

Air Pollution

What is Air Pollution?

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Air pollution refers to the contamination of the air, irrespective of indoors or outside. A physical, biological or chemical alteration to the air in the atmosphere can be termed as pollution. It occurs when any harmful gases, dust, particulate matter, fumes, metal ores as powder, smoke enters into the atmosphere and makes it difficult for plants, animals, and humans to maintain normal physiological processes and survive as the air becomes dirty.

There are many different types of air pollutants, such as gases (including ammonia, carbon monoxide, sulfur dioxide, nitrous oxides, methane, carbon dioxide and chlorofluorocarbons), particulates (both organic and inorganic), and biological molecules.

The Ozone layer considered crucial for the existence of the ecosystems on the planet. It is depleting due to increased pollution. Global warming, a direct result of the increased imbalance of gases in the atmosphere, has come to be known as the biggest threat and challenge that the contemporary world has to overcome in a bid for survival.

Types of Pollutants

In order to understand the causes of Air pollution, several divisions can be made.

Air pollution can be classified into two sections – **invisible** and **visible** air pollution.

Visible air pollution, as the name suggests, can be visible. The smog you see over a city is an example of visible pollution.

Invisible air pollutants are less noticeable, but they can be more deadly. Good examples of invisible air pollutants are sulfur dioxide, carbon monoxide and nitrogen oxides.

It can be further divided into **Primary and Secondary air pollutants**.

Primary air pollutants can be caused by primary sources. The pollutants that are a direct result of the process can be called [primary pollutants](#). A classic example of a primary pollutant would be the sulfur-dioxide emitted from factories.

Secondary pollutants are the ones that are caused by the reactions of primary pollutants. [Smog](#) created by the interactions of several primary pollutants is known as a secondary pollutant.

Causes and stepwise effects of air pollution may be as follows: (1) greenhouse effect, (2) particulate contamination, (3) increased UV radiation, (4) acid rain, (5) increased ground-level ozone concentration, (6) increased levels of nitrogen oxides.

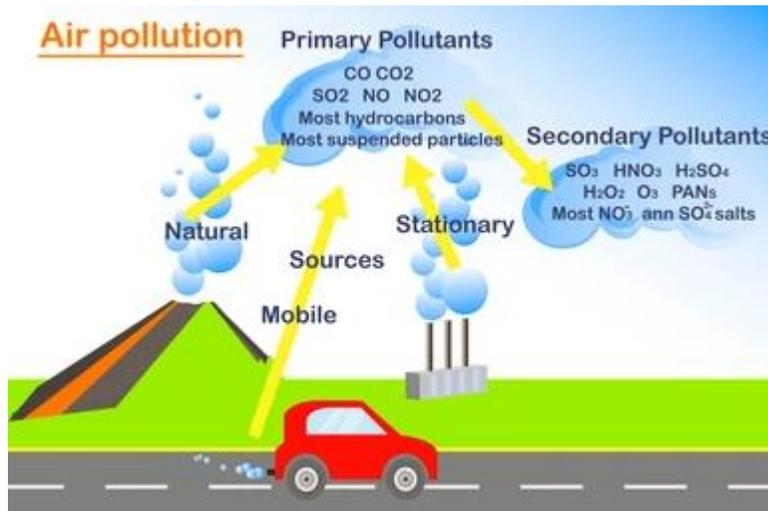
Pollutants emitted into the atmosphere by human activity include:

- [Carbon dioxide](#) (CO₂) – Because of its role as a [greenhouse gas](#) it has been described as "the leading pollutant" and "the worst climate pollutant". Carbon dioxide is a natural component of the atmosphere, essential for plant life and given off by the human [respiratory system](#).
- [Sulfur oxides](#) (SO_x) – particularly sulfur dioxide, a chemical compound with the formula SO₂. SO₂ is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulfur compounds, and their combustion generates sulfur dioxide. Further oxidation of SO₂, usually in the presence of a catalyst such as NO₂, forms H₂SO₄, and thus [acid rain](#) is formed.
- [Nitrogen oxides](#) (NO_x) – Nitrogen oxides, particularly [nitrogen dioxide](#), are expelled from high temperature combustion, and are also produced during [thunderstorms](#) by [electric discharge](#).
- [Carbon monoxide](#) (CO) – CO is a colorless, odorless, toxic gas. It is a product of [combustion](#) of fuel such as natural gas, coal or wood. Vehicular exhaust contributes to the majority of carbon monoxide.
- [Volatile organic compounds](#) (VOC) – VOCs are a well-known outdoor air pollutant. They are categorized as either methane (CH₄) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced [global warming](#).
- [Particulate matter](#) / particles, alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, [aerosol](#) refers to combined particles and gas. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols
- [Persistent free radicals](#) connected to airborne fine particles are linked to cardiopulmonary disease.
- Toxic [metals](#), such as [lead](#) and [mercury](#), especially their compounds.
- [Chlorofluorocarbons](#) (CFCs) – harmful to the [ozone layer](#); emitted from products are currently banned from use.
- [Ammonia](#) – emitted mainly by agricultural waste. [Ammonia](#) is a compound with the formula NH₃. It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and fertilizers.
- [Odors](#) — such as from garbage, sewage, and industrial processes
- [Radioactive pollutants](#) – produced by [nuclear explosions](#), nuclear events, war [explosives](#), and natural processes such as the [radioactive decay](#) of [radon](#).

Secondary pollutants include:

- Particulates created from gaseous primary pollutants and compounds in photochemical smog. [Smog](#) is a kind of air pollution. In the atmosphere by the exposure with [ultraviolet](#) light it forms photochemical smog.

Primary Air Pollutants



Following are some of the important causes of air pollution:

- 1. Agricultural Activities:** Spraying of insecticides, pesticides and fertilizers emit harmful chemicals into the atmosphere and contaminate the air.
- 2. Factories and Industries:** The harmful smoke or gases emitted by factories contaminates the air since they are rich in carbon monoxide, organic compounds, hydrocarbons and chemicals.
- 3. Burning of Fossil Fuels:** The combustion of fossil fuels emits a large amount of Sulphur dioxide, which pollutes the air.
- 4. Automobiles:** The gases emitted from the vehicle such as cars, trucks, jeeps, buses, lorry, etc. pollute the environment. These are the major source of greenhouse gases and also result in harmful diseases for the people who inhale this air. Hydrocarbons, CO, CO₂, Sulphur oxides are major constituents of automobile exhausts.
- 5. Mining Activities:** In the mining process, the minerals below the Earth are extracted using large pipes. The dust and chemicals released during the process not only pollute the air but also destroy the health of the workers.
- 6. Domestic Sources:** Painting of walls, using wooden sticks as fuel, burning cow dung, etc., are the basic usage in the home which lead to toxic smell in the air which causes health hazards.

Harmful Effects of Air Pollution

Air pollution can cause harmful health effects such as eye, nose, throat irritation, headache, and allergic reaction in the short term.

Following are the important effects of air pollution:

1. **Diseases:** Air pollution gives rise to several respiratory disorders and heart diseases. Lung cancer, pneumonia and asthma have increased in the last few years due to air pollution.
2. **Acid Rain:** The great monument Taj Mahal is affected due to acid rain. This acid rain is caused due to the burning of fossil fuels which releases harmful gases such as nitrogen oxide and sulphur dioxide into the air. The water droplets combine with this pollutant to become acidic and fall as acid rain, which affects the ecosystem.

Acid rain results when sulfur dioxide (SO₂) and nitrogen oxides (NO_x) are emitted into the atmosphere and transported by wind and air currents. The SO₂ and NO_x react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

While a small portion of the SO₂ and NO_x that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels. The major sources of SO₂ and NO_x in the atmosphere are:

- Burning of fossil fuels to generate electricity. Two thirds of SO₂ and one fourth of NO_x in the atmosphere come from electric power generators.
- Vehicles and heavy equipment.
- Manufacturing, oil refineries and other industries.

3. **Ozone Layer Depletion:** The hole in the ozone layer is caused by air pollutants. Chemicals used as refrigerants such as chlorofluorocarbons, halons and hydrochlorofluorocarbons are the major cause of depletion of the ozone layer. This depletion allows harmful ultraviolet rays from the sun to enter the atmosphere and causes skin diseases and eye problems among normal people.
4. **Global Warming:** It is caused due to the emission of gases from automobiles. This creates an imbalance in the atmosphere, which leads to an increase in the temperature of the Earth.

The main cause of ozone depletion and the ozone hole is manufactured chemicals, especially manufactured [halocarbon refrigerants](#), [solvents](#), [propellants](#), and foam- [blowing agents](#) ([chlorofluorocarbons](#) (CFCs), HCFCs, [halons](#)), referred to as **ozone-depleting substances (ODS)**. These compounds are transported into the [stratosphere](#) by [turbulent mixing](#) after being emitted from the surface, mixing much faster than the molecules can settle. Once in the stratosphere, they release [atoms](#) from the [halogen](#) group through [photodissociation](#), which [catalyze](#) the breakdown of ozone (O₃) into oxygen (O₂). Both types of ozone depletion were observed to increase as emissions of halocarbons increased.

Ozone depletion and the ozone hole have generated worldwide concern over increased cancer risks and other negative effects. The ozone layer prevents most harmful wavelengths of [ultraviolet](#) (UV) light from passing through the [Earth's atmosphere](#). These wavelengths cause [skin cancer](#), [sunburn](#), permanent blindness, and [cataracts](#), which were projected to increase dramatically as a result of thinning ozone, as well as harming plants and animals. These concerns led to the adoption of the [Montreal Protocol](#) in 1987, which bans the production of CFCs, halons, and other ozone-depleting chemicals.

Mortality

Absolute number of deaths from ambient particulate air pollution¹

The [World Health Organization](#) estimated in 2014 that every year air pollution causes the premature death of some 7 million people worldwide. Studies published in March 2019 indicated that the number may be around 8.8 million.

Cardiovascular disease

A 2007 review of evidence found that, ambient air pollution exposure is a risk factor correlating with increased total mortality from cardiovascular events (range: 12% to 14% per 10 $\mu\text{g}/\text{m}^3$ increase).

Lung disease

Research has demonstrated increased risk of developing asthma and COPD from increased exposure to traffic-related air pollution. Additionally, air pollution has been associated with increased hospitalization and mortality from asthma and COPD. [Chronic obstructive pulmonary disease](#) (COPD) includes diseases such as [chronic bronchitis](#) and [emphysema](#).

Cancer (lung cancer) Unprotected exposure to PM_{2.5} air pollution can be equivalent to smoking multiple cigarettes per day, potentially increasing the risk of [cancer](#), which is mainly the result of [environmental factors](#).

Kidney disease

In 2021, a study of 163,197 Taiwanese residents over a period of 2001–2016 estimated that every 5 $\mu\text{g}/\text{m}^3$ decrease in the ambient concentration of PM_{2.5} was associated with a 25% reduced risk of [chronic kidney disease](#) development.

Children

In the United States, despite the passage of the [Clean Air Act](#) in 1970, in 2002 at least 146 million Americans were living in [non-attainment areas](#)—regions in which the concentration of certain air pollutants exceeded federal standards.

Infants

Ambient levels of air pollution have been associated with [preterm birth](#) and [low birth weight](#). A 2014 WHO worldwide survey on maternal and perinatal health found a statistically significant association between low birth weights (LBW) and increased levels of exposure to PM2.5.

Central nervous system

Data is accumulating that air pollution exposure also affects the [central nervous system](#).

Agricultural effects

In India in 2014, it was reported that air pollution by [black carbon](#) and ground level ozone had reduced crop yields in the most affected areas by almost half in 2011 when compared to 1980 levels.

Economic effects

Air pollution costs the [world economy](#) \$5 trillion per year as a result of productivity losses and degraded quality of life, according to a joint study by the [World Bank](#) and the [Institute for Health Metrics and Evaluation](#) (IHME) at the [University of Washington](#).

Prevention/control of air pollution

There are now practical alternatives to the principal causes of air pollution:

- Areas downwind (over 20 miles) of major airports have more than double *total particulate emissions in air* than other areas, even when factoring in areas with frequent ship calls, and heavy freeway and city traffic like Los Angeles. [Aviation biofuel](#) mixed in with jetfuel at a 50/50 ratio can reduce jet derived cruise altitude particulate emissions by 50–70%, according to a NASA led 2017 study (however, this should imply ground level benefits to urban air pollution as well).
- Ship propulsion and idling can be switched to much cleaner fuels like natural gas. (Ideally a [renewable source](#) but not practical yet)
- Combustion of fossil fuels for space heating can be replaced by using [ground source heat pumps](#) and [seasonal thermal energy storage](#).
- Electric power generation from burning fossil fuels can be replaced by power generation from nuclear and renewable. For poor nations, heating and home stoves that contribute much to regional air pollution can be replaced by a much cleaner fossil fuel like natural gas, or ideally, renewables.
- Motor vehicles driven by fossil fuels, a key factor in urban air pollution, can be replaced by electric vehicles. Though lithium supply and cost is a limitation, there are alternatives. Herding more people into clean public transit such as electric trains can also help. Nevertheless, even in emission-free electric vehicles, rubber tires produce

significant amounts of air pollution themselves, ranking as 13th worst pollutant in Los Angeles.

- Reducing travel in vehicles can curb pollution. After Stockholm reduced vehicle traffic in the central city with a congestion tax, nitrogen dioxide and PM10 pollution declined, as did acute pediatric asthma attacks.
- [Biodigesters](#) can be utilized in poor nations where [slash and burn](#) is prevalent, turning a useless commodity into a source of income. The plants can be gathered and sold to a central authority that will break it down in a large modern biodigester, producing much needed energy to use.
- Induced humidity and ventilation both can greatly dampen air pollution in enclosed spaces, which was found to be relatively high inside subway lines due to braking and friction and relatively less ironically inside transit buses than lower sitting passenger automobiles or subways.