution. As the temperatures drop starting in November, the problem gets worse.²⁸

Effect of air pollution

Particulate and gaseous pollutants are the two types of air pollutants. Solid and liquid particles are among the particulate substances. The term "gaseous" refers to compounds that are gaseous at room temperature and pressure. Humans, animals, flora, and buildings are all affected by air pollution. Pollutants in the air also have an impact on the planet's climate. Air pollution has an impact on a person's aesthetic sense. The following are the many air contaminants and their effects:

- a) **Heart and Respiratory Issues**-The consequences of air pollution are grave. They have been linked to a variety of respiratory and cardiovascular diseases, including asthma, chronic bronchitis, emphysema, heart attacks, and strokes, as well as cancer. Several million people are thought to have died as a result of air pollution, either directly or indirectly.²⁹
- b) **Child Health Problems**- One of the biggest risks to children's health is air pollution, which is responsible for roughly one in ten fatalities among children under the age of five. Asthma, paediatric malignancies, chronic illnesses, impaired lung function, pneumonia, and other acute over respiratory infections can all be brought on by air

²⁶ *Delhi's solid waste: A systemic failure* (no date) *Down To Earth*. Available at: <https://www.downtoearth.org.in/blog/india/delhi-s-solid-waste-a-systemic-failure-56776> (Accessed: December 3, 2022).

²⁷ Chatterji, A. (2020) *Air pollution in Delhi: Filling the policy gaps*, *ORF*. Available at: <https://www.orfonline.org/research/air-pollution-delhi-filling-policy-gaps/> (Accessed: December 3, 2022).

²⁸ *Ibid*

²⁹ Stroke, heart disease, lung cancer, and chronic respiratory disorders are estimated to be the cause of 4.2 million deaths per year owing to ambient air pollution. Approximately 91 percent of the world's population lives in areas where air quality exceeds WHO standards.

pollution. Due to the high concentration of pollutants in the air in Delhi, every third child has lungs that are not functioning properly.³⁰

- c) **Acid Rain-** When fossil fuels are burned, harmful chemicals such as nitrogen oxides and sulphur oxides are emitted into the environment. When it rains, the water droplets interact with the contaminants in the air, becoming acidic and falling to the earth as acid rain. Acid rain has the potential to harm humans, animals, and agriculture.³¹ Sulfur dioxide and nitrogen oxides are particularly easy to dissolve in water and may be transported a long distance by the wind. As a result, the two compounds are able to travel vast distances and become part of the rain, sleet, snow, and fog that we encounter on some days. These pollutants cause acid rain.³² Acid rain is mostly caused by human activities. Humans have released so many different chemicals into the air over the last several decades that the mix of gases in the atmosphere has altered. When power plants burn fossil fuels like coal to generate electricity, they emit the bulk of sulphur dioxide and a significant amount of nitrogen oxides. Furthermore, automobiles, trucks, and buses emit nitrogen oxides and sulphur dioxide into the atmosphere.³³
- d) **Eutrophication-** Eutrophication is a phenomenon in which a large quantity of nitrogen found in some pollutants accumulates on the sea surface and transforms into algae, causing harm to fish, plants, and animals. The presence of this chemical is solely responsible for the prevalence of green-colored algae in lakes and ponds. Sulfur dioxide and nitrogen oxides are particularly easy to dissolve in water and may be transported a long distance by the wind. As a result, the two have formed a compound. Nitrogen N and phosphorus P are the two most frequent nutrients that cause eutrophication. Runoff from agricultural land is the primary source of nitrogen pollution, but the majority of phosphorus pollution originates from homes and industry, notably phosphorus-based detergents. Air, surface water, and groundwater all contribute to the nutrient input in aquatic environments..
- e) **Impact on animals-** Numerous instances of wildlife being harmed by air pollution have been documented in recent years across Delhi's veterinary facilities. In Delhi, stray

³⁰ *Opinion: Air pollution and child health: Time to act is now!* (no date) WION. Available at: <https://www.wionews.com/opinions/opinion-air-pollution-and-child-health-time-to-act-is-now-431138> (Accessed: December 3, 2022).

³¹ When sulphur dioxide and nitrogen oxides are discharged into the air, a chemical reaction occurs, resulting in acid rain. These compounds may ascend to great heights in the sky, where they mix and react with water, oxygen, and other molecules to produce additional acidic pollutants, which are known as acid rain. https://www3.epa.gov/acidrain/education/site_students/whatcauses.html

³² Ibid

³³ Ibid

animals have started exhibiting indications of nausea, frequent vomiting, redness in the eyes, and delayed responsiveness, while domesticated animals are seeming lethargic and uneasy. Such symptoms are attributed by experts to the capital's increasing pollution levels.³⁴ Delhi is home to around 250 kinds of migratory birds, 150 types of butterflies, and 10 different species of mammals, including hyenas, foxes, jackals, Nilgais, mongooses, and porcupines. Animal welfare organisations and clinics that care for animals are concerned that migration to other regions of the world would be forced by climate change and disruptions in the food chain brought on by growing pollution levels.³⁵

V. POLICIES OF DELHI GOVERNMENT TO TACKLE AIR POLLUTION IN DELHI

a) Graded response action plan

Once the air quality reaches a particular point, a set of emergency procedures known as GRAP are activated to stop further deterioration. Categories under GRAP activation are "poor" range (201 to 300). "Very poor" category (301 to 400), "severe" category (401 to 450), and "severe +" category (above 450), respectively.³⁶

Category	Ambient Particulate Matter (PM) Concentration	Measures
Moderate to Poor	<ul style="list-style-type: none"> PM 2.5 between 61-120 $\mu\text{g}/\text{m}^3$ PM10 between 101-350 $\mu\text{g}/\text{m}^3$ 	<ul style="list-style-type: none"> Enforce pollution control in thermal power plants Mechanized sweeping on roads Ban on firecrackers Stop garbage burning
Very Poor	<ul style="list-style-type: none"> PM2.5 between 121-250 $\mu\text{g}/\text{m}^3$ PM10 between 351-430 $\mu\text{g}/\text{m}^3$ 	<ul style="list-style-type: none"> Stop use of diesel generator sets Increase bus and metro services and increasing frequency of metro service Stop use of coal/firewood in hotels and open eateries
Severe	<ul style="list-style-type: none"> PM2.5 more than 250 $\mu\text{g}/\text{m}^3$ PM10 more than 430 $\mu\text{g}/\text{m}^3$ 	<ul style="list-style-type: none"> Increase frequency of mechanized sweeping of road and sprinkling of water on roads Close brick kilns, Hot Mix plants, Stone Crushers Shut down Badarpur power plant Introduce concessional rates to encourage off-peak travel in public transport.
Severe+ or Emergency	<ul style="list-style-type: none"> PM2.5 of or more than 300 $\mu\text{g}/\text{m}^3$ PM10 of or 500 $\mu\text{g}/\text{m}^3$ <p>(persist for 48 hours or more)</p>	<ul style="list-style-type: none"> Stop entry of diesel trucks into Delhi (except essential commodities) Stop construction activities Introduce odd and even scheme Shutting of schools

³⁴ *Delhi pollution is choking birds and animals too, but nobody seems to care* (2019) *IndiaTimes*. Available at: <https://www.indiatimes.com/news/delhi-pollution-is-choking-birds-and-animals-too-but-nobody-seems-to-be-caring-379154.html> (Accessed: December 3, 2022).

³⁵ Animals that are exposed to high levels of air pollution may experience serious respiratory issues. The same is undoubtedly true of animals who live and sleep outside, such monkeys and neighbourhood cats and dogs, since studies have shown that domesticated, "indoor" animals have an elevated risk of tumours when exposed to polluted air over an extended period of time. Due to their constant exposure to the dirty air released by the moving cars around them, working animals including bullocks, donkeys, horses, camels, and other species are severely harmed by air pollution.

³⁶ Editor, I. (2022) *Graded response action plan*, *INSIGHTSIAS*. Available at: <https://www.insightsonindia.com/2022/10/07/graded-response-action-plan> (Accessed: December 3, 2022).

The Ministry of Environment, Forestry and Climate Change initially informed the GRAP in January 2017. It was based on a proposal that the Central Pollution Control Board (CPCB) provided in November 2016. The Environment Pollution (Prevention and Control) Authority for the NCR, which has now been dissolved, was given the responsibility of implementing the GRAP. From 2021 CAQM is implementing the GRAP.³⁷ It is noted that the air quality is getting worse even after the Graded Response Action Plan is being implemented.³⁸

b) Construction & demolition (c&d) waste management rules

The government has made public the rules for handling garbage from construction and demolition (C&D). Concrete, soil, steel and wood, plastics, and bricks and mortar are the four categories into which all manufacturers of C&D trash are obligated by law to segregate their waste. Then, they must either bring their segregated garbage to processing facilities for processing or to collection centers established by the local government.³⁹

c) Red light on, gaadi off campaign

This plan was started by the Delhi government in 2020. Vehicles that emit smoke significantly add to air pollution. Additionally, it's been shown that turning off all of the engines while waiting for the green light can cut vehicle pollution by 15–25%. The Delhi government hopes to increase public awareness of air pollution among Delhi residents with this programme. This occurred when pollution levels in the national capital rose to worrisome heights.⁴⁰

d) National clean air programme

In January 2019, the government unveiled the National Clean Air Program (NCAP), a five-year action plan to decrease air pollution, establish an India-wide network for air quality monitoring, and increase public awareness. The initiative focuses on creating city-specific action plans for 102 Indian cities where air quality criteria are exceeded. It aims to reduce PM2.5 levels by 20–30% by the year 2024. (compared to 2017 levels). The NCAP emphasises the necessity of robust coordination and cross-sector cooperation among federal agencies, state

³⁷ Harigovind, A. (2022) *What is Grap and how are its measures to combat Delhi-NCR's air pollution different this year?*, *The Indian Express*. Available at: <https://indianexpress.com/article/explained/explained-climate/grap-delhi-ncr-air-pollution-control-explained-8192952/> (Accessed: December 3, 2022).

³⁸ Pti (2020) *Financialexpress, The Financial Express*. Available at: <https://www.financialexpress.com/lifestyle/science/graded-response-fails-to-help-delhi-ncr-air-quality-remains-very-poor/2108166/>

³⁹ *Steps taken to reduce air pollution in Delhi - environment notes - PREPP* (no date). Available at: <https://prepp.in/news/e-492-steps-taken-to-reduce-air-pollution-in-delhi---environment-notes> (Accessed: December 3, 2022).

⁴⁰ *All about Delhi's 'red light on, gaadi off' campaign - what is it?* (no date) *The Economic Times*. Available at: <https://economictimes.indiatimes.com/all-about-delhis-red-light-on-gaadi-off-campaign/why-now/slideshow/78823503.cms> (Accessed: December 3, 2022).

governments, and local groups.⁴¹

e) **Odd –even scheme**

The odd-even method was first adopted in the nation's capital in 2016 by Delhi Chief Minister Arvind Kejriwal, but the idea is not new. The Delhi government's odd-even traffic restriction plan allows private vehicles with registration numbers ending in an odd digit to drive on odd days and those with an even digit to drive on even days. As soon as the plan is put into place, vehicles with registration numbers that end in odd numerals, like 1, 3, 5, 7, or 9, will not be permitted on the road on even days, like 2, 4, 6, or 8. Similar restrictions would apply to automobiles with registration numbers that end in an even number, such as 0, 2, 4, 6, or 8 would not be allowed on the roads on days with odd number date, like 5, 7, 9, 11, 13 and 15.⁴² The researchers found two reasons for Even-odd scheme's failure 1) People changed their travel plans to avoid the 8 am–8 pm limitations 2) A rapid increase in the number of buses, auto-rickshaws, taxis, and two-wheelers that were exempted from the road restriction rule.⁴³

f) **Anti-smog guns**

Water cannons called anti-smog guns are used to scatter suspended dust particles that have accumulated in the air and created heavy smog. A water tank installed on a truck is linked to the cannon. ASGs may spray 30-100 liters of water per minute, and the water is transformed into a fine mist with droplets that are between 50 and 100 microns in size as it travels through high-pressure propellers. They are also known as spray guns and mist guns, and they trap dust particles, PM2.5, and PM10 as well as other pollutants and bring them down to the ground.⁴⁴ The Central Pollution Control Board (CPCB) pronounced the anti-smog gun experiment by the Delhi government inefficient in open spaces and on small particles.⁴⁵

g) **Smog towers**

Smog is the nasty brown haze that hangs over the skylines of big cities, including Delhi, and causes

⁴¹ The NCAP has set a target of decreasing critical air pollutants PM10 and PM2.5 (ultra-fine particulate matter) by 20-30% by 2024, using 2017 pollution levels as a baseline.

⁴² Business Standard (no date) *What is odd-even scheme, origin, benefits of Delhi odd-even scheme*, *Business Standard*. Available at: <https://www.business-standard.com/about/what-is-odd-even-scheme> (Accessed: December 3, 2022).

⁴³ DH News Service (2018) *Delhi's odd-even scheme has no impact: Study*, *Deccan Herald*. DH News Service. Available at: <https://www.deccanherald.com/content/666902/delhis-odd-even-scheme-has.html> (Accessed: December 3, 2022).

⁴⁴ *Anti-smog guns to battle air pollution in Delhi this diwali but how effective are they?* (2022) <https://www.outlookindia.com/>. Available at: <https://www.outlookindia.com/national/anti-smog-guns-to-battle-air-pollution-in-delhi-this-diwali-but-how-effective-are-they--news-232182> (Accessed: December 3, 2022).

⁴⁵ Standard, B. (no date) *Current affairs and breaking news: Daily india current news, today current news*, *Business Standard*. Available at: <https://www.business-standard.com/article/current-affairs/anti-smog-guns-ineffective-in-delhi-fail-pollution-control-test> (Accessed: December 3, 2022).

a variety of health issues, especially during the winter months.⁴⁶ Smog towers are large air purifiers having many layers of air filters, which remove contaminants from the air as it passes through them. In 2019, the Supreme Court ordered the Central Pollution Control Board (CPCB) and the Delhi government to devise a strategy to battle air pollution by constructing smog towers. The city's first 24-meter-tall smog tower is constructed at Connaught Place, and a second tower is built in Anand Vihar.⁴⁷ But due to its dynamic nature and lack of boundaries, air flows in all directions. A smog tower cannot manage free-flowing air because PM 2.5 and PM 10 particles are thoroughly mixed in the air. According to a research and advocacy organisation that focuses on air pollution it is unreasonable to think that one can catch air, clean it, and release it into the same environment at the same time in the absence of any physical limitations.⁴⁸

h) Ban on old vehicles

The National Green Tribunal (NGT) prohibited the operation of petrol cars older than 15 years and diesel vehicles older than 10 years in the national capital region in a 2015 decision (NCR). It also prohibited the parking of automobiles older than 15 years in any public space. With Delhi's air quality reaching "severe" the transport department issued a notice threatening to seize 15-year-old petrol and 10-year-old diesel cars found on city roads in violation of Supreme Court and National Green Tribunal (NGT) rulings.⁴⁹

i) Pusa decomposer

PUSA's Indian Agricultural Research Institute scientists have devised a simple, practical, and cost-effective solution to the problem of burning straw and stubble. A solution for spraying in fields to control agricultural residue deterioration has been developed. Finally, the residue is converted into manure.⁵⁰

j) Banning Of Diesel Generators

Diesel exhaust includes more than 40 harmful air pollutants, including benzene, arsenic, and

⁴⁶ *Air pollution: How well do Delhi's Giant Smog Towers combat bad air?* (no date) *Moneycontrol*. Available at: <https://www.moneycontrol.com/news/trends/health-trends/air-pollution-how-well-do-delhis-giant-smog-towers-combat-bad-air-7676951.html> (Accessed: December 3, 2022).

⁴⁷ *Livemint* (2021) *In the fight against air pollution, Delhi to get Second Smog Tower Today*, *mint*. Available at: <https://www.livemint.com/news/india/in-the-fight-against-air-pollution-delhi-to-get-second-smog-tower-today-11630973108049.html> (Accessed: December 3, 2022).

⁴⁸ *Sirur, S.* (2021) *Delhi has two smog towers, but here's why they are unlikely to help fight Air Pollution*, *ThePrint*. Available at: <https://theprint.in/india/delhi-has-two-smog-towers-but-heres-why-they-are-unlikely-to-help-fight-air-pollution/749815/> (Accessed: December 3, 2022).

⁴⁹ *Pti* (2018) *Supreme Court imposes ban on old petrol, diesel vehicles in Delhi*, *mint*. Available at: <https://www.livemint.com/Politics/WyuoVB1IM65ELIKWs2TYBL/Govt-may-stop-private-vehicles-in-Delhi-if-pollution-worsens.html> (Accessed: December 3, 2022).

⁵⁰ The States of Punjab, Haryana, Uttar Pradesh, and NCT of Delhi have used the bio-decomposer Pusa Decomposer invented by The Indian Council of Agricultural Research (ICAR) to handle 2.4 million tonnes of straw on a total of 978,713 acres (3,91,485 ha).

formaldehyde, which are all recognised or suspected cancer-causing chemicals. It also contains other dangerous environmental pollutants, such as nitrogen oxide, which is now the most significant ozone-depleting emission.⁵¹ The Environment Pollution Authority has ordered the governments of Delhi, Haryana, and Uttar Pradesh to outlaw diesel generators, with the exception of emergency and vital services.

k) Potential banning of construction

Delhi government regulations state that if the hourly average value of PM2.5 and PM10 at a construction site is higher than the level at the closest Continuous Ambient Air Quality Monitoring Stations (CAAQMS), a computerised warning will be sent to the project proponent, instructing them to identify the source and take corrective action within three hours. Therefore, every year when PM2.5 and PM10 at a construction site rise higher, steps are taken to stop construction work to reduce the amount of pollution.⁵²

l) Green war room launched to monitor air pollution

The Delhi government launched an advanced Green War Room in the month of October 2022. This Green War Room will be used to monitor the AQI⁵³ and occurrences of stubble burning. It will operate around the clock and will also monitor data and complaints received through the Green Delhi App, where users can complain instances of activities that cause air pollution.⁵⁴ This war room would operate from the seventh floor of the Delhi Secretariat, where a 12-member team of environmental scientists and other officials will be posted.⁵⁵

VI. SUPREME COURT'S ACTION PLAN TO CURB AIR POLLUTION IN DELHI

The Supreme Court has created a detailed multi-faceted action plan for pollution management in Delhi. It includes proposals for switching to cleaner vehicles and fuels, limiting car growth and expanding public transportation as an alternative, reducing pollution from coal-fired power plants, controlling pollution from industry, putting a stop to garbage burning, preventing

⁵¹ "Generator Diesel Exhaust: a Major Hazard to Health and the Environment in Nigeria." *American Journal of Respiratory and Critical Care Medicine*, 183(10), p. 1437

⁵² Krishna, S. (2021) *Can the ban on construction really improve Delhi's air quality?*, *Citizen Matters*. Available at: <https://citizenmatters.in/delhi-ban-on-construction-to-curb-air-pollution-28636> (Accessed: December 3, 2022).

⁵³ Daily air quality is reported using the Air Quality Index (AQI). It indicates how clean or filthy the air is, as well as any potential health consequences of polluted air. The AQI is concerned with the health impacts that individuals experience within a few hours or days of inhaling dirty air.

⁵⁴ *Advanced green war room launched in Delhi ahead of Winter Pollution* (2022) *Hindustan Times*. Available at: <https://www.hindustantimes.com/cities/delhi-news/advanced-green-war-room-launched-in-delhi-ahead-of-winter-pollution-101664821891320.html> (Accessed: December 3, 2022).

⁵⁵ PTI / Updated: Oct 3, 2022 (no date) *Delhi government launches Green War Room to monitor, Combat Air Pollution 24X7: Delhi News - Times of India, The Times of India*. TOI. Available at: <https://timesofindia.indiatimes.com/city/delhi/delhi-government-launches-green-war-room-to-monitor-combat-air-pollution-24x7/articleshow/94621232.cms> (Accessed: December 3, 2022).

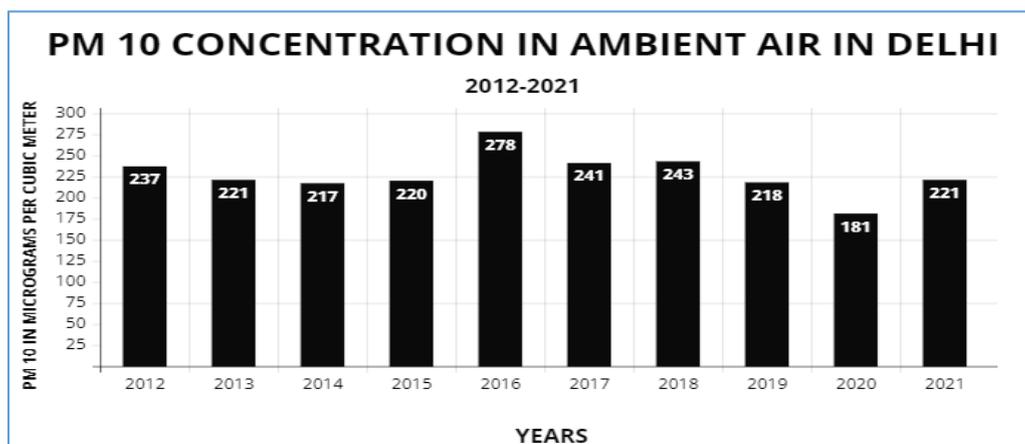
pollution from construction activities, and regulating crop residue burning in neighbouring states.⁵⁶

Air pollution at glance in Delhi

i. Three main issues to link with Delhi's pollution

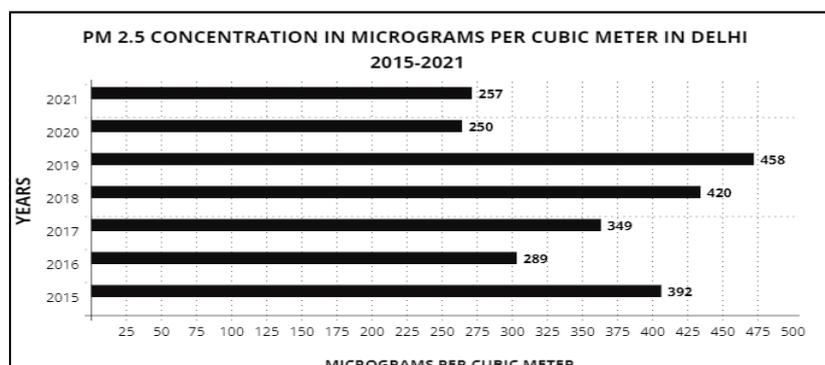
- The first is dust, which includes soil dust, road dust, and construction dust.
- Local emissions from transportation and industry, and
- Transfer of pollution from neighbouring states.

ii. PM 10 LEVEL 2012 TO 2021



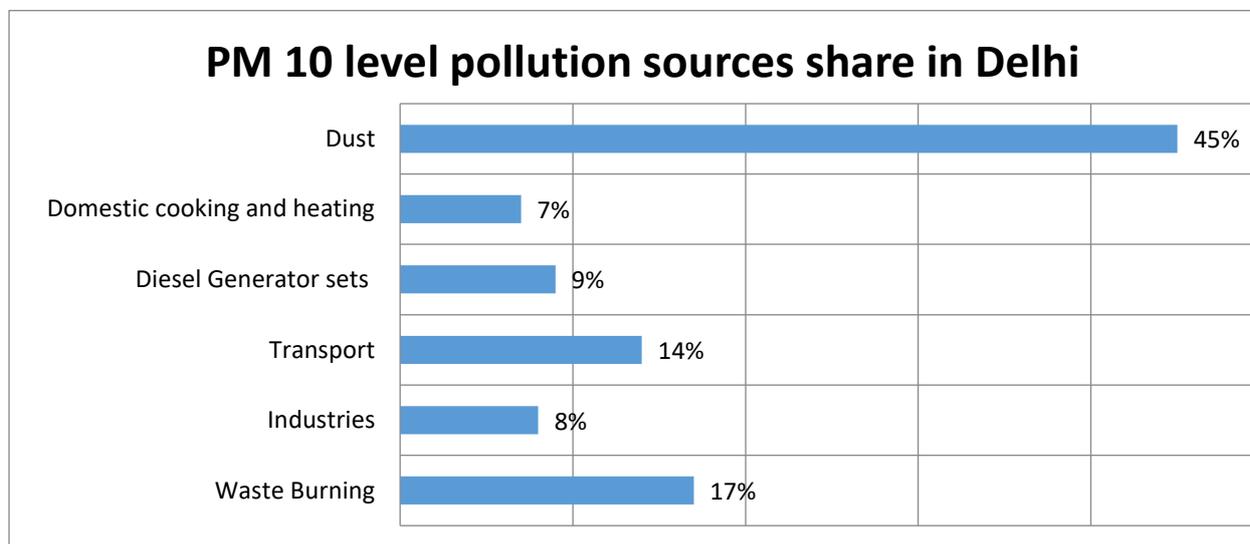
The PM10 concentration in ambient air in India's capital area of Delhi was 181 micrograms per cubic meter in 2020. For more than a decade, elevated levels of the pollutant were continuously detected. Increased levels of particulate matter in the atmosphere cause a variety of physical, environmental, and health issues. In 2021, the level of PM 10 was 221 micrograms per cubic meter.

iii. PM 2.5 LEVEL FROM 2015 TO 2021

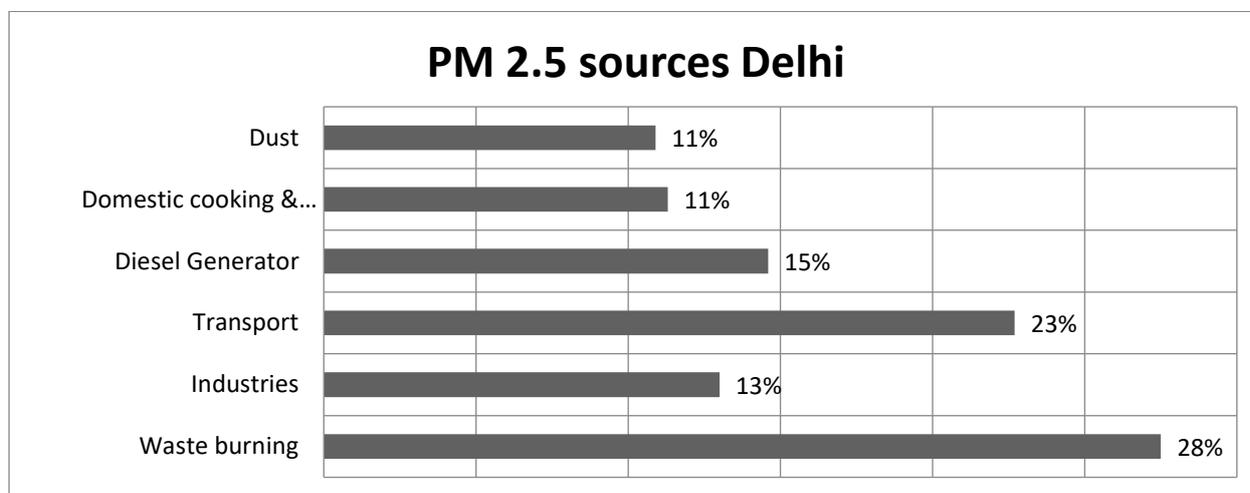


⁵⁶ Ahluwalia, M.S. (2017) *Delhi's air pollution is both a challenge and an opportunity, mint*. Available at: <https://www.livemint.com/Opinion/cxTMqiyXOBgJRrV7VMra3H/Delhis-air-pollution-is-both-a-challenge-and-an-opportunity.html> (Accessed: December 3, 2022).

Data from the previous four years reveal that 2020 was the cleanest year, but we also had a national lockdown in place for extended periods of time. Following on from the previous year, 2021 has been the cleanest in terms of good and satisfactory days. This year's excellent air spell occurred mostly during the monsoon season, when rainfall held Delhi's air quality in control.⁵⁷



The primary source of PM 10 in Delhi is dust, which is followed by waste burning, transportation, diesel generating sets, industry, and residential cooking.⁵⁸



For four consecutive years, Delhi has been ranked as the world's most polluted city.

iv. List of 20 most polluted cities in the world

RANK	CITY	COUNTRY	RANK	CITY	COUNTRY

⁵⁷ Delhi met national PM2.5 standards for only half of 2021 (2021) *Hindustan Times*. Available at: <https://www.hindustantimes.com/cities/delhi-news/delhi-met-national-pm2-5-standards-for-only-half-of-2021-101640893481440.html> (Accessed: December 3, 2022).

⁵⁸ Information available at : <https://urbanemissions.info/blog-pieces/whats-polluting-delhis-air/>

1	Delhi	India	11	Chengdu,	China
2	Kolkata	India	12	Singapore	China
3	Kano	Nigeria	13	Abidjan	Cte d'Ivoire ⁵⁹
4	Lima	Peru	14	Mumbai	India
5	Dhaka	Bangladesh	15	Bamako	Mali
6	Jakarta	Indonesia	16	Shanghai	China
7	Lagos,	Nigeria	17	Dushanbe	Tajikistan
8	Karachi,	Pakistan	18	Tashkent	Uzbekistan
9	Beijing	China	19	Kinshasa	D. R. of the Congo ⁶⁰
10	Accra,	Ghana	20	Cairo,	Egypt

For the fourth year in a row, Delhi was named the most polluted city in the world. According to the report presented by State of global air (SoGA) project. The air quality report has determined which cities are most vulnerable to poor air quality. The SoGA study gives data on polluted cities throughout the world.⁶¹

According to an analysis conducted by Berkley Earth's Richard Muller and Elizabeth Muller, exposure to 22 micrograms per cubic meter of PM 2.5 is comparable to smoking one cigarette every day. This indicates that if the PM 2.5 level in the air is 300; it is equivalent to breathing 14 cigarettes' worth of smoke.⁶² If PM 2.5 is more than 500, it would be equivalent to smoking 25 cigarettes a day to live in Delhi. Therefore, whether a person smokes or not, if they live in Delhi, they probably smoke⁶³

Using data from the Central Pollution Control Board, the DIU discovered that the average level of PM 2.5 for all monitoring sites in Delhi was 227 between 20 October and 21 November (5

⁵⁹ Côte d'Ivoire, country located on the coast of western Africa. The de facto capital is Abidjan

⁶⁰ The Democratic Republic of Congo (DRC), about the size of Western Europe, is the largest country in Sub-Saharan Africa (SSA)

⁶¹ *List of 20 most polluted cities in the world (2022) India Today*. India Today. Available at: <https://www.indiatoday.in/education-today/gk-current-affairs/story/list-of-20-most-polluted-cities-in-the-world-1990041-2022-08-19> (Accessed: December 3, 2022).

⁶² *Children in Delhi smoke 10 cigarettes a day just by breathing (2022) India Today*. India Today. Available at: <https://www.indiatoday.in/diu/story/delhi-air-quality-toxic-smoke-smog-cigarettes-1621410-2019-11-21> (Accessed: December 3, 2022).

⁶³ *Delhi pollution: Nero is playing flute when Rome is burning (2022) Firstpost*. Available at: <https://www.firstpost.com/opinion-news-expert-views-news-analysis-firstpost-viewpoint/delhi-pollution-nero-is-playing-flute-when-rome-is-burning-11576511.html> (Accessed: December 3, 2022).

pm), which equates to 10 cigarettes a day. Another scary statistic is the amount of fatalities in the country as a result of air pollution. According to the DIU, the death rate from toxic air is 134 per 100,000 people, nearly twice the world average of 64.⁶⁴

Acceptable PM 10 level is 60	Acceptable 2.5 PM level is 100	Living in Delhi =Smoking 20 + cigarettes daily
PM 10 level reaches up to 250 to 300 in winter	PM 2.5 level reaches up to 500 to 530 PM In winter	

The table above indicates appropriate PM 10 and 2.5 levels, however in Delhi they are 5 or 6 times higher, which is like living in a gas chamber that Hitler used to kill his enemies.

VII. CONCLUSION

During the last decade, the government of Delhi has made many initiatives to minimise air pollution in the city. The results demonstrate the benefits of air pollution management strategies. However, more has to be done to further reduce air pollution levels. Existing measures must be enhanced and expanded on a bigger extent. Government efforts alone will not enough. Participation of the community is critical in order to have a tangible impact on pollution reduction. The usage of public transportation must be encouraged. The city authorities should conduct more regular checks on Pollution Under Control Certificates to guarantee that automobiles exhaust gases within acceptable limits. People must be instructed to turn off their automobiles when waiting at traffic crossings. Furthermore, the "upstream" sources of contamination must be addressed. By advancing and providing employment possibilities in the outlying and suburban districts, it is possible to reduce the continuously rising stream of migrants and stop additional congestion in Delhi. Additionally, mass reforestation and a complete end to the use of fossil fuels can help to tackle the pollution problem. The administration needs to act decisively. Fossil fuels ought to be banned. All vehicles must run on CNG or electricity. Every municipality must have a forest belt established by the government. Before being discharged into the environment, toxic smoke emissions and industrial effluents must be treated at treatment plants. Environmental rules must be followed, and noncompliant units must be shut down.

⁶⁴ Supra Note 62.