

Introduction to Air Quality

Introduction to Air Quality

Key concepts, why it matters, and how it's measured

1. What Is Air Quality?

Term	Definition
Air Quality	The condition of the air in terms of its composition, concentration of pollutants, and its suitability for human health, ecosystems, and climate.
Air Quality Index (AQI)	A standardized scale (usually 0-500) that translates complex pollutant measurements into a single number that indicates health risk levels.
Pollutant	Any substance in the air that can cause adverse effects—e.g., gases, particles, or biological materials.

2. Major Air Pollutants

Category	Common Species	Primary Sources	Typical Health/Environmental Impacts
Criteria Gases	- O₃ (ozone) - NO₂ (nitrogen dioxide) - SO₂ (sulfur dioxide) - CO (carbon monoxide)	Vehicle exhaust, power plants, industry, biomass burning	Respiratory irritation, reduced lung function, acid rain (SO₂, NO₂)
Particulate Matter (PM)	- PM₁₀ (>10µm) - PM_{2.5} (<2.5µm)	Combustion, construction dust, agricultural activities, wildfires	Cardiovascular disease, lung inflammation, visibility reduction
Volatile Organic Compounds (VOCs)	Benzene, formaldehyde, toluene	Solvent use, gasoline vapors, industrial processes	Eye/nose irritation, some are carcinogenic

Introduction to Air Quality

Category	Common Species	Primary Sources	Typical Health/Environmental Impacts
Heavy Metals	• Lead (Pb), mercury (Hg), arsenic (As)	• Smelting, waste incineration, coal combustion	• Neurological damage (Pb), bioaccumulation in food webs
Biological Particles	• Pollen, mold spores, bacteria	• Natural vegetation, indoor environments	• Allergic reactions, asthma triggers

3. Why Air Quality Matters

1. Human Health

- Acute effects: coughing, wheezing, eye irritation.
- Chronic effects: asthma, COPD, heart disease, lung cancer, premature death.

2. Ecosystem Health

- Acid deposition damages soils, forests, and aquatic habitats.
- Ozone and nitrogen oxides impair plant photosynthesis.

3. Climate Interaction

- Some pollutants (e.g., black carbon, methane) are short-lived climate forcers.
- Aerosols influence solar radiation and cloud formation.

4. Economic Impact

- Healthcare costs, lost labor productivity, reduced agricultural yields, damage to buildings.
-

4. Measuring Air Quality

4.1 Monitoring Techniques

Technique	What It Measures	Typical Deployment
-----------	------------------	--------------------

Introduction to Air Quality

Ground-based stations	Real-time concentrations of gases, PM, meteorology	Urban networks, regulatory sites
Passive samplers	Integrated (e.g., 1-week) averages of gases	Low-cost, community monitoring
Remote sensing (satellite)	Column densities of NO ₂ , SO ₂ , aerosol optical depth	Large-scale, regional trends
Mobile platforms (cars, drones, backpacks)	High spatial resolution of pollutants	Hot-spot investigations
Low-cost sensors (electrochemical, optical)	Approximate concentrations of CO, O ₃ , PM _{2.5}	Citizen