

VOLUME 10 ISSUE 2 2024

ISSN 2454 – 3055



**INTERNATIONAL
JOURNAL OF
ZOOLOGICAL
INVESTIGATIONS**

***Forum for Biological and
Environmental Sciences***

Published by Saran Publications, India



International Journal of Zoological Investigations

Contents available at Journals Home Page: www.ijzi.net

Editor-in-Chief: Prof. Ajai Kumar Srivastav

Published by: Saran Publications, Gorakhpur, India



ISSN: 2454-3055

Air Pollution: Types, Sources, Pollutants and Control Measures

Manda Anil Mhatre

Department of Zoology, Changu Kana Thakur Arts, Commerce & Science College, New Panvel, Raigad, Navi Mumbai 410 206, Maharashtra, India

Received: 24th July, 2024; **Accepted:** 11th October, 2024; **Published online:** 16th October, 2024

<https://doi.org/10.33745/ijzi.2024.v10i02.099>

Abstract: Clean air is one of the core metabolic requirements for human life. Reduction in either the quality or quantity of this essential resource constitutes a major threat to human health. Air pollution is considered as the world's most serious environmental health risk. Emissions from vehicles and industries, construction activities, burning of biomass and wastes, geographical factors, and decreased green cover and insufficient green spaces have resulted in pollution of the atmosphere. Hence, it is an urgent need to develop innovative and digitalized techniques for monitoring of air quality and control measures should be developed that should be affordable for common public for the betterment of the health. Present review aims to provide an illustrative account of air pollution thorough types, sources, major air pollutants, prevention and control measures along with awareness to be created among students, general public and research community. Control measures such as fuel quality improvement, green spaces and urban planning, international cooperation, particulate control, public awareness and education, regulatory measures, source control, and technological solutions will minimize the hazardous effects of air pollution to a greater extent.

Keywords: Air, Control measures, Particulate matter, Pollution, Major pollutants, Vulnerability

Citation: Manda Anil Mhatre: Air pollution: Types, sources, pollutants and control measures. Intern. J. Zool. Invest. 10(2): 1002-1008, 2024.

<https://doi.org/10.33745/ijzi.2024.v10i02.099>



This is an Open Access Article licensed under a Creative Commons License: Attribution 4.0 International (CC-BY). It allows unrestricted use of articles in any medium, reproduction and distribution by providing adequate credit to the author (s) and the source of publication.

Introduction

Mabahwi *et al.* (2014) stated that the normal air/atmosphere consists of nitrogen (79%), oxygen (20%), and 1% mixture of carbon dioxide, water vapour, and other gases. For sustenance of life on the earth, the atmosphere provide and maintain the supply of oxygen, controls the earth's energy budget, and dispose of waste material or pollutants generated by natural or human activity (Admassu and Wubeshet, 2006).

National Institute of Disaster Management (2023) noted that air pollution refers to the presence of harmful substances in the air, which can have detrimental effects on human health, the environment, and the overall well-being of living organisms. Clean air is the basic requirement of all living plants, animals, and human for a good health and well-being (Penard and Maesano, 2004; Shaharukh *et al.*, 2020). Sources of air pollution

includes automobile emissions, biological contaminants, burning garbage, carbon monoxide (CO), chemical companies, heavy metals, nitrogen oxides (NO_x), ozone (O₃), power plants, tobacco smoke, and contaminants from volcanic eruptions (Shetty *et al.*, 2023).

Turk and Kavraz (2011) documented that; anthropogenic activities produces air pollutants such as ash, dust, fog, smoke, soot, steam, etc. which spoils the air quality and affects the environment and human health. The major pollutants of the ambient air are CO, hydrocarbons, lead, NO_x, O₃, and sulphur dioxides (SO₂). These pollutants are present in the gaseous form or particulate form (Doreswamy and Sudheendra, 2010).

Kumar and Gupta (2016) reported that major causes of air pollution are burning of fossil fuels, deforestation, increase in population, rapid industrialization, unscientific agricultural activities, urbanization, and vehicles emission. Major air polluting industries/activities includes boilers, buffing/metal polishing, cooking and kitchen operations; electroplating, anodizing, galvanizing, pickling, and phosphating; foundries or casting; furnaces; grinding mills of flour/dal/spices; plastic reprocessing; powder coating/spray painting/super-enamelling; ready mix concrete plants; and thermal power plants (Singh, 2023).

According to CPCB (2012), the air pollution is a result of rapidly increasing demand for transportation, industrialization, meteorological conditions, population growth, urbanization, rise in income, and use of motor vehicles. It occurs mainly due to suspended particles/ particulate matter (PM) (mixture of tiny particles and liquid droplets that includes acids, organic chemicals, metals, and dust) and hazardous gases (CO, NO_x, O₃, SO₂, and volatile organic compounds VOC) (The Center for Ecogenetics and Environmental Health, 2012).

Singh *et al.* (2022) recorded that in metropolitan areas with megacities, the air quality

is continuously deteriorating with the increased settlement of human population. Increased number of automobiles and industries add toxic gases and PM into the atmosphere (NIH, 2020). Air pollution is a public health hazard in concern to cardiovascular disease; diabetes; obesity; reproductive, neurological, and immune system disorders; and as a human carcinogen (Manisalidis *et al.*, 2020). This review focuses on the air pollution with special emphasis on types, sources, major air pollutants, and control measures for prevention and to reduce the air pollution.

The existing literature shows that on the topic, types, sources and control measures of air pollution, in-depth research has been conducted. For present review the searched literature contains research papers, reviews, reports, and conference papers with the help of Internet search engines like Google, Google Scholar, PubMed, ScienceDirect, and ResearchGate. The purpose of this review is to summarize the updated published literature on air pollution with respect to its types, major sources, types of air pollutants, and strategies to be practiced for control measures.

Types of Air Pollution:

Shaharukh *et al.* (2020) reported that air pollution can be broadly categorized into two types such as, indoor air pollution and outdoor air pollution. PM, NO_x, O₃, and SO₂ are the common indoor and outdoor air pollutants (Singh *et al.*, 2022).

Indoor Air Pollution:

Singh *et al.* (2022) noted that the deterioration of indoor air by deleterious gases, toxic chemicals, and other substances like building materials is called indoor air pollution. It is the result of pollutants produced within and around the buildings and structures. Areas such as attic/store, bathrooms, bedrooms, garage/basement, kitchen, living area, and yard produce different pollutants (Shaharukh *et al.*, 2020).

Common indoor pollutants include asbestos, biological pollutants (moulds and fungal spores), CO, indoor PM, pesticides, radon gas, second-hand smoke (tobacco smoke), and VOC, etc. Inadequate

Table 1: Sources of air pollution based on origin of pollutants (Source: Mark and Mallat, 2018)

Source	Subtypes of sources
Natural sources	Emissions from plants, biomass of the ocean, and volcanic gas. Re-suspension of dust in arid areas such as deserts.
Anthropogenic sources	Abrasion of brakes and tyres, agriculture, with the use of entrants, combustion engines of diesel and petrol, Combustion of coal, lignite, heavy oil and biomass, Erosion of roads by vehicles, household and industry solid fuel combustion, industrial activities.
	Stationery sources: - Point sources: Industry, power plants, fuel combustion. - Area sources: Incineration, residential, industrial estates, rail yards, ports.
	Mobile sources: Line sources - Highways, railroads.

Table 2: Main sources of air pollution (Source: Fahad *et al.*, 2019; Manisalidis *et al.*, 2020)

Sources of air pollution	Emission of pollutants from
Indoor area sources	Air conditioning systems, building equipment, domestic cleaning activities, dry cleaners, furnishings, heating, petrol stations, printing shops, ventilation.
Major sources	Chemical and fertilizer industries; metallurgical and other industrial plants; municipal incineration; power stations; refineries and petrochemicals.
Mobile sources	Airways, automobiles, cars, railways, other types of vehicles.
Natural sources (Physical disasters)	Sources: Agricultural burning, dust storms, forest fire, volcanic erosion. Examples: PM, thunderbolts, algae, humid zones, and wind erosion. Biological material: pollen, spores, plant and animal debris. Thunderbolts: produce oxides of nitrogen. Algae: hydrogen sulphide. Wind erosion: Release particles into the atmosphere. Humid zones: produce methane.

ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area (Sharma, 2020).

Outdoor Air Pollution:

Outdoor pollution is the pollutants emitted in the outside environment (outside of a closed building or space) predominantly from vehicles, power plants, industrial boilers, incinerators, ships or aircraft, etc. (Singh *et al.*, 2022). It is caused due to mixture of airborne particulate matter and the gaseous pollutants (CO, NO₂, O₃, SO₂, and VOC). Sources of outdoor air pollution include agriculture, dust, energy and industry supply, forest fires, household energy, sea sprays, transport, volcanoes, and waste (Health Effects Institute, 2019; Shaharukh *et al.*, 2020).

Major Sources of Air Pollution:

Penard and Maesano (2004) reported that; sources of air pollution are natural, or human-made. Major sources include household activities, industrial emissions, soil resuspension, and vehicular emissions (Singh *et al.*, 2022). Increase in the population growth and income along availability of funding agencies has increased the number of vehicles on large scale. Steady increase in road transport vehicles such as private vehicles (2-wheelers, cars, Jeeps etc.); public transport vehicles (bus, taxi, auto rickshaws, etc.); and goods transport vehicles (trucks, tempos, etc.) has major contribution to air pollution (CPCB, 2012) (Table 1).

Manisalidis *et al.* (2020) described that the sources of air pollution are of four types such as, indoor area sources, major sources, mobile

Table 3: Types of air pollutants (Source:Kampa and Castanas, 2008; Mark and Mallat, 2018; Sharma, 2020)

Air pollutants	Sources and examples
Primary pollutants	- Directly emitted from the processes: fossilfuel consumption, volcanic eruption andfactories. - Examples: Ammonia (NH₃), methane, oxides of carbon (CO), oxides of nitrogen (NO_x), oxides of sulphur (SO_x), PM, toxic metals (As, Cd, Pb, Hg, Ni), VOC (Methane VOC, Non methane VOC, Benzene Methyl Chloride, Chlorofluorocarbons (CFCs), Radioactive pollutants etc.
Secondary pollutants	- Not emitteddirectly. - Formed due to reactions among primary pollutants orother components of the atmosphere. - Examples: Ground level ozone, NO_x, smog, persistent organic pollutants (POPs), and peroxyacetyl nitrate (PAN).

Table 4: Major air pollutants: Sources and examples (Source: Kampa and Castanas, 2008; Kumar and Katoria, 2013)

Air pollutants	Examples	Sources
Gaseous pollutants	CO,NO _x (NO,NO ₂) Ozone, SO _x (SO ₂ , SO ₃), VOCs (Benzene, ethylene glycol,formaldehyde, methylene chloride, tetrachloroethylene, toluene, xylene, and 1, 3-butadiene)	Combustion of fossil fuels. NO _x : Emerges from high temperature combustion. Mobile and stationary combustion sources. O ₃ : Reactions involving NO ₂ and VOC. CO: Incomplete combustion of fuel - natural gas, coal or wood; and vehicular exhaust. SO ₂ : Combustion of coal, heavy oils, smelting of sulphur containing ores, volcanoes and oceans. VOCs: Paint application, pesticides, building materials and furnishing, glues and adhesives, road transport, dry-cleaning and other solvent uses.
Heavy metals	Ag, Cd, Cr,Hg, Mn, Ni, Pb, V	Combustion, manufacturing facilities, and waste water discharges.
PM/ Coarse particles	Complex and varying mixturesof suspendedparticles (UFP, SPM, PM ₁ , PM _{2.5} , PM ₁₀)	Generated by industry, transport and agriculture. Major components: Metals, organic compounds, material of biologic origin, ions, reactive gases, and the particle carbon core. Examples: Dust, pollen, soot, smoke,and liquid droplets. Source:Construction activity, factories, fires, motor vehicles,natural windblown dust, power plants, refuse incinerators, increased burning of fuel for winter, burning of agricultural crop residues, weather patterns, etc.
Persistent organic pollutants (POPs)	Dioxins (PCDDs & PCDFs), furans, PAHs, PCBs, pesticides	Dioxins:Incomplete combustion and burning of materials containing chlorine (e.g. plastics). PAH: Burning of coal, crude oil, gasoline, wood, garbage, and tobacco. Pesticides: Agricultural activities.

sources, and natural sources (Table 2).

Types of Air Pollutants:

According to Manisalidis *et al.* (2020); air pollutants are the substance dwelling temporarily or permanently in the air, which adversely alters the environment by interfering with the health,

the comfort, or the food chain, or by interfering with the property values of people. They are dispersed particles, hydrocarbons, CO, CO₂, NO, NO₂, SO₃, etc.

Air pollutants are the chemical, biological and physical agents that modify the natural characteristics of the atmosphere (Tables 3, 4).

Table 5: Common Air Pollutants (Source: Gul and Das, 2023)

Air pollutants	Sources
Ammonia (NH ₃)	Combustion of fossil fuels. Transport and waste disposal. Agriculture, primarily livestock manure/slurry management and fertilisers.
Carbon dioxide (CO ₂)	Burning of fossil fuels (coal, oil) in furnaces of thermal power plants, industries, etc.
Carbon monoxide	Incomplete combustion of fossil fuels. Automobile, industrial furnaces, open fires, forest fires and domestic fuel.
Lead (Pb)	Fumes from diesel/petrol, paints, metal mining and smelting, waste incineration, battery recycling, wood and coal burning.
Oxides of Nitrogen (NO _x): NO & NO ₂	Road transport, electricity supply industry and other industrial and commercial sectors.
SO ₂	Oil refineries and ore smelters which use sulphur containing fuels.
Ozone (O ₃)	Formed by photo chemical action on NO _x and VOC by solar radiation. Sources: Vehicular emission, industries and power generation. Automobile exhaust emission consists of toluene, xylene and ethyl-benzene isomer.
Particulate matter (PM _{2.5} and PM ₁₀)	Small particles and are noxious air pollutants. Examples: Cigarette smoke, asbestos fibres. Sources: Power sector, industries, transport, and residential sector.

Table 6: Control Measures of Air Pollution (Source: National Institute of Disaster Management, 2023)

Control	Method	Procedure
Fuel quality improvement	Low-sulphur fuels	Reduce SO ₂ emissions, especially in power plants and industries.
	Alternative fuels	Use of natural gas or renewable energy sources to reduce emissions from combustion processes.
Green spaces and urban planning	Increasing vegetation	Planting trees and creating green spaces to absorb pollutants and improve overall air quality.
	Urban design	Planning cities to minimize congestion and encourage public transportation to reduce vehicle emissions.
International cooperation	Global agreements	Participation in international agreements and protocols for cross-border air pollution issues.
Particulate control	Particulate filters	Used to capture and remove PM from industrial processes and vehicle exhaust.
	Electrostatic precipitators	Used to remove particulate matter from flue gases in industrial settings.
Public awareness and education	Public campaigns	To create awareness in general public to adopt cleaner practices.
	Compliance monitoring	Regular monitoring of air quality and enforcement of penalties for non-compliance.
Regulatory measures	Zoning and land use planning	Allotting specific areas for industries and set up of high-emission industries away from densely populated areas.
	Emission trading systems	Special incentives for companies to encourage low emissions to meet regulatory limits.
Source control	Emission standards	Regulations for the industries and vehicles to release specific amount of pollutants into the air.
	Technological improvements	Use of cleaner technologies and processes in industries to minimize emissions.
Technological solutions	Scrubbers	Use of scrubbers to remove pollutants from exhaust gases in industries.
	Catalytic converters	Used in vehicles to convert harmful pollutants in the exhaust gases into less harmful substances.

They arise both from natural processes (volcanic activities, oceans, forests, etc.) and human activities (fossil fuel combustion, transportation, power plant emissions or emissions from other industrial processes) (Shaharukh *et al.*, 2020) (Table 5).

Control Measures of Air Pollution:

National Institute of Disaster Management (2023) and Union Performance Environment Management (2012) stated that control measures of air pollution should be strictly implemented to reduce the concentration of pollutants in the air, improving air quality and safeguarding public health. They can be applied at various stages of the pollution generation and dispersion process (Japan International Cooperation Agency, 2005; Ghorani-Azam *et al.*, 2016) (Table 6).

Conclusion

This review revealed that increased living standards, financial status and exponential hike in the number of vehicles; have deteriorated the air quality in most populated cities of the world. Emissions from vehicles and industries, construction activities, burning of biomass and wastes, geographical factors, and decreased green cover and insufficient green spaces have resulted in pollution of the atmosphere. Acute or chronic exposure to the hazardous air pollutants affects the environment, vegetation, animals, and even the human health. Hence, it is an urgent need to develop innovative and digitalized techniques for monitoring of air quality and control measures should be developed for the betterment of the environment, vegetation, animals, and health of human.

References

Admassu M and Wubeshet M. (2006) Air Pollution. University of Gondar in collaboration with the Ethiopia Public Health Training Initiative, The Carter Centre, the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education, pp. 217.

CPCB (Central Pollution Control Board) (2012) Epidemiological study on effect of air pollution on human health (Adults) in Delhi. Environ Hlth

Managem Series: EHMS/01/2012. Ministry of Environment & Forests, Parivesh Bhawan, East Arjun Nagar, Delhi, pp. 342.

Doreswamy HS and Sudheendra SR. (2010) Major air pollutants and their effects. Mapana J Sci. 9(2): 21-27.

Fahad A, Sahadat H, Shakhaoat H, Fakhruddin ANM, Abdullah ATM, Chowdhury MAZ and Siew HG. (2019) Impact of household air pollution on human health: source identification and systematic management approach. SN Appl Sci. 1(5): 418.

Ghorani-Azam A, Riahi-Zanjani B and Balali-Mood M. (2016) Effects of air pollution on human health and practical measures for prevention in Iran. J Res Med Sci. 21: 65.

Gul H and Das BK. (2023) The impacts of air pollution on human health and well-being: A comprehensive review. J Environ Impact Managm Policy. doi: 10.55529/jeimp.36.1.11.

Health Effects Institute (2019) Health effects of air pollution. The Institute for Health Metrics and Evaluation, and University of British Columbia, pp. 1-2.

Japan International Cooperation Agency (2005) Environmental pollution control measures. Japan's Experiences in Public Health and Medical systems. Towards Improving Public Health and Medical Systems in Developing Countries. Institute for International Cooperation, pp. 145-164.

Kampa M and Elias C. (2008) Human health effects of air pollution. Environ Pollut. 151: 362-367.

Kumar R and Gupta P. (2016) Air pollution control policies and regulations. In: Plant Responses to Air Pollution. (eds.) Kulshretra U. and Saxena P. doi: 10.1007/978-981-10-1201-3_12.

Kumar S and Katoria D. (2013) Air pollution and its control measures. Int J Environ Engineer Managem. 4(5): 445-450.

Mabahwi NAB, Oliver LHL and Dasimah O. (2014) Human health and wellbeing: Human health effect of air pollution. Procedia - Social Behavioral Sci. 153: 221-229.

Manisalidis I, Stavropoulou E, Stavropoulos A and Bezirtzoglou E. (2020) Environmental and health impacts of air pollution: A review. Front Public Health 8: 14.

Mark LI and Mallat L. (2018) Health impacts of air pollution. SCOR Paper #42, pp. 1-40.

National Institute of Disaster Management (2023) How air pollution control measures works? Ministry of Home Affairs, Govt. of India. pp. 13.

- NIH (National Institutes of Health) (2020) Air pollution and your health. U. S. Department of Health and Human Services, pp. 1-4.
- Penard, MC and MaesanoI A. (2004) Air pollution: from sources of emissions to health effects. *Breathe* 1(2): 109-119.
- Shaharukh M, Prerana P, Ahmed AY, Prasadkumar T, Ahmad A, Mohd. Razi A, Hifjurrehman S and Asif S. (2020) Impact of air pollution on human health. *Bull Environ Pharmacol Life Sci.* 9(7): 91-97.
- Sharma A. (2020) Types of air pollutants. <https://www.shivajicollege.ac.in/sPanel/uploads/eccontent/781ae1c0a4e8e6d89eb034903a49353e.pdf>
- Shetty SS, Deepthi D, Harshitha S, Sonkusare S, Naik PB, Kumari NS and Madhyastha H. (2023) Environmental pollutants and their effects on human health. *Heliyon* 9(9): e19496.
- Singh AA, Eram R, Agrawal M and Agrawal SB. (2022) Air pollution: sources and its effects on humans and plants. *Int J Environ.* 8(1): 10-24.
- Singh DK. (2023) Measures for air pollution control from industrial activities. Delhi Pollution Control Committee (DPCC), pp. 44.
- The Centre for Ecogenetics and Environmental Health (2012) Fast facts about health effects of air pollution. University of Washington, 5/2012. NIEHS Grant #ESO7033. pp. 1-2.
- Turk YA and Kavraz M. (2011) Air pollutants and its effects on human healthy: The case of the city of Trabzon. doi: 10.5772/20016
- Union Performance Environment Management (2012) Prevention and control of pollution. Union Government Railways, Report No. 21 of 2012-13 (Railways), pp. 8-29.