

Air, Ventilation and Housing, Climate change and global warming

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Air

- Air is a mechanical mixture of gases.
- The normal composition of air:
 - Nitrogen- 78.1%
 - Oxygen- 20.93%
 - Carbon dioxide- 0.03%
 - Others- 0.94%

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Sources of impurities of air

- Air is rendered impure by-
 - Respiration of men and animals
 - Combustion of coal, gas, oil etc.
 - Decomposition of organic matter
 - Trade, traffic and manufacturing processes which give off dust, fuels, vapours and gases.

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Air quality of an occupied room

- Changes in air that occur in an occupied room are as follows:
 - a. Physical changes:
 - Rise in indoor temperature due to body heat emanation
 - Increase in relative humidity due to moisture evaporation from skin and lungs
 - Decrease in natural movement of air due to crowding
 - Unpleasant odour arising from perspiration and poor personal hygiene

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Air quality of an occupied room

b. Chemical changes:

- Increase in CO₂ and decrease in O₂ due to metabolic processes

c. Biological changes:

- Pathological microorganisms are discharged into air during talking, coughing, laughing, sneezing etc.
- These are primarily saprophytic and pathogenic bacteria

Indices of thermal comfort

- **Air temperature**
- **Air temperature and humidity**
- **Cooling power:** Air temperature, humidity and air movement. Hill's Kata thermometer is used to measure cooling power.
- **Effective temperature**
- **Corrected effective temperature**
- **McArdle's maximum allowable sweat rate:** Predicted four hour sweat rate (P₄SR)

Comfort zone

- **Comfort zone** may be defined as the range of **effective temperature** at which majority of adults feel comfortable.
- Comfortable thermal conditions are those under which a person can maintain a balance between production and loss of heat at normal body temperature and without sweating.

Pleasant and cool	69°F	20°C	Hot and uncomfortable	81-82°F	27-28°C
Comfortable and cool	69-72°F	20-25°C	Extremely hot	83°F+	28°C+
Comfortable	77-80°F	25-27°C	Intolerably hot	86°F+	30°C+

Sources of air pollution (PARK)

- a. **Automobiles:** Motor vehicles emit hydrocarbons, CO, lead, NO_x and particulate matters (PM)
- b. **Industries:** Produce smoke, sulfur dioxide, NO_x and fly ash.
- c. **Domestic sources:** Domestic combustion of coal, wood or oil produce smoke, sulfur dioxide, NO_x and dust.
- d. **Tobacco smoke:** Both active and passive smoking
- e. **Miscellaneous:** Comprises burning refuse, incinerators, pesticide spraying, natural source and nuclear energy programs

Sources of air pollution (RKH)

- a. **Pollution by natural phenomenon:** Volcano eruption, forest fires, radioactive substances in the nature, UV rays, microbes, mould and spores.
- b. **Pollution by products of combustion:** Coal and petroleum products containing sulfur, fossil fuel containing carbon and hydrogen, natural gas burnt for any purposes.
- c. **Pollution by industrial waste:** Dust, fumes and other wastes from factories, mills, power plants, mines, refineries, cement plants, industrial incinerators, chemical and fertilizer industries etc.

Sources of air pollution (RKH)

- d. **Pollution by internal combustion:** Various types of engine. Motor vehicles, trucks, trains, aircrafts and other forms of transports pollute air by emitting hydrocarbons, CO₂, CO, lead, Oxides etc.
- e. **Photochemical pollution:** Volatile hydrocarbons and oxides of nitrogen produce ozone and many complex organic compounds in the presence of sunlight.
- f. **Acid rain:** Sulfuric and nitric oxides in urban and industrial cities.
- g. **Miscellaneous:** Burning of refuse, agricultural burning, crop spraying, pest control and nuclear energy programs.

Major sources of air pollution in Bangladesh



Source: Bangladesh National Air Quality Management Plan 2024-2030; DoE, MoEFCC, Bangladesh

Air pollutants

- More than 100 air pollutants have been identified.
- **Gaseous pollutants:** Oxides of carbon, sulfur and nitrogen; Hydrogen sulfide and organic sulfides; Fluorine compounds; Ammonia, Aldehydes; Carcinogens
- **Particulate matters:** Dusts, fumes, mists and smokes. Mineral dusts include coal, cement, asbestos, limestone; Metal dusts include zinc, copper, iron, lead; Acid mists include sulfuric acid, fluorides, paint pigments, pesticides, carbon black, tobacco smoke and oil smoke.

Air pollutants

• Primary air pollutants:

- Those that are emitted into the atmosphere from a source such as a factory chimney or exhaust pipe, or through suspension of contaminated dusts by the wind. e.g. **CO**, **SO₂**, **NO_x**, **PM** etc.

• Secondary air pollutants:

- Secondary air pollutants are those formed within the atmosphere itself.
- These arise from chemical reactions of primary pollutants with oxygen and water. e.g. **O₃**, **acid rain**, **photochemical smog** etc.

Criteria air pollutants

- Six pollutants are termed as the criteria air pollutants for their abundance as pollutants in the atmosphere and ability to harm human health, plants and properties. These are-

- **Particulate matters (PM_{2.5} and PM₁₀)**
- **Sulfur dioxide (SO₂)**
- **Nitrogen oxides (NO_x)**
- **Carbon monoxide (CO)**
- **Ozone (O₃)**
- **Lead (Pb)**

Criteria air pollutants

PM₁₀	Worsening of respiratory diseases including asthma and COPD
PM_{2.5}	Acute and chronic bronchitis, asthma attacks, respiratory symptoms
SO₂	Corrosive and severe irritant. Causes respiratory paralysis and pulmonary edema
NO_x	Collapse, rapid burning and tissue swelling in the throat and upper respiratory tract, difficult breathing, throat spasm, lung edema
O₃	Damage to lung tissue, worsening of asthma, eye irritation, chest pain, coughing, nausea, headache and chest congestion
CO	Hemoglobin saturated with CO prevents oxygen delivery to cells may even cause death. May cause headache, fatigue, dizziness.

Air quality index (AQI) for Bangladesh

AQI value	Status	Colour
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for sensitive groups	Orange
151-200	Unhealthy	Red
201-300	Very unhealthy	Purple
300-500	Hazardous	Maroon

Indicators of air pollution

- Sulphur dioxide gas
- Smoke or soiling index
- Grit and dust measurement
- Coefficient of haze
- Air pollution index
- Suspended materials

Effects of air pollution

- **Effects on health:**
 - a. Immediate effects: Respiratory illness, increased mortality and morbidity
 - b. Delayed effects: Chronic bronchitis, emphysema, asthma, respiratory allergies and lung cancer.
- **Effects on visibility**
- **Effects on other areas:**
 - a. Effects on plants and animals
 - b. Effects on social and economic life

Air-borne diseases

- a. **Droplet infection and droplet nuclei:**
 - Mainly respiratory diseases like tuberculosis, diphtheria, pertussis, pneumonia, influenza, measles, mumps, chicken pox, monkey pox, Covid-19, streptococcal sore throat etc.
 - Skin diseases through direct contact and contagious diseases might occur if air is polluted
- b. **Inhalation of air pollutants:**
 - Pneumoconiosis like silicosis, asbestosis and anthracosis, chronic bronchitis, emphysema, bronchial asthma, lung carcinoma, lead poisoning etc.

Air pollution control (PARK)

- The WHO has recommended the following procedures for the prevention and control of air pollution:
 - **Containment:** Enclosure, ventilation and air cleaning
 - **Replacement:** Using green energy
 - **Dilution:** Establishment of 'Green belts'
 - **Legislation:** Environment Conservation Act 1995, Bangladesh; Air Pollution Control Rules 2022, Bangladesh
 - **International action**

Air pollution control (RKH)

- a. Land use planning:** To reduce the impact of pollution-
- Industries should be placed distant from human habitation
 - Zoning of industries
 - Green belt between industries and residential areas
 - Planned waste disposal
 - Reservation of parks and open spaces

Air pollution control (RKH)

- b. Control of the source:** This can be achieved by-
- Containment: Prevention of escape of toxic substance into the air
 - Substitution: Substitution of more toxic by less toxic solvents
 - Modification or change of the industrial processes
 - Adequate housekeeping and storage
 - Maintenance of internal combustion engines
 - Work practices
 - Atmospheric dispersion

Air pollution control (RKH)

- c. Green plantation:** Encouraging “green city, clean city”
- d. Other practical measures:**
- Enforcing proper maintenance of motor vehicle
 - Cautious use of insecticides/pesticides
 - Control of dusts by spraying water
 - Health education regarding harmful effects of air pollution
- e. Control of odours**
- f. Legislation**
- g. International action**

Disinfection of air

- The methods of disinfection of air are:
 - **Mechanical ventilation**
 - **Ultraviolet radiation**
 - **Chemical mists**
 - **Dust control**

Standards of ventilation

- **Cubic space:** A space of **300-3000 cft. per person** is sufficient
- **Air change:** In living room there should be **2-3 air changes** per hour and in work room and assemblies **4-6 air change** per hour
- **Floor space:** Optimum floor space is **50-100 sq. ft.** per person

Residential	5 sq.m. per person
Factory	5 sq.m. per person
General hospital	10 sq.m. per person
Infectious disease hospital	15 sq.m. per person
School	0.8 sq.m. per child

Types of ventilation

- **Natural ventilation:**
 - **Wind**
 - **Diffusion**
 - **Inequality of temperature** (Temperature difference)
- **Mechanical ventilation:**
 - **Exhaust ventilation:** Air is extracted or exhausted outside
 - **Plenum ventilation:** Fresh air is blown into room
 - **Balanced ventilation:** Combination of above two
 - **Air conditioning:** Simultaneous control of at least temperature, humidity and air movement

Effects of ill-ventilation

- The effects of ill-ventilation or overcrowding room are:
 - **Rise in room temperature**
 - **Increase in humidity**
 - **Unpleasant body odour**
 - **Increased bacterial pollution**
- **These factors may cause-** headache, drowsiness, lassitude, inability to concentrate, depression, feeling of fatigue, increased chances of contracting communicable diseases.

Examination of room for effective ventilation

- **Odour** of the room
- Adequate **open space** for cross ventilation
- **Types of ventilation** in operation
- Velocity of air or **air movement**
- **Comfort level** by Kata thermometer
- Available **floor space** per person
- Examination of the air for **temperature, humidity, percentage of CO₂ and bacterial pollution**

Housing

- Housing in the modern concept includes **not only the physical structure** providing shelter, but also the **immediate surroundings and the related community services and facilities**.
- It has become the **part of human settlement** which is defined as **all places** in which a group of **people reside and pursue their life goals**.
- A WHO expert group on public health aspects of housing prefers to use the term **“residential environment”** which is defined as the physical structure that man uses and the environs of the structure desired for the physical and mental health and social well-being of the family and the individuals.

Social goals of housing

- **Shelter**
- **Family life**
- **Access to community facilities**
- **Family participation in community life**
- **Economic stability**

Criteria for healthful housing

- An expert committee of the WHO recommends following criteria for healthful housing:
 - Provides **physical protection and shelter**
 - Provides adequately for **cooking, eating, washing, and excretory functions**
 - Is designed, constructed, maintained and used in a manner such as **to prevent the spread of communicable diseases**
 - Provides for **protection from** hazards of exposure to **noise and pollution**

Criteria for healthful housing

- Is **free from unsafe physical arrangements** due to construction or maintenance, and from toxic or harmful materials
- Encourages **personal and community development**, promotes **social relationships**, reflects a regard for ecological principles and by these means **promotes mental health**

Housing standards

• Site:

- Should be **elevated** from surroundings
- Should have **an access to a street** of adequate width
- Should be **away from breeding places** of mosquitoes and insects
- Should be **away from nuisances** i.e. dust, smoke, smell, excessive noise and traffic
- Should be in **pleasant surroundings**
- The soil should be **dry and safe**
- The **subsoil water** should be below **10 feet (3 meters)**

Housing standards

• Set back:

- For proper lighting and ventilation, there should be an open space all around the house- this is called **"set back"**

• Floor:

- Should be **pucca**
- Should be **impermeable** so that can be easily washed and dried
- Must be **smooth and free from cracks and crevices**
- Should be **damp proof**
- The height of the **plinth should be 2-3 feet**

Housing standards

• Walls:

- Should be reasonably **strong**
- Should have a **low heat capacity**
- Should be **weather resistant**
- Unsuitable for harborage of rats and vermin
- Should not easily damaged
- Should be **smooth**
- **9-inch brick-wall** plastered smooth and colored cream or white

Housing standards

• Roof:

- Height should **not be less than 10 feet**

• Rooms:

- Living room should **not be less than two.**

• Floor area:

- A living room should be **at least 120 sq.ft.** for more than 1 person and **100 sq.ft. for one person.**
- Per person not less than **50 sq.ft.**, the optimum is **100 sq.ft.**

Housing standards

- **Cubic space:**
 - At least **500 c.ft. per capita**, preferably **1000 c.ft.**
- **Windows:**
 - Every room should have **at least 2 windows**
 - Windows should be placed at a **height not less than 3 feet**
- **Must have a separate kitchen**
- **A sanitary privy is a must in every house**
- **Should have a safe and adequate water supply**

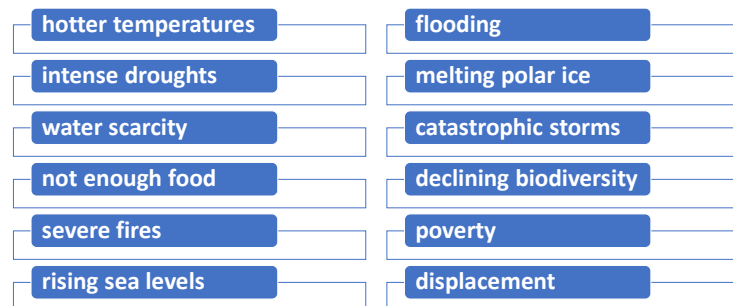
Effects of poor housing condition

- **Respiratory infections:** Common cold, TB, influenza, diphtheria, bronchitis, measles, pertussis etc.
- **Skin infections:** Scabies, ringworm, impetigo, leprosy
- **Rat infestation:** Plague
- **Arthropod-borne diseases:** By houseflies, mosquitoes, fleas and bugs
- **Accidents:** Due to defect in the house
- **High morbidity and mortality**
- **Psychological effects:** The sense of isolation felt by persons living in the upper floors of high-rise building

Climate change

- Climate change refers to **long-term shifts** in temperatures and weather patterns.
- Such shifts can be **natural**, due to changes in the sun's activity or large volcanic eruptions.
- But since the 1800s, **human activities** have been the main driver of climate change, primarily due to the **burning of fossil fuels like coal, oil and gas** in generating power, manufacturing goods, using transportation, producing food, powering buildings. Besides cutting down forests is also responsible for this.

Consequences of climate change

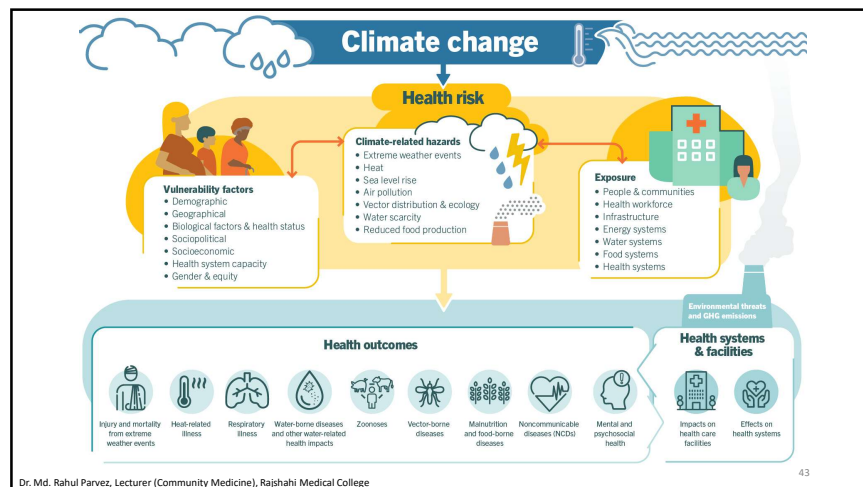


Effects of climate change on human health

Acute effects	Natural disasters and extreme events
	Direct: traumatic deaths and injuries, mental illness
	Indirect: pollution, infections, mental illness
	Droughts
	Direct: malnutrition, under-nutrition, impaired childhood development
	Indirect: civil violence
	Heat waves
	Complications for chronically ill patients

Effects of climate change on human health

Chronic effects	Reduced availability of water
	Conflicts
	Drying up the soil, alterations and shrinking arable land
	Malnutrition
	Pollution
	Chronic illness, toxic substances in the food chain
	Habitats suitable to pathogens
	Water-borne diseases, vector-borne diseases



Climate change: Solution

- Climate change is a huge challenge, but we already know many solutions – such as **renewable energy** like wind and solar power.
- These can deliver economic benefits while improving our lives and protecting the environment.
- We also have global agreements to guide progress, such as the UN Framework Convention on Climate Change and the Paris Agreement.
- Three broad categories of action are: **cut emissions, adapt to climate impacts and finance required adjustments.**

Climate change: Solution

- Switching energy systems from fossil fuels to renewables like wind and solar will reduce the emissions driving climate change.
- But we have to start right now.
- While a growing coalition of countries is committing to **net zero emissions by 2050**, about half of emissions cuts must be in place by 2030 to keep warming below **1.5°C**.

Green house gases

- The following seven types of greenhouse gases are covered by the **Kyoto Protocol and the Paris Agreement**, which aim to coordinate the global response to climate change:
 1. **Carbon dioxide:** CO₂ is naturally produced by animals during respiration and through the decay of biomass. It also enters the atmosphere through burning fossil fuels and chemical reactions.
 2. **Methane:** Methane is a colourless gas, which is the main constituent of natural gas. Its emissions result from the production and transport of coal, natural gas and oil, livestock and other agricultural practices, land use and by the decay of organic waste in municipal solid waste landfills.

Green house gases

3. **Nitrous oxide:** This gas is mainly produced as a result of microbial action in the soil, the use of fertilizers containing nitrogen, the burning of timber and in chemical production. It is emitted in agricultural and industrial activities as well as in land use; the combustion of fossil fuels and solid waste; and the treatment of wastewater.
4. **Hydrofluorocarbons:** They are mainly used to absorb heat in refrigerators, freezers, air conditioners and heat pumps; as propellants in asthma sprays and technical aerosol spray cans; as blowing agents for foams and in fire extinguishers.

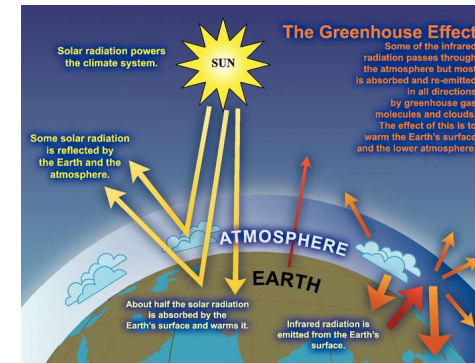
Green house gases

5. **Perfluorocarbons:** Perfluorocarbons are man-made compounds commonly used in industrial manufacturing processes.
6. **Sulphur hexafluoride:** Sulphur hexafluoride is commonly used in the insulation of power lines.
7. **Nitrogen trifluoride:** Nitrogen trifluoride is used as a chamber-cleaning gas in production processes to clean unwanted build-ups on microprocessor and circuit parts as they are being constructed.

Green house gases

- **Carbon dioxide and methane** are the main greenhouse gases that are causing climate change.
- These **emissions come from burning fossil** fuels such as gasoline when driving a car or coal when heating a building.
- **Energy, industry, agriculture and waste disposal** are among the major greenhouse gas emitters.
- The G20, the group of the **world's largest 20 economies**, is responsible for **about 77 per cent** of global greenhouse gas emissions.

Green house effect



Global warming

- **Increasing greenhouse gas emissions** from human activity act like a blanket wrapped around the earth, trapping the sun's heat and raising temperatures. This is called global warming.
- Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years.
- The Earth is **now about 1.42°C warmer than it was in the pre-industrial era (1850-1900)**.
- **2024 was the warmest year** on record, with the global average near-surface temperature 1.55°C above the pre-industrial baseline.
- **2015-2024** was the **warmest recorded decade**.

Global warming

- Temperatures for any single month or year fluctuate due to natural variability, **including El Niño/La Niña and volcanic eruptions**.
- Consequently, long-term temperature changes are typically considered on **decadal timescales**.
- About **90 per cent of the excess heat** from global warming is stored in the ocean, making ocean heat content a critical indicator of climate change.
- Today, the ocean is the warmest it has ever been as recorded by humans, not only at the surface but also for the **upper 2000 meters**.

Global warming

- Glaciers around the world thinned by an average of one meter per year and sea level rose at a rate of **4.7mm per year between 2015 and 2024**.
- **Greenland and Antarctica lost 38 per cent** more ice during the period 2011-2020 than during 2001- 2010.

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