



Cleaning up Toxic Air

This editorial is based on [Devise holistic plans to clean up toxic air](#) which was published in The Hindustan Times on 30/08/2023. It talks about the issue of rising Air Pollution in Indian cities and a holistic approach towards cleaning toxic air.

For Prelims: [PM10 and PM2.5](#), [Ozone](#), [Nitrogen dioxide \(NO₂\)](#), [Carbon monoxide \(CO\)](#), [Chronic obstructive pulmonary disease \(COPD\)](#), [VOCs](#), [Black carbon](#), [Kaalink](#), [High efficiency particulate air \(HEPA\) filters](#), [Biomimicry](#), [Biomass Briquettes/Pellets](#), [Ultraviolet \(UV\) rays](#), [Acid Rain](#), [smog](#)

For Mains: Air Pollution: Pollutants, Causes, Challenges and Way Forward

The noxious mix of vapors in Delhi is **shaving off nearly 12 years from a resident's life expectancy**, a global report has estimated, painting a damning picture of the administrative apathy that led the air to deteriorate year after year, intervening only with stop-gap measures once it literally gets too difficult to breathe. The **Air Quality Life Index 2023 report of the University of Chicago's Energy Policy Institute (EPIC) found that Delhi, Noida and Gurugram were the worst global performers**. In India, the northern plains — home to nearly 40% of the population — were found to be the worst performers with the average resident losing about eight years of life expectancy due to pollution.

What is Air Pollution?

Air pollution is the **contamination of air due to the presence of substances in the atmosphere that are harmful to the health of humans and other living beings**, or cause damage to the climate or to materials. Some of the common air pollutants are:

- **Particulate Matter (PM10 and PM2.5):** These are **tiny solid or liquid particles that are suspended in the air**. They can come from natural sources, such as dust, pollen, and volcanic eruptions, or from human activities, such as burning fossil fuels, wood, and waste, or from industrial processes, such as mining, construction, and agriculture.
 - **PM2.5 is more dangerous than PM10** because it can penetrate deeper into the lungs and bloodstream and cause more health problems.
- **Ozone (O₃):** This is a gas that is formed when sunlight reacts with nitrogen oxides and **volatile organic compounds (VOCs)** in the air.
 - Ozone can be beneficial or harmful depending on where it is found in the atmosphere.
 - **In the stratosphere, ozone protects the Earth from harmful ultraviolet (UV) rays** from the sun.
 - However, in the **troposphere, it is a pollutant** that can cause irritation in the eyes, nose, and throat, damage the lungs, and cause respiratory diseases.
- **Nitrogen Dioxide (NO₂):** This is a gas that is formed when nitrogen oxides (NO_x) react with oxygen in the air.

- NO_x are **emitted from combustion processes**, such as motor vehicles, power plants, and industrial boilers.
- NO_2 **can cause respiratory problems**, such as coughing, wheezing, and shortness of breath, and increase the risk of infections and allergies.
- NO_2 also **contributes to the formation of ozone and particulate matter** in the air.
- **Carbon Monoxide (CO):** This is a **colorless, odorless gas** that is **produced by incomplete combustion of carbon-containing fuels**, such as gasoline, diesel, coal, wood, and charcoal.
 - CO can **reduce the amount of oxygen that reaches the organs and tissues** of the body, especially the heart and brain.
 - CO can **cause headaches, dizziness, nausea, fatigue, confusion, and even death** at high levels of exposure.
- **Sulfur Dioxide (SO₂):** This is a gas that is formed when sulfur-containing fuels, such as coal and oil, are burned.
 - SO_2 **can cause irritation of the eyes, nose, and throat**, coughing, breathing difficulties, and asthma attacks.
 - SO_2 also reacts with water vapor and other chemicals in the air to form **acid rain**, which can damage plants, soil, water, and buildings.
- **Water Vapor:** Water vapor is the **most abundant greenhouse gas** in the atmosphere, and it plays a key role in regulating Earth's climate.
 - However, water vapor is **not a direct pollutant**, because it is part of the natural water cycle.
 - Water vapor **becomes a pollutant when it interacts with other greenhouse gasses**, such as **carbon dioxide** and **methane**, and amplifies their warming effect.
 - This is called the **water vapor feedback loop**.

What are the Primary Causes of Air Pollution in India?

- **Vehicular Emissions:** Vehicles are one of the major sources of air pollution in India, especially in urban areas. According to a study by the **Centre for Science and Environment (CSE)**, **vehicles contribute to 40% of PM_{2.5} emissions in Delhi**, 30% in Mumbai, 28% in Kolkata, and 20% in Bengaluru.
- **Industrial Chimney Wastes:** Industries are another major contributor to air pollution in India, especially in the northern and eastern regions.
 - According to a report by **Greenpeace India**, **139 of the 287 coal-based thermal power plants in India violated the emission norms set by the Ministry of Environment in 2019**.
 - These plants emitted sulfur dioxide, **nitrogen oxides**, carbon monoxide, lead, mercury, and VOCs, which can cause **acid rain, smog**, climate change, and health problems.
- **Burning Fossil Fuels:** Power plants, factories, and households that use coal, oil, or natural gas as fuel also contribute to air pollution in India by emitting greenhouse gasses.
 - According to the World Bank Group, **India is the third-largest emitter of CO₂ in the world**, after China and the United States.
- **Agricultural Activities:** Farming practices such as burning crop residues, using fertilizers and pesticides, and raising livestock also produce air pollution in India.
 - According to a **study by the IIT Delhi**, **crop burning contributed to 44% of Delhi's PM_{2.5} concentration** during the peak pollution season in November 2019.
 - Crop burning also emits smoke, dust, ammonia, **methane**, and nitrous oxide into the air.
 - These pollutants can affect soil quality, biodiversity, and human health.
- **Indoor Air Pollution:** Cooking with biomass fuels such as wood, dung, or charcoal is another source of air pollution in India, especially in rural areas.
 - According to a report by the **World Health Organization (WHO)**, **more than 800 million people in India rely on solid fuels for cooking**.
 - These fuels produce smoke and indoor air pollutants at concentrations five times higher than coal.
 - These pollutants can cause eye irritation, lung infections, **chronic obstructive pulmonary disease (COPD)**, and premature deaths.
- **Burning of Garbage Waste:** Many people in India dispose of their household waste by burning it

in open spaces. This practice releases toxic chemicals and dioxins into the air, which can cause cancer and other diseases.

- According to a **study by The Energy and Resources Institute (TERI), waste burning contributed to 29% of Delhi's PM10 concentration** during the winter season in 2018.
- Waste burning also emits **black carbon**, which **is a short-lived climate pollutant** that can accelerate global warming.
- **Slaughter Industry:** The emission of methane from the digestive processes of ruminant animals such as cows and buffaloes is a significant contributor to greenhouse gas emissions. **Methane has a global warming potential 28 times higher than carbon dioxide over a 100-year period.**
 - Additionally, the **decomposition of animal wastes and carcasses releases pollutants like ammonia, hydrogen sulfide, and volatile organic compounds.**
 - Another concern is the **burning of animal wastes and carcasses as a disposal method, which releases particulate matter, carbon monoxide, nitrogen oxides, and other harmful substances into the air.**
 - According to a report by the **Centre for Science and Environment (CSE), India's slaughter industry generates about 2.7 million tonnes of solid waste and 3.6 billion liters of wastewater per year.**
 - The report also reveals that most **slaughterhouses do not have proper waste management systems or pollution control devices**, and often violate environmental norms and regulations.

What are the Challenges in tackling Air Pollution?

- **Weak enforcement and compliance** of existing regulations and standards that can prevent or penalize polluting activities.
- **Inadequate financing and incentives** for adopting clean technologies and practices that can reduce emissions from various sectors.
- **Low awareness and engagement** of the public and other stakeholders on the causes, effects and solutions of air pollution.
- **Lack of capacity and expertise** among the relevant institutions and stakeholders that can design, implement and evaluate effective air pollution policies and programs.
- **Lack of adaptation and resilience** to the changing climatic conditions and extreme weather events that can exacerbate air pollution levels and effects.
- **Lack of research and innovation** that can generate evidence-based solutions and technologies for air pollution mitigation and adaptation.
- **Clean technologies have evolved** rapidly, but financing and regulation lag behind.
- **Inefficient transportation systems and poor land use patterns.**
- **Presence of many unregulated small-scale industries**, such as brick kilns, metal smelters, foundries, tanneries, etc., that operate without proper environmental permits or controls.

What should be the Way Forward?

- **Vertical forests:** Creating skyscrapers covered with vegetation not only helps absorb carbon dioxide and produce oxygen but also provides habitat for biodiversity. They can act as natural air purifiers and contribute to the overall aesthetics of the city.
- **Installing Air Purifiers and Smog Towers:** They can filter out airborne particulates and improve air quality. These devices can use various technologies, such as electrostatic precipitation, activated carbon, or **high efficiency particulate air (HEPA) filters**, to capture and remove pollutants from the air.
- **Developing and Promoting Low-Carbon Technologies:** Technologies such as solar panels, hydrogen fuel cells or biofuels, wind turbines, biogas plants and electric vehicles that can reduce the dependence on fossil fuels.
 - These technologies can also provide clean and renewable energy sources, create green jobs, and mitigate climate change.
- **Urban Green Spaces:** Creating urban **green spaces such as parks, gardens and rooftops that can improve air quality, reduce heat island effect and provide recreational benefits.** Urban green spaces can also enhance biodiversity, sequester carbon, and improve the aesthetic appeal of the city.
- **Congestion Pricing and Low Emission Zones:** Implementing congestion pricing or low

emission zones that can **charge vehicles for entering certain areas of the city or restrict the entry of high-polluting vehicles.**

- These policies can encourage drivers to switch to cleaner vehicles or use public transportation, reducing the traffic congestion and emissions in the city centers.
- **Biomass Briquettes/Pellets:** Biomass pellets are **made from agricultural or forest residues**, such as rice husk, sawdust, or bagasse, and can provide a cheap and efficient fuel source for rural households.
- **Biomimicry:** Using biomimicry to design **buildings and materials that can mimic natural processes of air purification**, such as the **Eastgate Centre in Zimbabwe** that uses passive cooling inspired by termite mounds.
 - Biomimicry can also inspire innovations such as self-cleaning paints, smog-eating concrete, or artificial leaves.
 - Biomimicry is a **practice that learns from and mimics the strategies found in nature** to solve human design challenges.
- **Supporting Innovative Solutions:** Supporting social enterprises or **start-ups that can provide innovative solutions for air pollution**, such as Graviky Labs, Chakr Innovation, HelpUsGreen, etc.
 - Graviky Labs created **Kaalink**. By attaching it to generators and fuel tanks, Kaalnik captures pollution and transforms it into usable ink.
- **Street Furniture for Pollution Mitigation:** Installing Street furniture to drive away pollution. With urbanization coming into the picture, there is a lack of space to plant more trees.
 - Green City Solutions have set up **moss covered tree benches** in significant landmarks in cities across Europe which can suck the pollutants.
- **Air Purifying Helmets:** These are **helmets that have a built-in air purifier that can filter out harmful pollutants from the air**. The helmets are designed for bikers who are exposed to high levels of air pollution on the roads. The helmets also have sensors that can monitor the air quality and alert the user when it is unsafe.
 - A Delhi-based startup called **Shellios** is testing a prototype of such a helmet.
- **Differential Toll Treatment:** This is a **policy that charges higher toll fees for vehicles that emit more pollutants**, such as diesel trucks and old cars. Differential toll treatment **can incentivize drivers to switch to cleaner vehicles** or use public transportation, reducing the traffic congestion and emissions on the roads.
- **Hot Lanes:** These are lanes that are **reserved for vehicles that have high occupancy, such as carpooling or public buses**. Hot lanes can encourage people to share rides or use mass transit, reducing the number of vehicles on the roads and the emissions they produce. Hot lanes can also reduce travel time and fuel consumption for the users.

Conclusion

In India, more basic livelihood issues often dominate the electoral discourse, allowing the authorities to escape scrutiny on the pollution front. But **no country has progressed economically without caring for the health of its citizens**. The government needs to take the health hazards of pollution seriously. The first step on this journey would be to delink air action plans from the winter and develop holistic year-long strategies.

Drishti Mains Question:

Air pollution has emerged as a critical environmental challenge. Analyze the major causes of air pollution. Suggest measures that could effectively mitigate air pollution and ensure a cleaner and healthier environment for future generations.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Consider the following: (2022)

1. Carbon monoxide
2. Nitrogen oxide
3. Ozone
4. Sulphur dioxide

Excess of which of the above in the environment is/are the cause(s) of acid rain?

- (a) 1,2 and 3
(b) 2 and 4 only
(c) 4 only
(d) 1,3 and 4

Answer - (b)

Mains

Q. Mumbai, Delhi and Kolkata are the three mega cities of the country but the air pollution is much more serious problem in Delhi as compared to the other two. Why is this so?

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