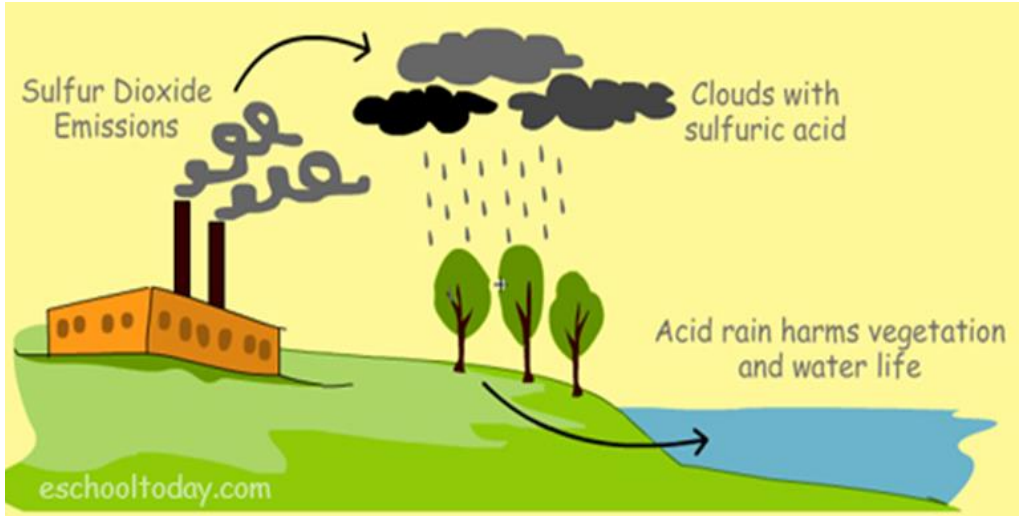
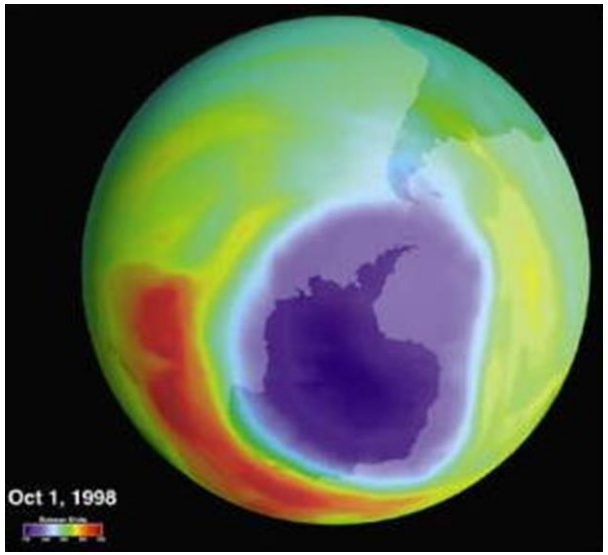
# Air Pollution

WORLD ENVIRONMENT DAY

Beat Air Pollution

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# Facts about air pollution

- It is the deadliest form of pollution, killing millions of people each year.
- Air pollution is the fourth-largest threat to human health, after high blood pressure, dietary risks and smoking.
- 4.2 million deaths every year as a result of exposure to ambient (outdoor) air pollution
- 3.8 million deaths every year as a result of household exposure to smoke from dirty cookstoves and fuels (in 2012, WHO).
- That's 11.6% of all global deaths – more than the number of people killed by HIV/AIDS, tuberculosis and road injuries combined.

# Facts about air pollution

- Air pollution did cost the globe an estimated $8.1 trillion in 2019 in lost labor and income, equivalent to 6.1 percent of global GDP (gross domestic product).
- 95 percent of deaths caused by air pollution occur in low- and middle- income countries.
- Research shows that close links between air pollution and incidence of illness and death due to COVID-19.
- More than nine out of 10 of the world's population ( 92%) live in places where air pollution exceeds safe limits (WHO).

# AIR POLLUTION – THE SILENT KILLER

Every year, around **7 MILLION DEATHS** are due to exposure from both outdoor and household air pollution.

**Air pollution is a major environmental risk to health.** By reducing air pollution levels, countries can reduce:

- **Stroke**
- **Heart disease**
- **Lung cancer, and both chronic and acute respiratory diseases, including asthma**

**REGIONAL ESTIMATES ACCORDING TO WHO REGIONAL GROUPINGS:**

- **Over 2 million** in South-East Asia Region
- **Over 2 million** in Western Pacific Region
- **Nearly 1 million** in Africa Region
- **About 500 000** deaths in Eastern Mediterranean Region
- **About 500 000** deaths in European Region
- **More than 300 000** in the Region of the Americas

**CLEAN AIR FOR HEALTH** #AirPollution World Health Organization

# Significance of the Problem

- Around 3 billion people (more than 40% of the world's population) still do not have access to clean cooking fuels and technologies in their homes (causing indoor air pollution).
- Parts of Africa, Eastern Europe, India, China and the Middle East are the biggest regional danger spots.
- WHO estimates that:

80% of these deaths were due to ischemic heart disease and strokes

14% of deaths were due to chronic obstructive pulmonary disease or acute lower respiratory infections

6% of deaths were due to lung cancer

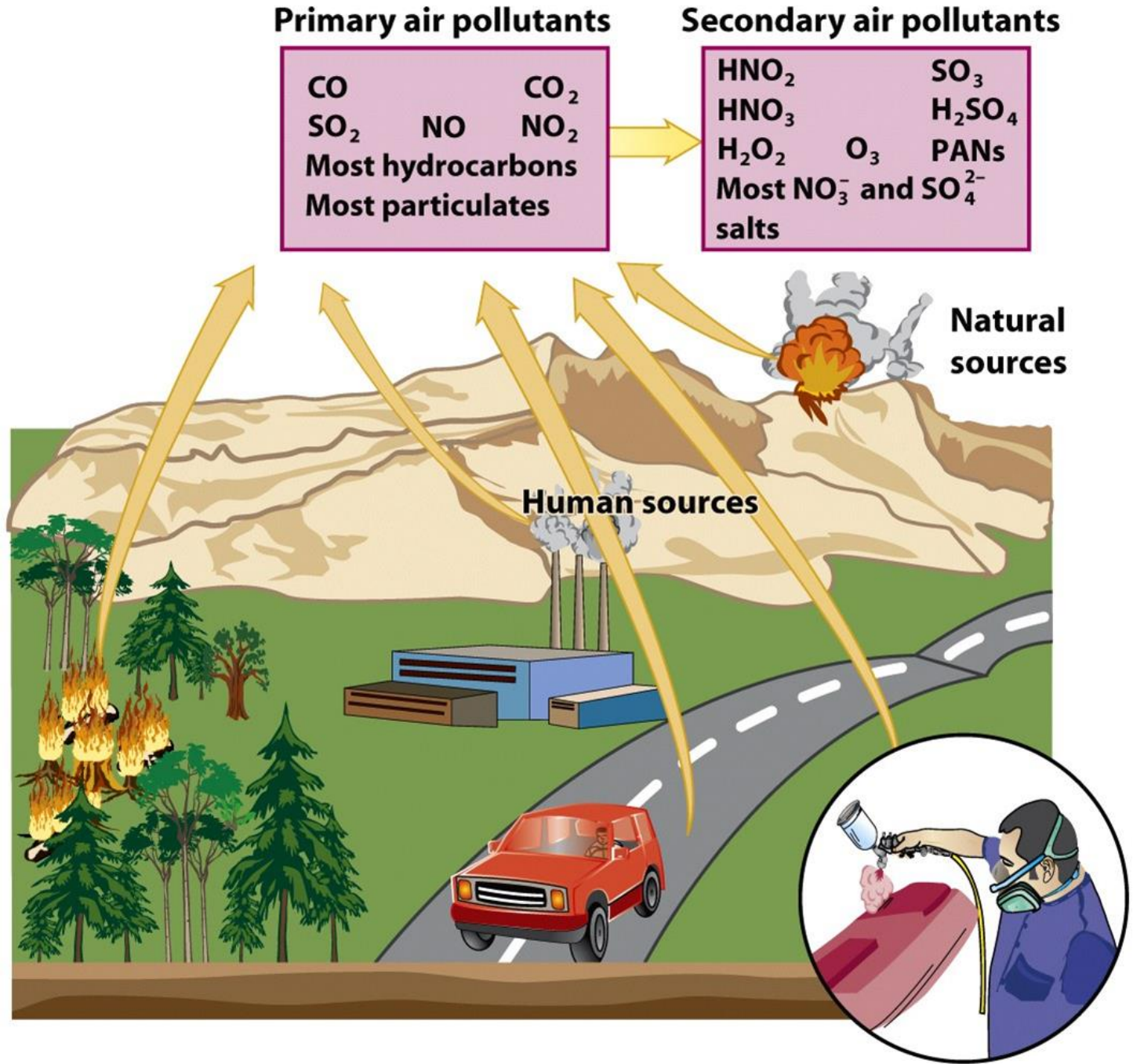
# What is Air Pollution?

**Air pollution occurs when gases, dust particles, fumes (or smoke) or odors are introduced into the atmosphere in a way that makes it harmful to humans, animals and plants.**

# Definitions

**Air pollutants** are airborne gases, particles, and aerosols that are added to the atmosphere by natural events or human activities in concentrations that threaten the well-being of organisms or disrupt the orderly functioning of the environment.

- **Primary air pollutants** pollute the air when emitted directly into the atmosphere.
- **Secondary air Pollutants** are created by chemical reactions between primary air pollutants in the atmosphere. May involve sunlight or a catalyst.


Primary air pollutants
CO
$CO_2$
$SO_2$
NO
$NO_2$
Most hydrocarbons
Most particulates
Secondary air pollutants
$HNO_2$
$SO_3$
$HNO_3$
$H_2SO_4$
$H_2O_2$
$O_3$
PANs
Most $NO_3^-$ and $SO_4^{2-}$ salts
Natural sources
Human sources

# The most common air pollutants

1. Oxides of Carbon
2. Volatile Hydrocarbons (VOC's)
3. Oxides of Nitrogen
4. Sulfur Compounds
5. Photochemical Smog
6. Suspended Particulates (aerosols)

# 1. Oxides of Carbon

**Oxides of Carbon:** odorless, colorless

1. Carbon dioxide ($CO_2$):
   - fourth most common atmospheric gas (naturally)
   - produced from oxidation of hydrocarbons (burning fuel, solid waste, trees, …).
   - asphixiant
   - greenhouse gas (contributes to global worming)
2. Carbon monoxide (CO):
   - toxic in low concentrations
   - produced by incomplete combustion of fossil fuels.

# 2. Volatile Hydrocarbons: (VOC's)

## Volatile Hydrocarbons

1. Methane (A greenhouse gas): Mostly natural sources (marshes, ruminant animals, rice paddies, trees), (livestock manure and agricultural practices, decay of organic waste in landfills, production of coal and natural gas).

2. Benzene, tetrachloroethylene, gasoline, formaldehyde, many others: products of chemical industry used as solvents, in paints, and as cleaning agents.

✓ All may form secondary pollutants that irritate eyes and damage respiratory system (photochemical smog).

# 3. Oxides of Nitrogen

## 1. Nitric Oxide (NO)

- Produced by soil microbes
- Forms $NO_2$ in combination with oxygen in atmosphere

## 2. Nitrous Oxide ($N_2O$)

- Natural and man made sources
- Anesthetic
- Greenhouse gas

## 3. Nitrogen Dioxide ($NO_2$)

- Formed in auto engines and electrical generating plants.
- Contributes to heart, lung, liver and kidney diseases at high concentration
- Responsible for brownish haze (photochemical smog)
- Forms nitric acid in rainwater (acidic rain)

# 4. Compounds of Sulfur

## Compounds of Sulfur:

### 1. Sulfur Oxides ($SO_2$, $SO_3$, $SO_4$):

volcanoes, sea spray, combustion of fossil fuels (coal)

Irritate respiratory passages ($SO_2$)

Form acidic aerosols, acid rain ($SO_3$, $SO_4$), damages lakes, forests, steel and stone structures.

### 2. Hydrogen Sulfide (H2S)

Gas produced in anaerobic environment. It is colorless with bad odor “rotten egg”, (sewer gas). It is highly toxic (eye irritant and asphixiant) and extremely flammable.

# 5. Photochemical Smog

- ✓ **Forms in bright sunlight from:**
  - **nitrogen oxides**
  - **Hydrocarbons (VOCs)**
  - **oxygen**
- ✓ **Interact chemically to produce powerful oxidants like ozone (O3) and peroxyacetyl nitrate (PAN).**
- ✓ **These secondary pollutants are damaging to plant life and lead to the formation of photochemical smog (smoke + fog).**
- ✓ **PAN and ozone are primarily responsible for the eye irritation so characteristic of this type of smog, in addition to reducing visibility.**

# Ozone

- ✓ Tropospheric Ozone
  - Man- made pollutant in the lower atmosphere
  - Secondary air pollutant
  - Component of photochemical smog
- ✓ Stratospheric Ozone
  - Essential component that screens out UV radiation in the upper atmosphere
  - Man- made pollutants (ex: CFCs*) can destroy it.
  - *CFC's are gases used in refrigeration and in pressured spray cans.

# 6. Suspended Particles

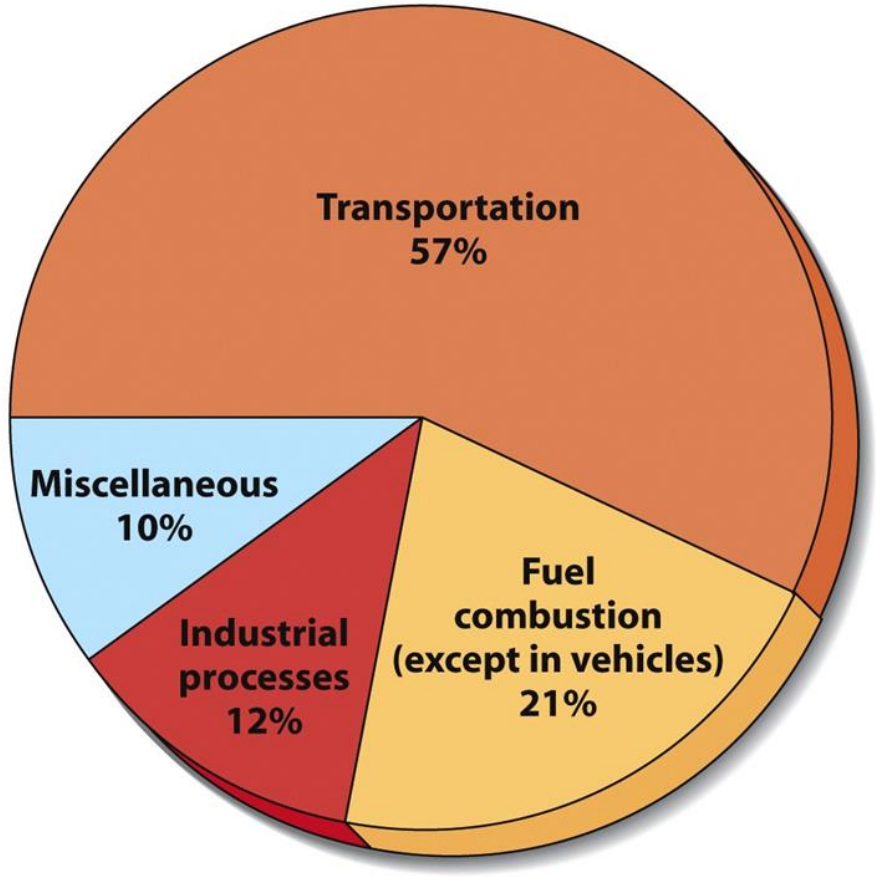
**Particulate mater (PM)**: Thousands of different solid or liquid particles suspended in air. It includes dust, fungal spores, ammonia, sodium chloride, lead, asbestos, black carbon (soot), soil particles, and sulfuric acid droplets.

- ✓ PM affects more people than any other pollutant.
- ✓ The most health-damaging particles are those with a diameter of 10 microns or less, ($\leq PM_{10}$), which can penetrate and lodge deep inside the lungs.
- ✓ Greatest threat to health among air pollutants.
- ✓ Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer.

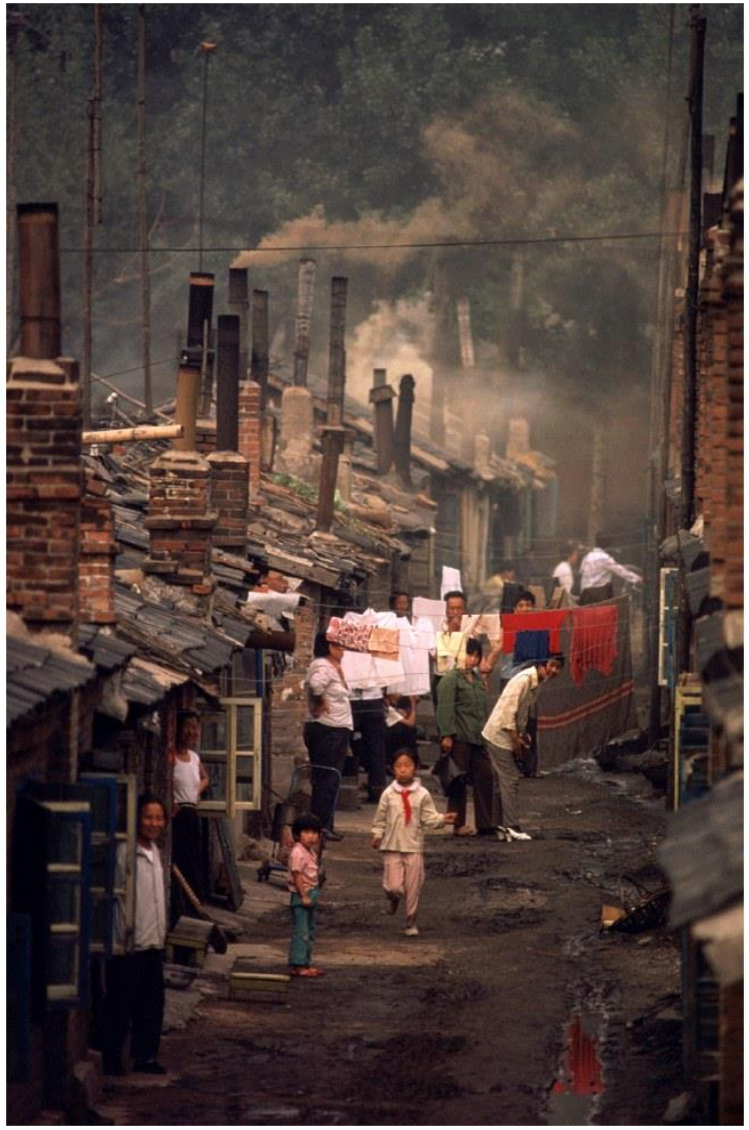
# What are the sources of air pollution?

## Three main sources of air pollution:

1) Transportation
2) Power plants: electricity generating
3) Industry

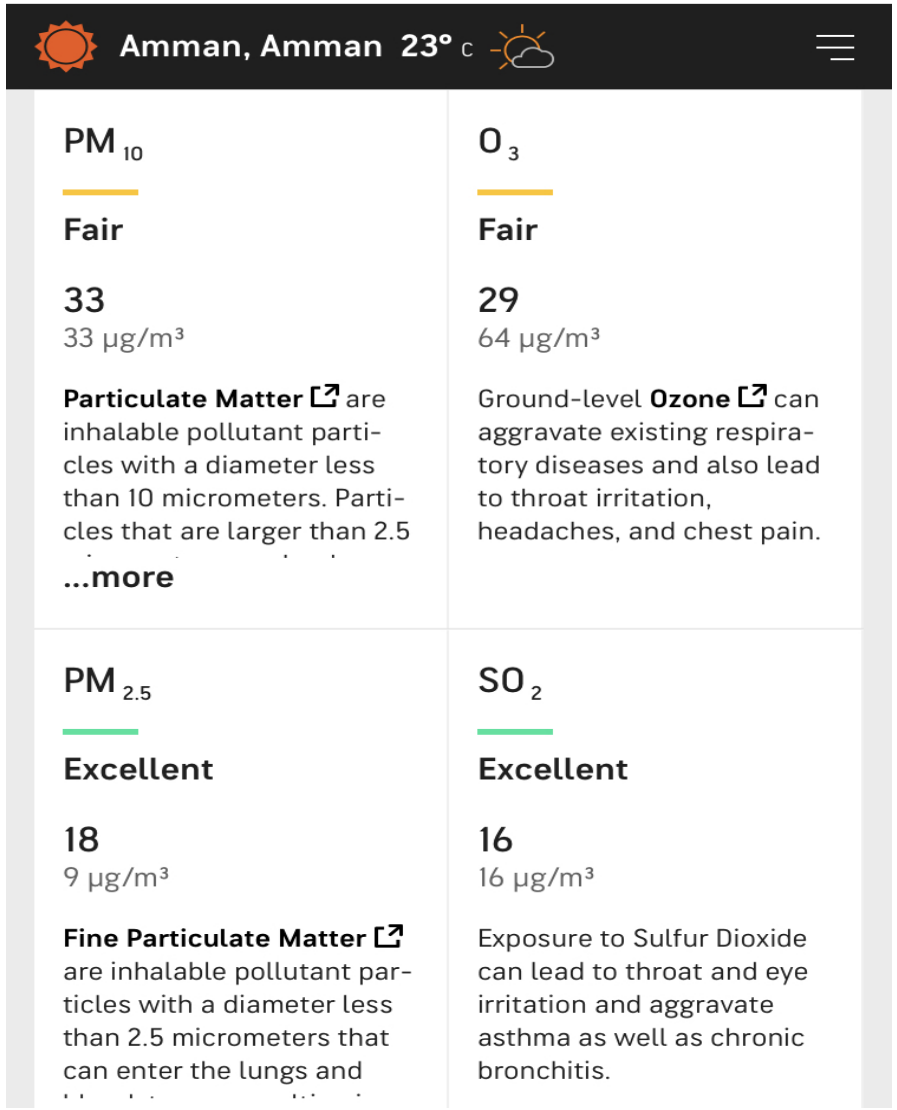


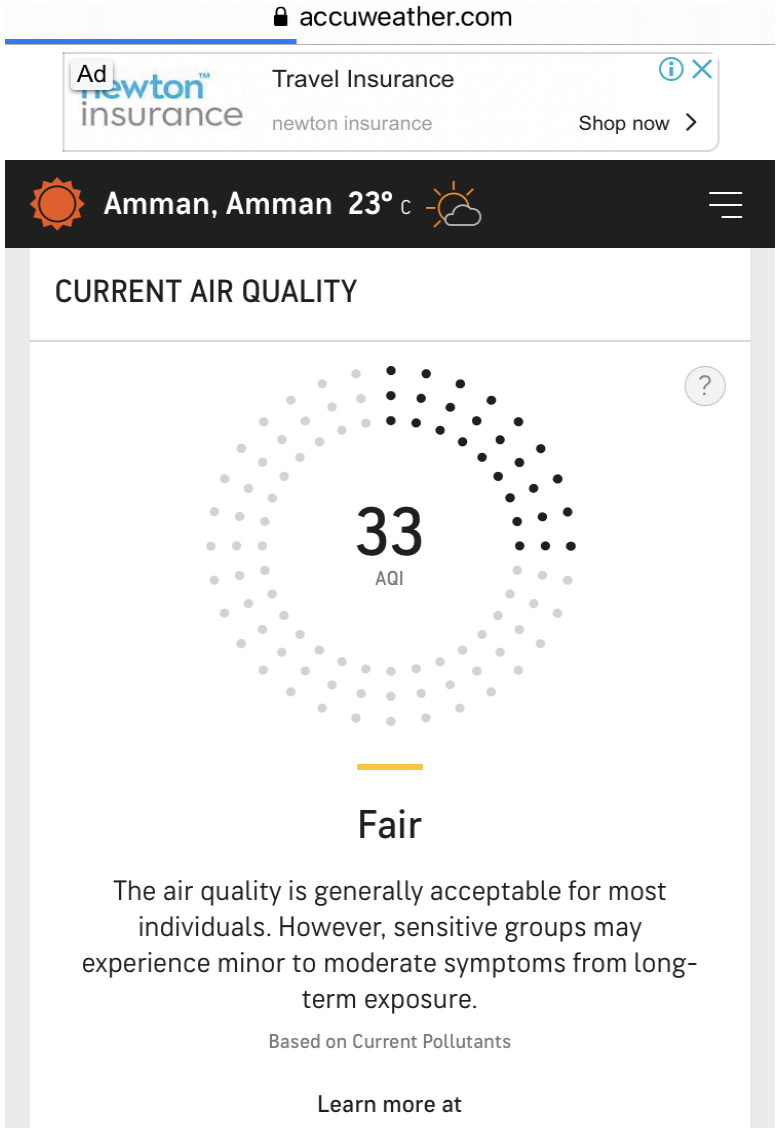
# Air Pollution in Beijing and Mexico City



- Beijing (left)
- Mexico City (above)

# Air quality indicators in Amman, Jordan on November 2nd, 2021:



# Climate Change and Global Warming:

**Climate changes** like global warming is the result of human practices like emission of Greenhouse gases(fossil fuel use) and deforestation .

✓ Global warming leads to rising temperatures of the oceans and the earth' surface causing:

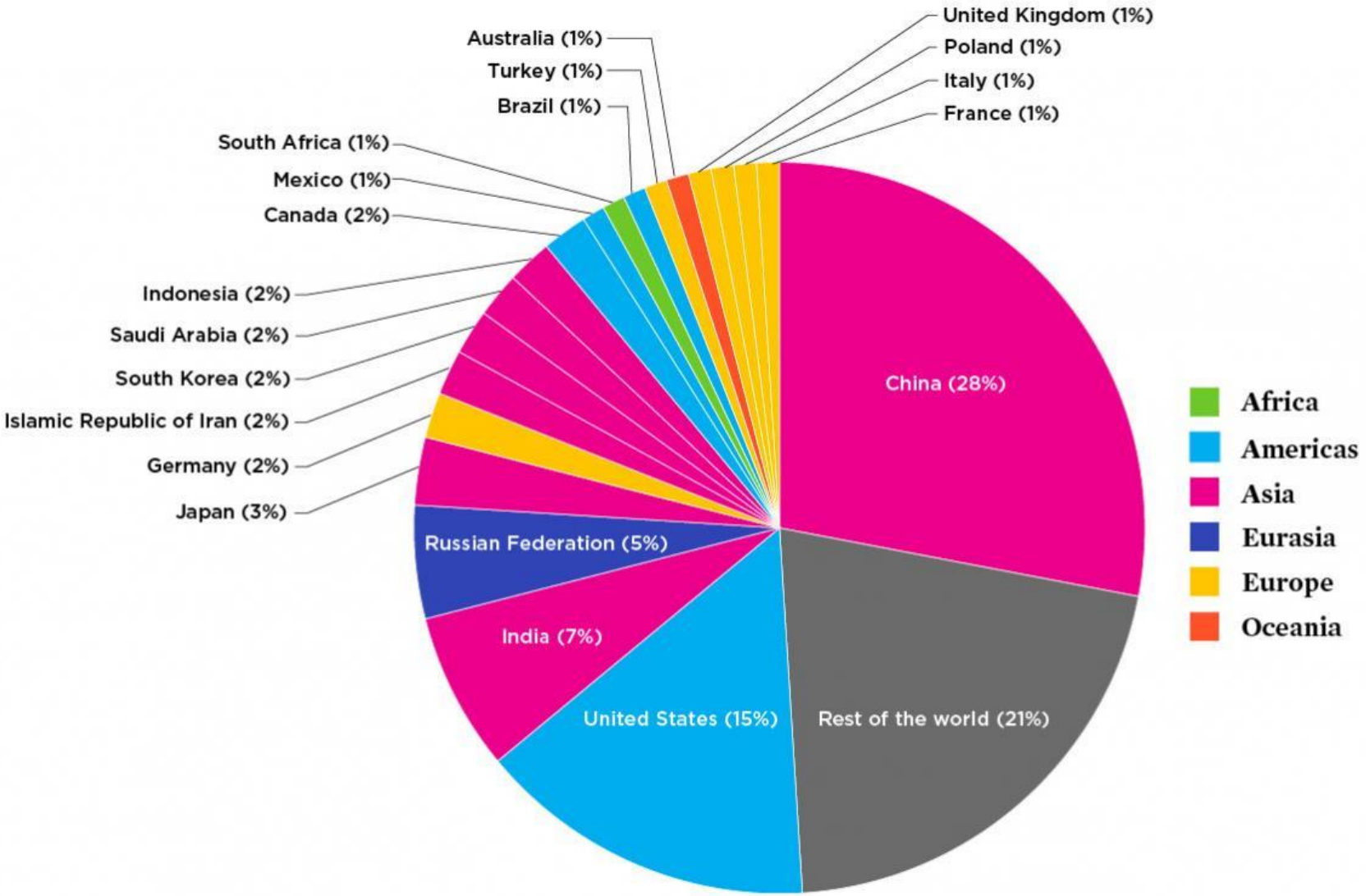
1. Melting of polar ice caps
2. Rise in sea levels and also
3. Unnatural patterns of rain such as flash floods, excessive snow or desertification in other areas, changing seasons, change in weather scenario, and occurrence of new diseases.

# Global Warming:

These gases possess heat trapping capacity that are needed to create greenhouse effect so that this planet remains warm for people to survive.

- ✓ During past several decades, the accumulation of greenhouse gases have grown rapidly, which means more heat gets trapped in the atmosphere and few of these gases escapes back into the space.
- ✓ These gases heat up the earth's surface and this results in global warming. The earth's temperature has increased by 0.8 degrees Celsius over the past century.

# Share of CO2 emissions by country: Carbon Footprint



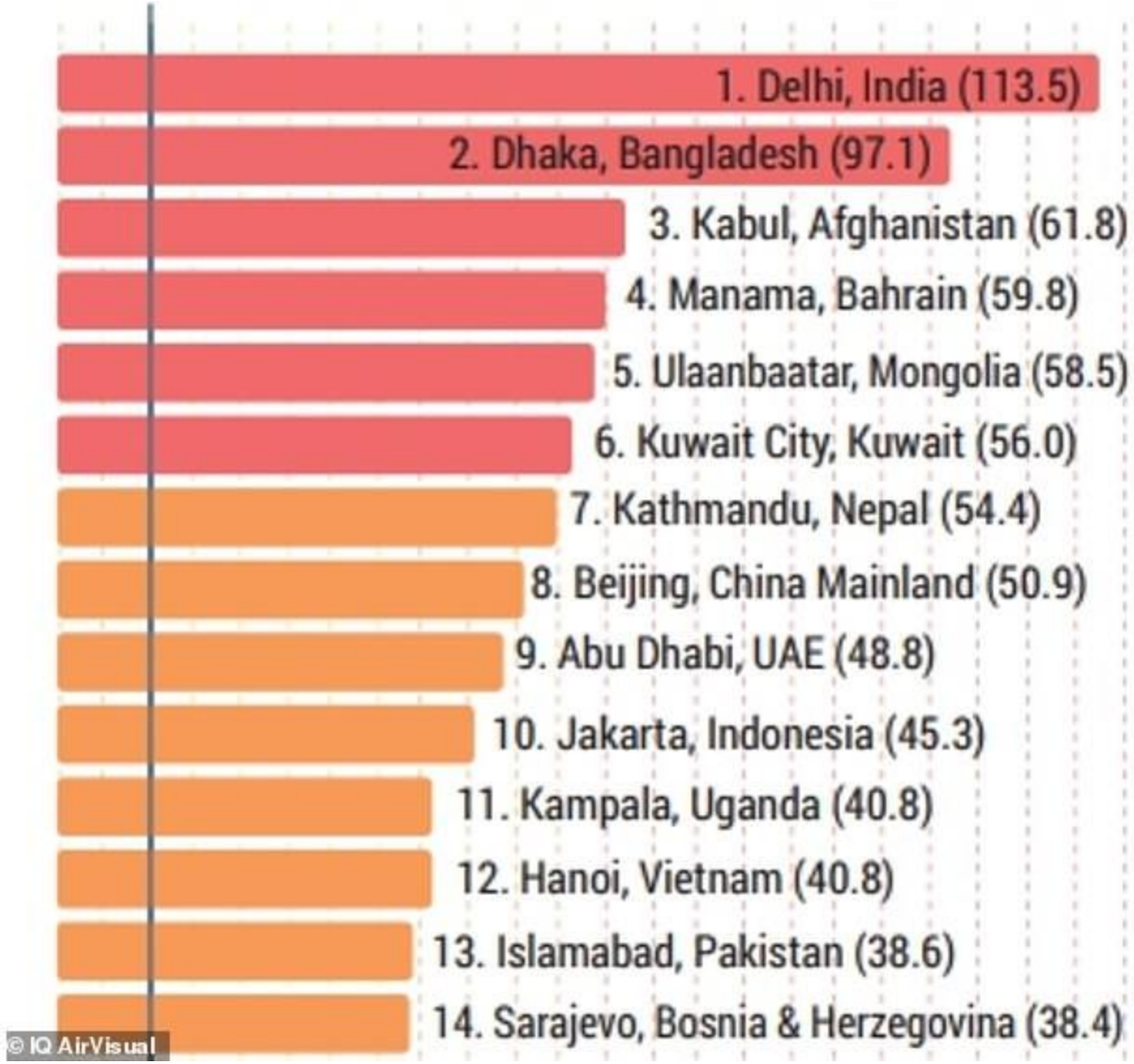
# Acid Deposition

**Sulfur dioxide and nitrogen dioxide emissions react with water vapor in the atmosphere and form acids that return to the surface as either dry or wet deposition (droplets).**

# Effects of Acid Deposition

- Declining Aquatic Animal Populations
- Damages lakes and streams
- Thin-shelled eggs prevent bird reproduction
- Damages building and objects
- Forest decline (deforestation)
  - Ex: Black forest in Germany (50% is destroyed)

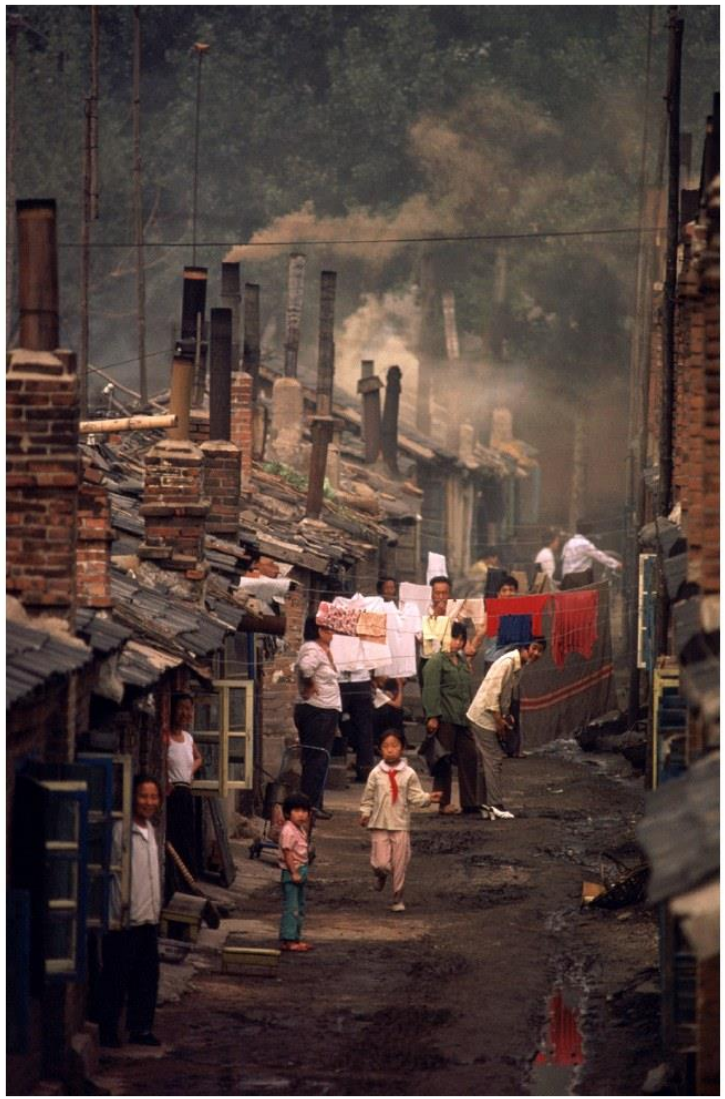
# Most polluted capitals in the world In 2018:



# Agricultural Effects of Air pollution

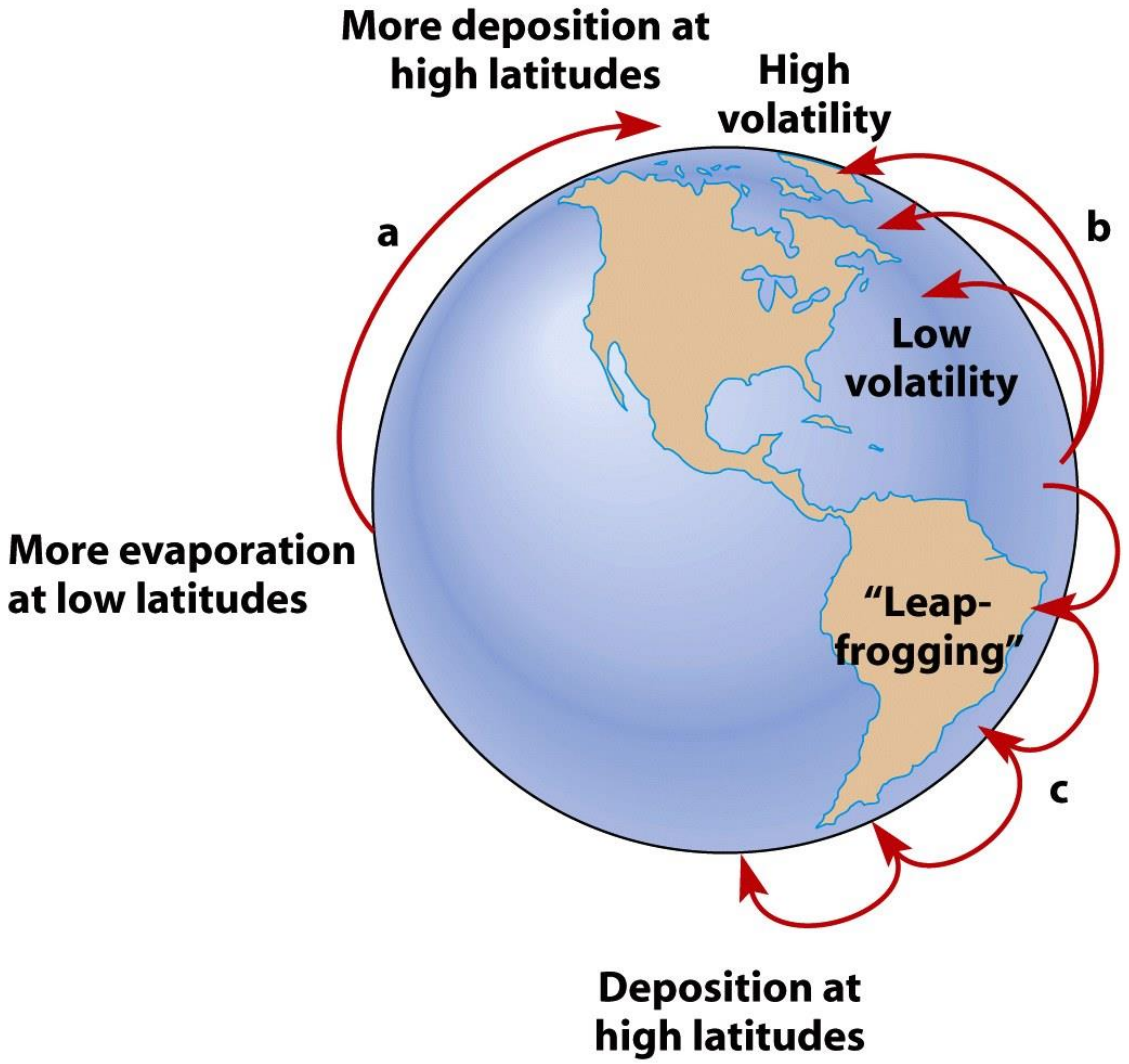
- Air pollution can seriously affect the growth of plants.
- It is easy to find chemical residues in plants that grow alongside highways.
- Also, the huge increase in atmospheric carbon dioxide now causing **global warming**, and climate change is expected to have a major impact on the world's agriculture (reducing crop yields in some places but potentially increasing yields elsewhere).

# Air Pollution Around the World

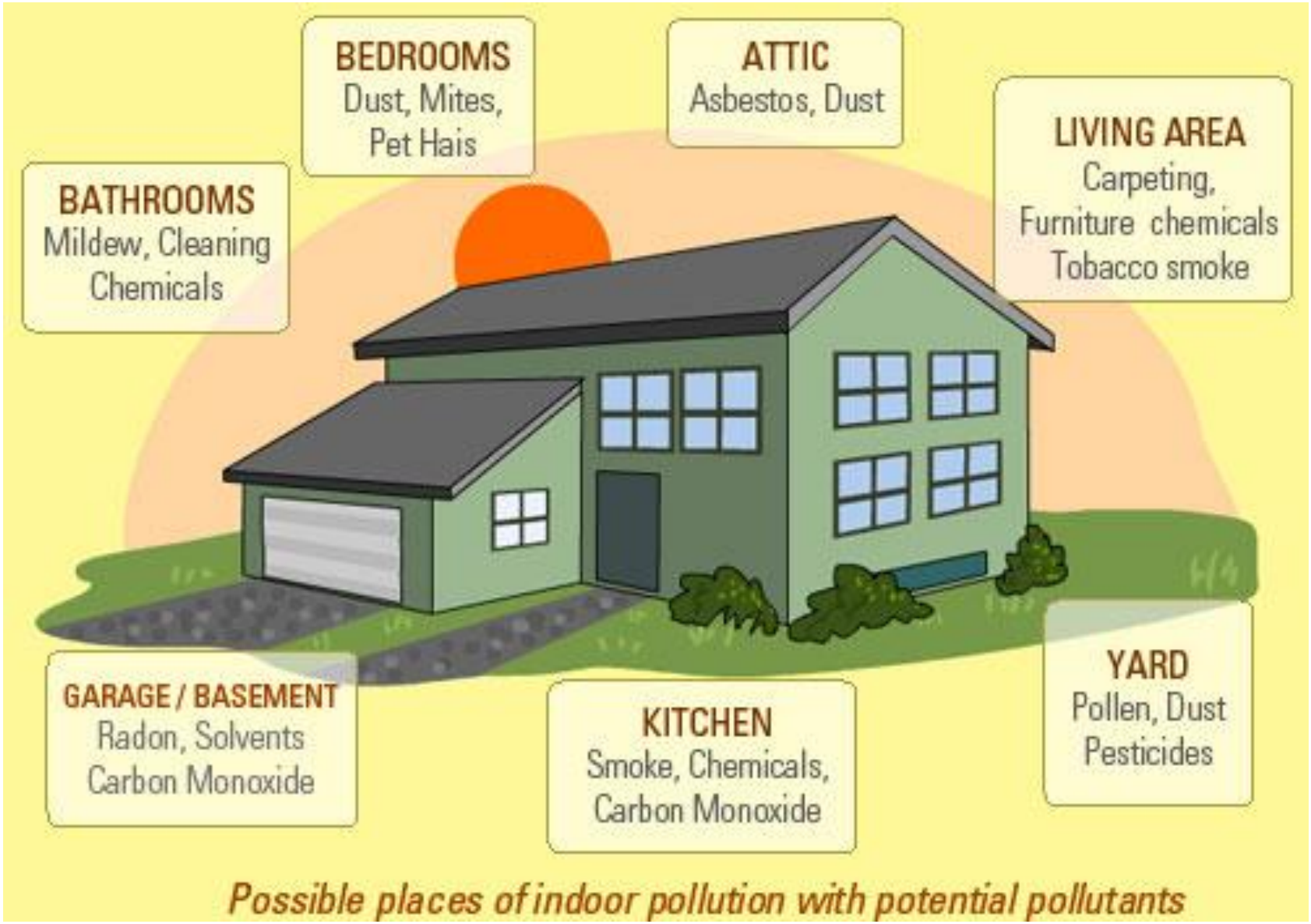


- Air quality is deteriorating rapidly in developing countries
- Shenyang, China
  - Residents only see sunlight a few weeks each year
- Developing countries have older cars
- Still use leaded gasoline

# Long Distance Transport of Air Pollutants



# Indoor Air Pollution




*Possible places of indoor pollution with potential pollutants*

# Indoor Air Pollution

- Around 3 billion people cook and heat their homes using open fires and leaky stoves, and burning biomass (wood, animal dung and crop waste) and coal.
- Nearly 3.5 million people die prematurely from illness attributable to indoor air pollution from household solid fuel use (e.g. chronic obstructive respiratory disease).
- Nearly 50% of pneumonia deaths among children under five are due to particulate matter inhaled from indoor air pollution.
- Both women and men exposed to heavy indoor smoke are 2-3 times more likely to develop COPD

Source: WHO: http://www.who.int/mediacentre/factsheets/fs292/en/

# Indoor Air Pollution

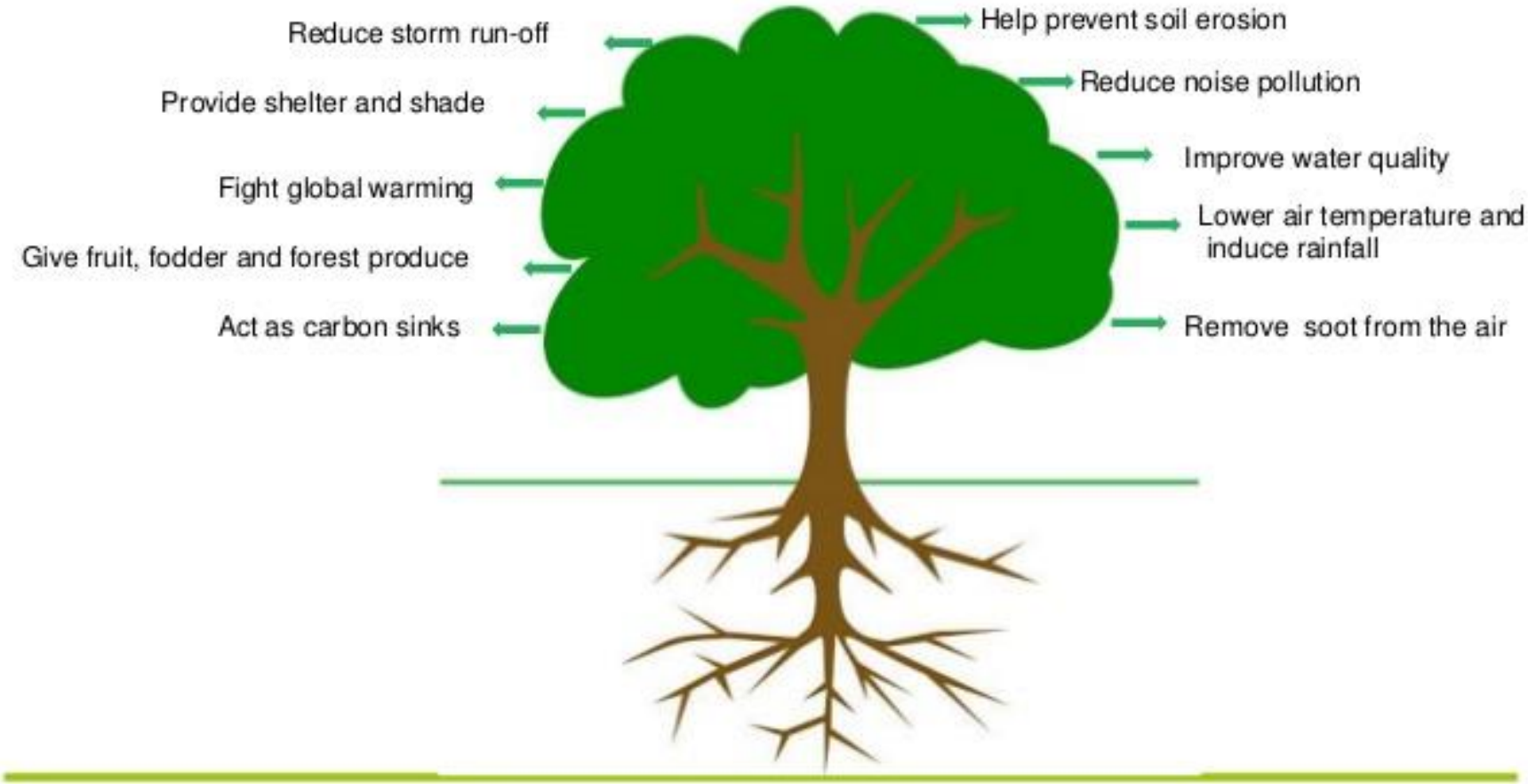
## Common indoor air pollutants include:

- **Tobacco smoke:** This is smoke burning cigarettes or exhaled smoke by people smoking.
- **Biological Pollutants:** These include allergens such as pollen from plants, hair from pets, fungi and some bacteria.
- **Radon:** This is a gas that is naturally emitted from the ground. Radon can be trapped in basements of building and homes. The gas is known to cause cancer after exposure over a period.
- **Carbon Monoxide:** Carbon monoxide is produced when fuels such as gas, kerosene, coal or wood is incompletely burned or with lack of indoor ventilation.

# How can we solve the problem of air pollution?


1. Technological Solutions: cars and factories with less pollution, and using all types of renewable energy.
2. Laws and Regulations
3. Raising awareness and changing human behavior……

# Why Trees?


Reduce storm run-off
Provide shelter and shade
Fight global warming
Give fruit, fodder and forest produce
Act as carbon sinks
Help prevent soil erosion
Reduce noise pollution
Improve water quality
Lower air temperature and induce rainfall
Remove soot from the air