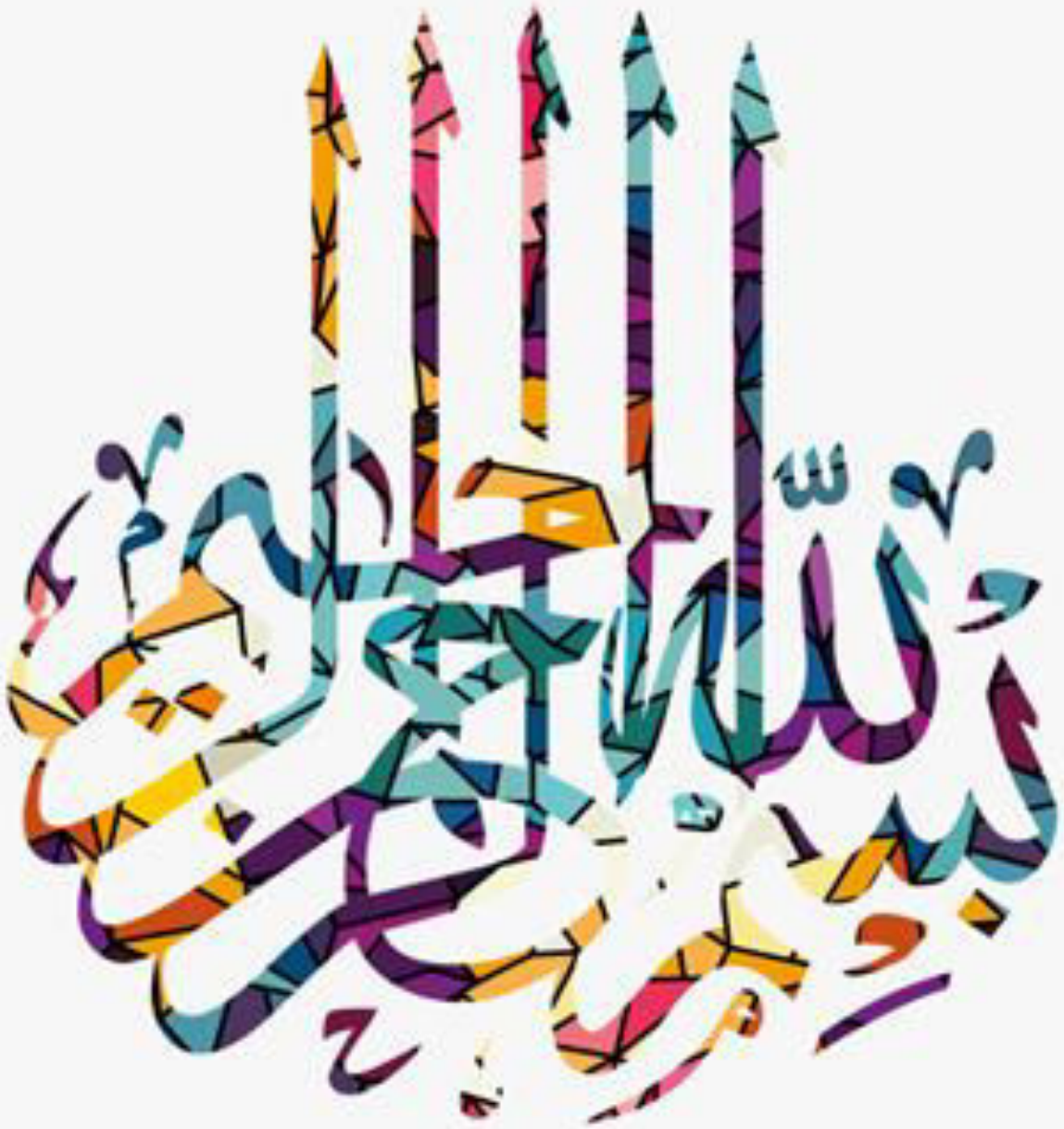
بسم الله الرحمن الرحيم

Air Pollution & Air Quality Management

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Learning objectives

Define	air pollution
Enumerate	types of air pollutants
Enumerate	criteria air pollutants
Describe	the sources and limits of air pollutants
Describe	the adverse effects of air pollutants on health
Explain	the measures for control of air pollution
Describe	the global adverse effects of air pollution- ozone depletion, greenhouse effect, smog, acid rain

Air Pollution

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.

Types of Air Pollutants

- **Primary air pollutant:** harmful substance that is emitted directly into the atmosphere. *Examples are particulates, carbon monoxide, nitrogen oxide, and sulfur oxide.*
- **Secondary Air Pollutant:** harmful substance formed in the atmosphere when a primary air pollutant reacts with substances normally found in the atmosphere or with other air pollutants. *Examples are ozone and secondary organic aerosol (haze).*

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- **Particulates:** are small pieces of solid material dispersed into the atmosphere e.g. smoke particles from fires, bits of asbestos & ash, aerosol, mist, dust, fumes, fog & smog.

Criteria Air Pollutants

Six common air pollutants (also known as “criteria air pollutants") can harm our health and the environment. These are:

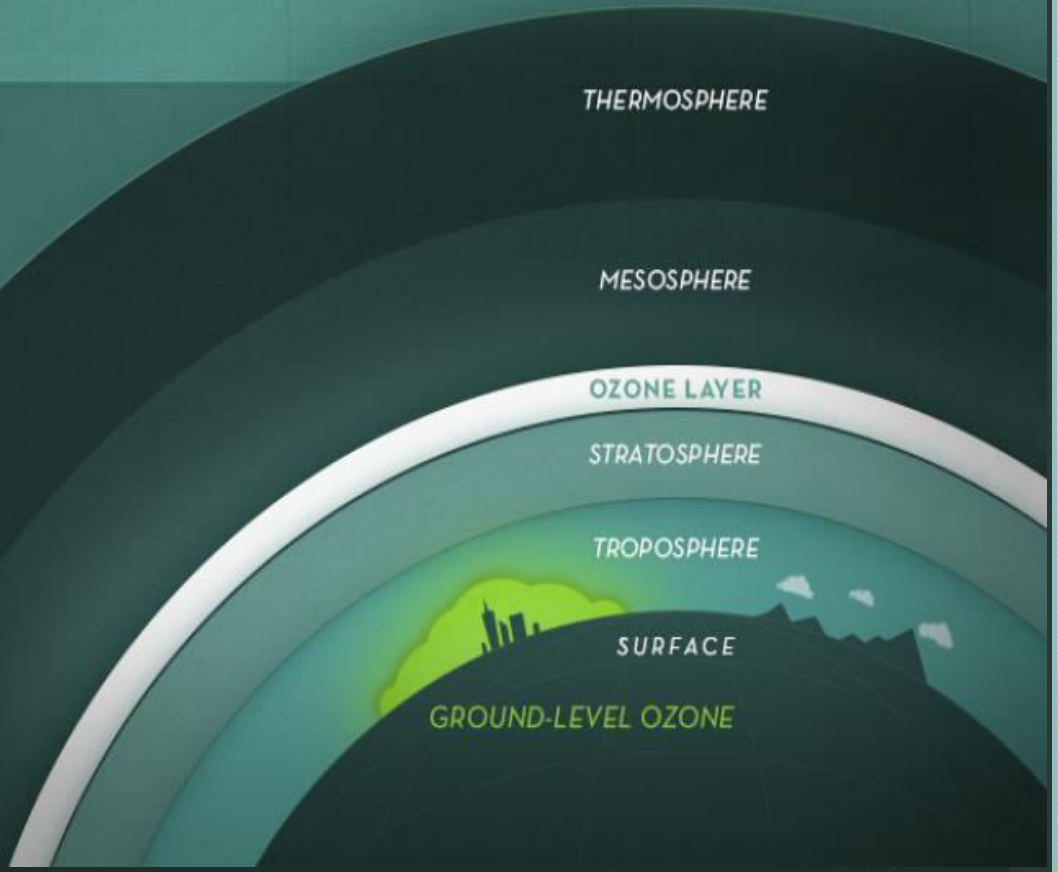
- carbon monoxide
- lead
- ground-level ozone
- particulate matter
- nitrogen dioxide
- sulfur dioxide

I THOUGHT **OZONE** WAS A **GOOD THING?**

It is – when it's in the upper atmosphere. Ozone (abbreviated O_3) is a colorless, odorless gas composed of three atoms of oxygen.

Ozone occurs naturally in the upper atmosphere, shielding the earth's surface from the sun's harmful ultraviolet rays.

However, when ozone forms closer to the ground, in the troposphere, it can cause big problems.



Sources of Air Pollution

Undesirable materials can be emitted to the atmosphere from either **natural** or **human** sources. The air pollution caused by nature is generally small, compared to anthropogenic pollution.

Natural Sources of Air Pollution

- Some of the natural sources of air pollution are organic compounds from plants, sea salt, suspended soils and dusts (e.g. from the Sahara).
- Other natural sources are released during catastrophes such as volcanic eruptions and forest fires. Large amounts of harmful gases and smoke are released which can increase background pollution levels for years - even in areas far away from the original source. Radon, fog & mist, and ozone are the most common natural air pollutants.

Man-Made Sources of Air Pollution

Can be divided into 3 groups:

1. Point sources: Industries, power plants, oil refineries
2. Area sources: Residential areas, apartments, office buildings, hospitals, & schools
3. Line sources: Highways (motor vehicles, transportation services)

Effects of Air Pollution

1. **Effects on human health**
   - Irritation of the respiratory tract and eyes
   - Pb particulate cause convulsions, coma & even death
   - Pollens can initiate asthmatic attack
   - Hg results in kidney, nerve & brain damage
   - Carbon particulates through cigarette smoking cause CVDs, kidney, lung & liver damage & even death

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2. Effects on plants

- SO_2 bleaches the leaf surface and causes chlorosis
- NO_2 causes premature leaf fall
- O_3 causes necrosis & damage leaves
- PAN (peroxy acetyl nitrate) is responsible for suppressed growth, silvering of lower leaf surface
- Ethylene induces leaf abscission, leaf epinasty

3. Effect on climate

- Increase of CO_2
- Global warming
- Melting of ice, glaciers
- Thinning of ozone layer
- Penetration of UV rays
- Acid rain

- **4. Effects on aquatic life**
- Air pollutants mixing up with rain can cause high acidity (lower pH) in fresh water lakes. This effects aquatic life especially fish.
- **5. Effect on materials**
- Because of their corrosiveness, particulates can cause damage to exposed surfaces. Presence of SO_2 moisture can accelerate corrosion of metallic surfaces. SO_2 can affect fabric, leather, paint, paper, marble & limestone. Ozone in the atmosphere can cause cracking of rubber. Oxides of nitrogen can also cause fading of acetate, cotton and rayon fibres.

Prevention & Control of Air Pollution

1. **Methods of controlling gaseous pollutants**

Air pollution caused by hydrocarbons, SO_2, NH_3, CO etc. can be controlled by 3 different methods– *Combustion, Absorption & Adsorption*

1. **Methods of controlling particulate emissions**

PM like dust, soot, ash, etc. can be controlled by using *mechanical devices, fabric filters, wet scrubbers & electrostatic precipitators*

- **Combustion:** this technique is applied when the pollutants are organic gases or vapours. The organic air pollutants are subjected to ‘flame combustion or catalytic combustion’ when they are converted to less harmful product ‘CO_2’ & a harmless product ‘H_2O’

- **Absorption:** The polluted air containing gaseous pollutants is passed through a scrubber containing a suitable liquid absorbent, which absorbs the harmful gases.

- **Adsorption:** The polluted air is passed through porous solid adsorbents kept in suitable containers. The gaseous pollutants are adsorbed at the surface of the porous solid & clean air passes through.

- **Mechanical devices:** works on the basis of following:
  - Gravity: particulates settle down by the action of gravitational force & get removed.
  - Sudden change in the direction of air flow: brings about separation of particles due to greater momentum
- **Fabric filters:** a porous medium made of woven or filled fabrics. The particulate present in the polluted air are filtered & gets collected in the fabric filters, while the gases are discharged. The process of controlling air pollution by using fabric filters is called ‘bag filtration’.
- **Wet scrubbers:** are used to trap SO_2, NH_3 & metal fumes by passing the fumes through water.
- **Electrostatic precipitators:** induce electric charge on the particles & then the aerosol particles get precipitated on the electrodes.

Indoor Air-Specific Recommendations

- Investigate effective interventions & implementation methods for sustainable & financially viable changes to reduce indoor air pollution.
- Encourage the substitution of solid fuels in the home by cleaner & more efficient fuels & technology.
- Encourage the use of improved stoves to lower pollution levels in poor rural communities where access to alternative fuels is limited & biomass remains the most practical fuel.
- Improve ventilation homes, schools & work paces

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- Change user behavior (e.g. drying wood before use).
- Prevent & remediate problems related to dampness & mould in housing to decrease the risk of exposure to hazardous microbes.
- Eliminate or reduce tobacco smoking indoors.
- Prohibit smoking in public buildings.
- Promote risk reduction strategies for indoor radon exposure.
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Outdoor Air-Specific Recommendations

- Encourage technological innovation to decrease emissions from stationary sources & conventional vehicles, and investigate alternative fuels.
- Implement control mechanisms (e.g. emission inspections).
- Integrate environmental & health considerations in urban planning. Including locating offices and commercial spaces in areas convenient for pedestrians and bicyclists in order to reduce the need for motorized transport, preventing traffic congestion, creating green areas, separating pedestrians and bicyclists from road traffic etc.

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- Focus on transportation systems that provide an alternative to cars and diesel buses, including rail, electric or alternative fuel-powered buses & cycling or walking networks.
- Promote the use of clean, renewable energy sources, such as solar and wind-powered energy, and encourage the movement away from dirtier fuels, such as coal.
- Monitor air quality.
- Inform the public of effective pollution reduction activities and associated health benefits.

- **Biofuels:** Fuels made from cellulosic biomass resources. Biofuels include ethanol, biodiesel & methanol. Replacing fossil fuels with biofuels for energy production could bring environmental & health benefits by lowering greenhouse gas emissions.

- **Carbon sink:** It is the natural mechanism that removes CO_2 from the atmosphere, such as the absorption of CO_2 by growing trees and /or protecting existing forests.

Anthropogenic Climate Change

Human induced climate change as a result of fossil fuel burning for energy, deforestation and land use changes that result in net increase in greenhouse gases or emissions.

Ozone Depletion

Gradual thinning of Earth's ozone layer in the upper atmosphere caused by the release of chemical compounds containing gaseous chlorine or bromine from industry and other human activities. The thinning is most pronounced in the polar regions, especially over Antarctica. Ozone depletion is a major environmental problem because it increases the amount of ultraviolet (UV) radiation that reaches Earth's surface, which increases the rate of skin cancer, eye cataracts, and genetic and immune system damage.

Greenhouse Effect

Human activities contribute to global warming by increasing the greenhouse effect. The greenhouse effect happens when certain gases—known as greenhouse gases—collect in Earth's atmosphere. These gases, which occur naturally in the atmosphere, include carbon dioxide, methane, nitrogen oxide, and fluorinated gases sometimes known as chlorofluorocarbons (CFCs).

Smog

Smog is a specific type of air pollution. It is a combination of harmful pollutants (often appearing relatively low to the ground as a yellow-brown haze) that are introduced into the atmosphere by both natural and human induced processes. It was first described over 5 decades ago as a mixture of smoke and fog, hence the name "smog"—but today it has a more specific definition and composition.

Smog is made up of many chemicals including NO_2, SO_2, CO, and volatile organic compounds (VOCs), but the two main components of smog are particulate matter (PM) and ground-level ozone (O_3).

Acid Rain

Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.

Acid rain results when SO_2 and nitrogen oxides (NO_X) are emitted into the atmosphere and transported by wind and air currents. The SO_2 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.

Intergovernmental Panel on Climate Change (IPCC)

A group of experts established in 1988 by the World Meteorological Organization (WMO) & the UN Environment program (UNEP). Its role is to assess the scientific, technical & socio-economic information relevant for the understanding of the risk of human-induced climate change, based mainly on peer reviewed & published scientific/technical literature.

UN Framework Convention on Climate Change (UNFCCC)

Convention signed at United Nations conference on Environment & Development in 1992. governments that become parties to the Convention agree to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

References

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