

# introduction

- Air is essential for life it self, without it we could survive only a few minutes.
- It constitutes immediate physical environment of living organisms
- The atmosphere is layered in to four distinct which are: Troposphere, stratosphere, mesosphere, and thermosphere.

# Normal components of our atmosphere

- ❑ **Nitrogen - 78.1%**
- ❑ **Oxygen - 20.9%**
- ❑ **Carbon dioxide - 0.03%**
- ❑ **Everything else - 0.07%**
  - noble gases (krypton, xenon, argon, helium)
  - methane
  - sulfur dioxide

# What is air Pollution?

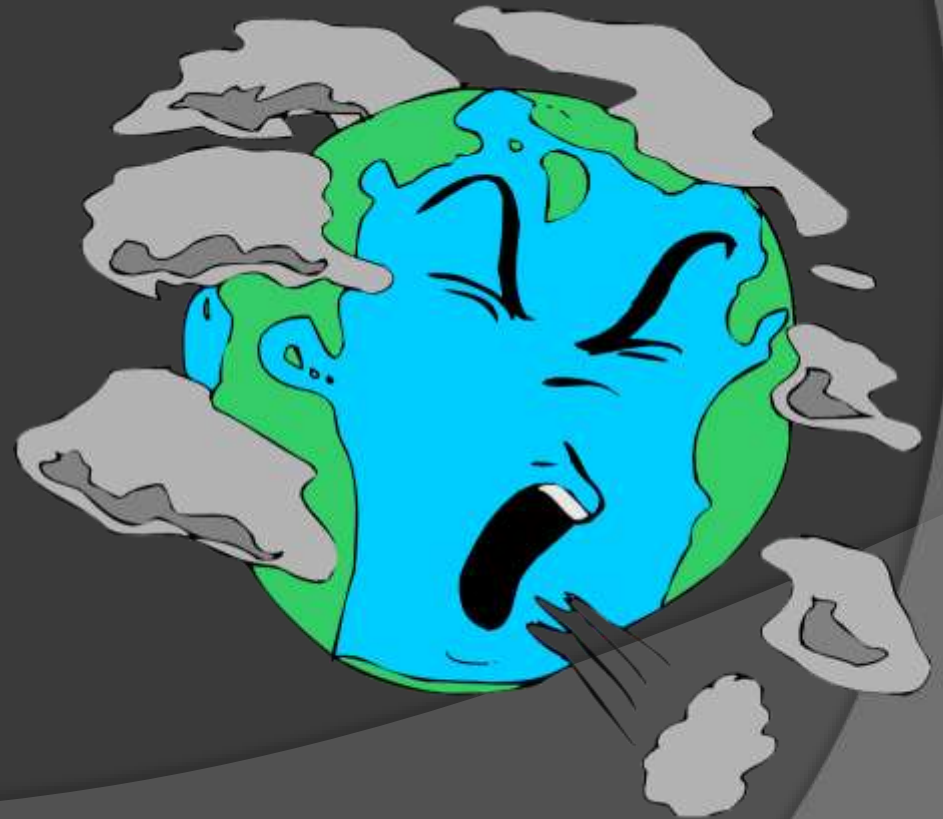
Air pollution consists of gases, liquids, or solids present in the atmosphere in high enough levels to harm humans, other organisms, or materials



# Cont....

- may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and his environment.

- Any visible or invisible particle or gas found in the air that is not part of the original, normal composition.



# What is air Pollution?

- Air pollutants may be either emitted into the atmosphere or formed within atmosphere itself:

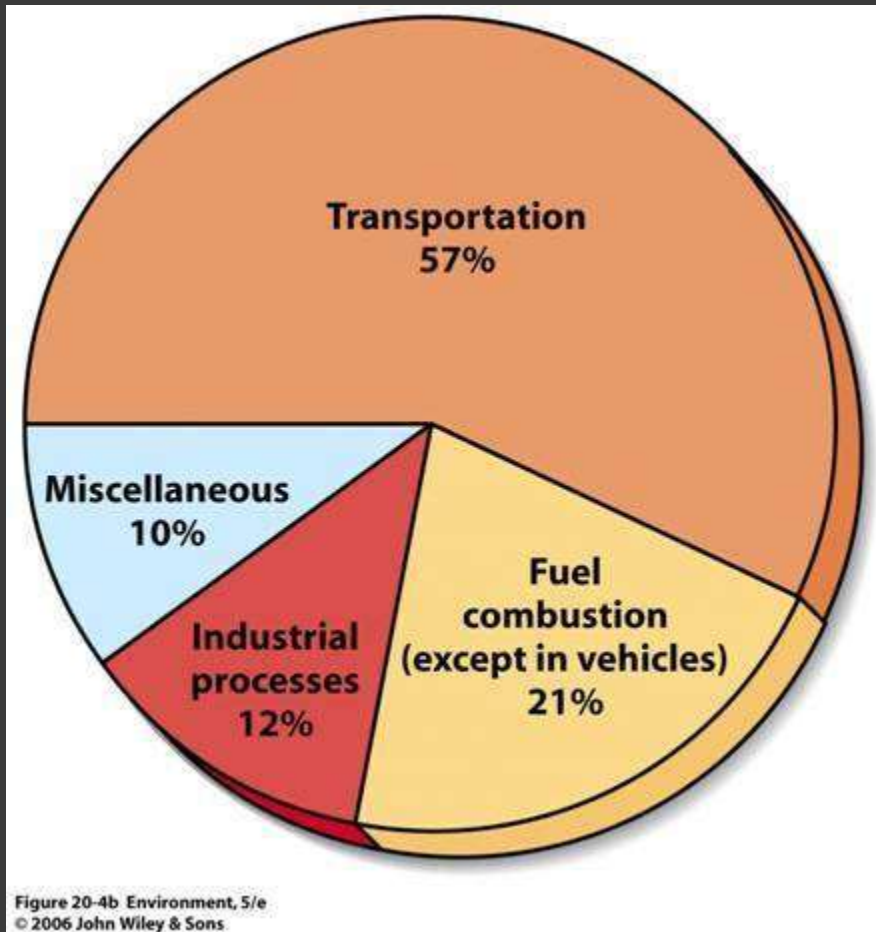
- Primary air pollutants:

Sources such as factory chimneys or exhaust pipe.

- Secondary air pollutants:

Ex ozone.

# Sources of Primary Air Pollutants



# The main sources of air pollution are:

## (a) AUTOMOBILES:

- ⦿ Motor vehicles are a **major source** of air pollution throughout the urban areas.
- ⦿ They emit hydrocarbons, carbon monoxide, lead, nitrogen oxides and particulate matter.
- ⦿ In strong sunlight, certain of these hydrocarbons and oxides of nitrogen may be converted in the atmosphere into "photochemical" pollutants of oxidizing nature.



# The main sources of air pollution are:

- In addition, diesel engines, when misused or badly adjusted are capable of emitting black smoke and malodorous, fumes.

# The main sources of air pollution are:

## (b) INDUSTRIES:

- ⦿ Combustion of fuel to generate heat and power produces smoke, sulphur dioxide, nitrogen oxides and fly ash.
- ⦿ Petrochemical industries generate hydrogen fluoride, hydrochloric acid and organic halides.

# The main sources of air pollution are:

- Many industries discharge carbon monoxide, carbon dioxide, ozone, hydrogen sulphide and sulphur dioxide.
- Industries discharge their wastes from high chimneys at high temperature and high speed.

# The main sources of air pollution are:

## (c) DOMESTIC SOURCES :

- ⦿ Domestic combustion of coal, wood or oil is a major source of smoke, dust, sulphur dioxide and nitrogen oxides.

## (d) tobacco smoke:

- ⦿ The most direct and important source of air pollution affecting the health of many people .
- ⦿ Even those who do not smoke may inhale the smoke produced by others ("passive smoking").

# The main sources of air pollution are:

## (e) MISCELLANEOUS:

- These comprise burning refuse, incinerators, pesticide spraying, natural sources (e.g., wind borne dust, fungi, molds, bacteria) and nuclear energy programmes.

All these contribute to air pollution.

# NOTE...


- ⦿ Although the Earth's atmosphere extends to several layers above the surface, it is only the **first 30 km** that hold the major portion of the atmospheric gases.
- ⦿ Man is most directly concerned with only the **8-10 km** of the atmosphere.
- ⦿ The level of atmospheric pollution at anyone time depends **upon meteorological factors, e.g., topography, air movement and climate.**
- ⦿ Winds help in the dispersal and dilution of pollutants.
- ⦿ If the topography is dominated by mountains (or tall buildings) the winds become weak and calm, and pollutants tend to concentrate in the breathing zone.

# NOTE...

- ① The vertical diffusion of pollutants depends upon the temperature gradient.
- ① When there is a rapid cooling of lower layers of air (temperature inversion), there is little vertical motion and the pollutants and water vapours remain trapped at the lower levels and the result is "smog".
- ① The "temperature inversion "which is more frequent in the winter months than in spring or summer, is a threat to human health.



## 5 Major Pollutants:

- 1.) Carbon Monoxide
  - 2.) Sulfur Dioxide
  - 3.) Nitrogen Dioxide
  - 4.) Particulate Matter
  - 5.) Ground Level Ozone
- 



# (1) Carbon monoxide

- ⦿ It is colorless , odorless gas , a product of incomplete combustion of carbon containing materials, such as in in automobiles, industrial process, heating facilities and incinerators
- ⦿ Some widespread natural non biological and biological sources have also been identified.
- ⦿ Concentrations in urban areas depend on weather and traffic density.

# Effect of CO pollution on the health:

- It causes harmful effect by reducing oxygen delivery to body organ , in extremely high level it can cause death.
- CO's affinity for Hb is 240–270 times greater than oxygen and Fetal Hb has higher affinity for CO , so it competes with O<sub>2</sub> to bind (irreversibly) with haemoglobin.

# Effect of CO pollution on the health:

- By this exposure to it reduce the oxygen-carrying capacity of the blood to the heart, brain and other organs .
- deprives body of O<sub>2</sub> causing headaches, fatigue, MI and impaired vision.

## (2) Sulphur dioxide

- It is one of the several forms in which sulphur exists in air.
- The others include  $\text{H}_2\text{S}$ ,  $\text{H}_2\text{SO}_4$  and sulphate salts.
- Sulphur dioxide results from the combustion of sulphur containing fossil fuel, and when coal and fuel oil are burned.
- Domestic fires can also produce emissions containing sulphur dioxide.
- Acid aerosol - sulphuric acid ( $\text{H}_2\text{SO}_4$ ) is a strong acid that is formed from the reaction of sulphur trioxide gas ( $\text{SO}_3$ ) with water.

# (3) Nitrogen Dioxide

- Nitric oxide (NO) is produced by combustion.
- Nitrogen dioxide (NO<sub>2</sub>), which has greater health effects, is a **secondary pollutant created by the oxidation of NO under conditions of sunlight**, or may be formed directly by higher temperature
- combustion in power plants or indoors from gas stoves.

# (3) Nitrogen Dioxide

- reddish, brown gas present in car exhaust and power plants.
- ⦿ Levels of exposure to nitrogen dioxide that should not be exceeded (WHO guideline levels) are respectively 400  $\mu\text{g}/\text{m}^3$  (0.21 parts per million (ppm) for one hour and 150  $\mu\text{g}/\text{m}^3$  (0.08 ppm) for 24 hours (WHO, 1987a).

# (4) Particulate matter :

- represents a complex mixture of organic and inorganic substances.
- Mass and composition tend to divide into two principal groups :
- coarse particles larger than  $2.5 \mu\text{m}$  in aerodynamic diameter, and fine particles smaller than  $2.5 \mu\text{m}$  in aerodynamic diameter.
- The smaller particles contain the secondarily formed aerosols , combustion particles and recondensed organic and metal vapours.
- The large particles usually contain earth's crustal material and fugitive dust from roads and industries.

## (4) Particulate matter :

- Particulate matter of respirable size may be emitted from a number of sources, some of them natural (e.g. dust storms) and many others that are more widespread and more important (e.g., power plants and industrial processes, domestic coal burning, industrial incinerators).



# (5) Ground level ozone

- ⦿ This is formed when pollutants such as nitrogen oxides and volatile organic compounds (VOCs) react in sunlight .
- ⦿ High levels can cause breathing problems, reduce lung function and trigger asthma symptoms.
- ⦿ Ground level ozone can also seriously damage crops and vegetation.
- ⦿ Ozone is a powerful greenhouse gas and contributes to global warming both directly and by reducing carbon uptake by vegetation.

## (5) Ground level ozone

- The WHO guidelines are 150–200  $\mu\text{g}/\text{m}^3$  (0.076–0.1 ppm) for one hour exposure and 100–200  $\mu\text{g}/\text{m}^3$  (0.05–0.06 ppm) for 8 hour exposures (WHO, 1987a)

These 5 together form.....

SMOG

# SMOG

- Smog is made up of mixture of those pollutants in the atmosphere .
- Combination of words smoke and fog.
- There are two types : reducing smog characterized by sulphur dioxide and particulate.
- And photochemical smog characterized by ozone and other oxidants.

- 1<sup>st</sup> smog related deaths were in London in 1873; death of 500 people; can you imagine how much worse the atmosphere is now?!

- Limits visibility

- Decreases UV radiation

- Yellow/black color over cities

- Causes respiratory problems and bronchial related deaths



◎ Other pollutant...



# Carbon dioxide:

- ⦿ This is not commonly regarded as an air pollutant, although man generates enormous amount of it in combustion process using coal, oil and gas.
- ⦿ Carbon dioxide is a natural constituent of the air.
- ⦿ It does not take part in any significant chemical reactions with other substances in the air.
- ⦿ However, its global concentration is rising above the natural level by an amount that could increase global temperature enough to affect climate markedly

# Volatile organic compounds:

- ⊙ VOCs are divided into the separate categories of methane ( $\text{CH}_4$ ) and non-methane (NMVOCs)
- ⊙ Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming
- ⊙ NMVOCs, the aromatic compounds benzene, toluene and xylene are suspected carcinogens and may lead to leukaemia through prolonged exposure .

# Polynuclear aromatic hydrocarbons (PAH) :

- ⦿ are a large group of organic compounds with two or more benzene rings.
- ⦿ They are formed mainly as a result“ of pyrolytic processes, especially the incomplete combustion of organic materials, as well as in natural processes such as carbonization.
- ⦿ There are about 500 PAH in the air ,the best known is BaP.

# Polynuclear aromatic hydrocarbons (PAH) :

- The average total BaP content in the mainstream smoke of one cigarette was **35 ng** before 1960 and **18 ng** in 1978/79; modern low-tar cigarettes give **10 ng** BaP .
- The concentration of BaP in a room extremely polluted with cigarette smoke can be **22 ng/m<sup>3</sup>**.
- In the past, chimney sweeps and tar-workers were dermally exposed to substantial amounts of PAH and there is sufficient evidence that skin cancer in many of these workers was caused by PAH.

# Polynuclear aromatic hydrocarbons (PAH) :

- Epidemiological studies in coke-oven workers, coal-gas workers and employees in aluminium production plants provide sufficient evidence of the role of PAH in the induction of lung cancer.
- Owing to its carcinogenicity, **no safe level of PAH can be recommended.**

# Toxic metals:

Lead

Cadmium

Copper

- Those metals are produced from different factories and can have immediate health effects and long term effects on human health

# Others...

- ⦿ **Chlorofluorocarbons: (CFCs) –**
- ⦿ **Peroxyacetyl nitrate (PAN)**

# Monitoring of air pollution





# Monitoring of air pollution

- ⦿ The best indicators of air pollution are :
  - (1) sulphur dioxide.
  - (2) smoke and suspended particles:
    - ⦿ A known volume of air is filtered through a white filter paper under specified conditions and the stain is measured by photoelectric meter.
    - ⦿ Smoke concentration is estimated and expressed as micrograms/cubic metre of air as an average level over a period of time.

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# Monitoring of air pollution

- (c) *Grit and dust measurement :*
- *Deposit gauges collect grit, dust and other solids. They are analyzed monthly.*
- (d) *Coefficient of haze:*
  - A factor used, particularly in the USA in assessing the amount of smoke or other aerosol in air.

# Monitoring of air pollution

## ● (e)AQI: Air Quality Index

- Indicates whether pollutant levels in air may cause health concerns or not.
- Ranges from 0 (least concern) to 500 (greatest concern)

# Types of air pollution

Air pollution can be divided into:

- ⦿ Indoor air pollution (domestic level)
- ⦿ Outdoor pollution

# Indoor air pollution





# Indoor air pollution

- Indoor air pollution is one of the most critical global environmental problems,
- probably exposes more people worldwide to important air pollutants than does pollution in outdoor air.
- Rural people in developing countries may receive as much as two-thirds (2/3) of global exposure to particulates.



# According to WHO.....

- Around **3 billion** people still cook and heat their homes using **solid fuels** in open fires and leaky stoves.
- About **2.7 billion** burn **biomass** (wood, animal dung, crop waste) and a further **0.4 billion** use **coal**.
- Such cooking and heating produces high levels of air pollution with a range of health-damaging pollutants

# Indoor air pollution

- In poorly ventilated dwellings, indoor smoke can be **100 times higher than acceptable levels** for small particles.
- Exposure is particularly high among **women and young children**, who spend the most time near the domestic hearth

## Pollutant

## Sources

Respirable particles

Tobacco smoke  
Stove  
Aerosol sprays

Carbon monoxide

Combustion equipment  
Stove  
Gas heaters

Nitrogen dioxide

Gas cookers  
Cigarettes

Carbon dioxide

Combustion  
Respiration

Formaldehyde

Particle board  
Carpet adhesives  
Insulation

## Pollutants

## Sources

Sulphur dioxide

Coal combustion

Other organic vapours  
(benzene, toluene, etc)

Solvents  
Adhesives  
Resin products  
Aerosol sprays

Ozone

Electric arcing  
UV light sources

Radon & “daughters”

Building material

Asbestos

Insulation  
Fireproofing

Mineral fibres

Appliances

# SMOKY COOKING FUELS

Open fire cooking stoves produce heavy smoke containing::

- Fine particles
- Carbon monoxide (CO)
- Polycyclic aromatic hydrocarbons (PAHs)



# CARBON MONOXIDE (CO): SOURCES

- ⦿ Gas, kerosene, wood stoves and coal
- ⦿ Fires, fireplaces, furnaces
- ⦿ Leaking chimneys and vents
- ⦿ Room and water heaters
- ⦿ Vehicle exhaust in closed garage
- ⦿ Tobacco smoke

Any place where combustion is incomplete



# SECONDHAND TOBACCO SMOKE

## Children whose mothers smoke:

- 70% more respiratory problems
- Pneumonia and hospitalization in year 1 is **38%** higher
- Infant mortality is 80% higher
- 20% of all infant deaths could be avoided if all pregnant stop smoking.
- 5 times higher risk of sudden infant death syndrome (SIDS)



# PESTICIDES

## **Spraying pesticides at home / school:**

- ⦿ Higher concentrations near the floor
- ⦿ Persistence in some surfaces (carpets, soft toys)
- ⦿ Overuse and misuse

## **Children's behaviour and inhalation of pesticides**

- ⦿ Crawling
- ⦿ Playing close to the floor
- ⦿ Plush toys
- ⦿ Hand-to-mouth
- ⦿ Object-to-mouth



# MOSQUITO COILS

- ⦿ Household use in Africa, Asia, South America
- ⦿ Major active ingredient – pyrethrins
- ⦿ Long-term exposures linked to asthma and wheezing



# SOLVENTS AND VOLATILE ORGANIC COMPOUNDS

Allkanes,, aromattiic hydrocarbons,, allcoholls,, aldehydes,, kettones

- **Sources:**
- Solvents, fabric softeners, and cleaning products
- Paints, glues, waxes and polishing materials
- Spray propellants, dry cleaning fluids
- Pens and markers
- Binders and plasticizers
- Cosmetics: hair sprays, perfumes



# BIOLOGICAL POLLUTANTS

**Biological pollutants are/were living organisms:**

- Animal dander, dust mites, moulds, infectious agents.

**Sources of biological agents:**

- Water-damaged surfaces and materials
- Humidifiers and stagnant water
- Water vapour from cooking and showering
- Air conditioning systems
- Mattresses, upholstered furniture and carpets

# Adverse health effect of indoor air pollutants in health

## Acute:

- ◉ Irritation of the mucous membranes (eyes, nose, throat)
- ◉ Cough, wheeze, chest tightness
- ◉ Increased airway responsiveness to allergens
- ◉ Increased incidence of acute respiratory illness:
  - ◉ "cold", pneumonia, otitis media
  - ◉ Tracheobronchitis Exacerbation of asthma

# Adverse health effect of indoor air pollutants in health

- **Chronic:**
  - Long-term exposure decreases lung growth
  - Impairment of pulmonary function
  - Increased susceptibility to chronic obstructive lung diseases, including asthma
- Others..



# Outdoor air pollution



# Outdoor air pollution

- Worldwide it is estimated that 1.3 million people -- more than half of them in developing countries -- die every year from urban outdoor air pollution.
- Urban outdoor air pollution is a major environmental health problem affecting people in both developed and developing countries

# Major air pollutant and their effect

- **OZONE (O<sub>3</sub>)**: significant decreases in lung function, inflammation and pain when breathing.
- **PARTICULATE MATTER AIR POLLUTION (PM )** chronic bronchitis and emphysema, as well as people with heart disease. Exposure can trigger asthma attacks and cause wheezing, coughing, and respiratory irritation in individuals with sensitive airways.



# Major air pollutant and their effect

- ⦿ **NITROGEN OXIDE (NOX):** irritate the lungs and lower resistance to respiratory infections such as influenza.
- ⦿ **SULFUR DIOXIDE (SO<sub>2</sub>):** effects on breathing, respiratory illness, changes in the lung's defenses, and aggravation of existing heart disease.

# Major air pollutant and their effect

- **Acid Rain** or **Acid Deposition**

a form of precipitation that contains high levels of sulfuric or nitric acids, can contaminate drinking water and vegetation, damage aquatic life, and erode buildings



# Effects of outdoor air pollution

- ① (a) Health aspects
- ① (b) Social and economic aspects

# (a) Health aspects:

- The health effects of air pollution are both immediate and delayed. The immediate effects are borne by the respiratory system, the resulting state is acute bronchitis.
- If the air pollution is intense, it may result even in immediate death by suffocation.
- The delayed effects most commonly linked with air pollution are chronic bronchitis, lung cancer, bronchial asthma, emphysema, and respiratory allergies.

# (a) Health aspects:

- ⦿ Lead poisons many systems in the body and is particularly dangerous to children developing brain and nervous system.
- ⦿ Elevated lead levels in children have been associated with impaired neuropsychological development as measured by loss of IQ, poor school performance and behavioral difficulties.
- ⦿ The elderly, children, smokers and those with chronic respiratory difficulties are most vulnerable.

## (b) Social and economic aspects :

- These comprise destruction of plant and animal life; corrosion of metals; damage to buildings; cost of cleaning and maintenance and repairs and aesthetic nuisance:
- Air pollution also reduces visibility in towns. It can soil and damage clothing.

# Control of air pollution

# Control and prevention of air pollution

- WHO has recommended the following procedures for the prevention and control of air pollution:



# APPROACHES TO REDUCE INDOOR AIR POLLUTION

## 1. Eliminate or control the sources of pollution:

- Improved stoves
- Clean fuels (kerosene, gas)
- Venting stoves for cooking and heating
- Regular maintenance of cooking, heating and cooling systems

# APPROACHES TO REDUCE INDOOR AIR POLLUTION

- 2. Ventilation –  
building design
  - Dilute and remove  
pollutants through  
ventilation with  
outdoor air



# APPROACHES TO REDUCE INDOOR AIR POLLUTION

## 3. Air cleaning – NOT air fresheners!

- Air filters and ionizers may remove some airborne particles
- Gas adsorbing material is used to remove gaseous contaminants

# APPROACHES TO REDUCE INDOOR AIR POLLUTION

## EDUCATION AND ADVOCACY

### Education of:

- Children
- Family and community
- Health care providers



# APPROACHES TO REDUCE INDOOR AIR POLLUTION

## Environment policymaking:

- ◉ Framework Convention on Tobacco Control
- ◉ Clean indoor air regulations
- ◉ Community actions

## Research

# Control of outdoor air pollution

## *(a) Containment:*

- That is, prevention of escape of toxic substances into the ambient air.
- Containment can be achieved by a variety of engineering methods such as enclosure, ventilation and air cleaning.
- A major contribution in this field is the development of "**arresters**" for the removal of contaminants.

# Control of outdoor air pollution

- **(b) Replacement:**
- *That is, replacing a technological process causing air pollution, by a new process that does not.*
- Increased use of electricity, natural gas and central heating in place of coal have greatly helped in smoke reduction.
- There is a move now to reduce lead in petrol which is a cumulative poison.

# Control of outdoor air pollution

- ⦿ **(c) Dilution:**
- ⦿ *Dilution* is valid so long as it is within the self-cleaning capacity of the environment.
- ⦿ some air pollutants are readily removed by vegetation.
- ⦿ The establishment of "**green belts**" between industrial and residential areas is an attempt at dilution.
- ⦿ The capacity for dilution is, however, limited and trouble occurs when the atmosphere is overburdened with pollutants.



green belts



# Control of outdoor air pollution

## d) *Legislation:*

- ⊙ e.g., Clean Air Acts, legislation covers such matters as:
  - height of chimneys .
  - powers to local authorities to carry out investigations, research and education concerning air pollution
  - creation of **smokeless zones** and enforcement of standard for ambient air quality.

# smokeless zones



# OZONE HOLE

Hole in the Ozone Layer?



# OZONE HOLE

- ◎ The term ozone hole refers to annual thinning of the ozone layer observed yearly over the South Pole areas,
- ◎ whereby the amount of ozone in the atmosphere drastically decreases in local spring
- ◎ .Since the beginning of the eighties one notices that this **hole is getting deeper** and that the covered surface is **getting larger**.



# Montreal Protocol



# Montreal Protocol

- ⦿ The Montreal Protocol was one of the first environmental agreements to formally recognize the precautionary principle.
- ⦿ Related actions taken consistent with this principle have included the preemptive decision to ban new ozone depleting substances before they were ever produced commercially;

# Montreal Protocol

- In 2009, the Montreal Protocol became the first treaty in history to achieve universal ratification with 196 governments (Parties).
- As a consequence, it can now be said that the entire global community has legally committed it self to meeting **specific time-bound targets for the virtual phase-out of nearly 100 chemicals that have ozone depleting properties;**















