ENVIRONMENTAL POLLUTION with reference to India

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Human ecology – human evolution

- Scientific advancement
- Controlling and dominating nature
  - Exploiting natural resources for his benefit
  - Urbanization & industrialisation for life comfort
  - Green revolution
  - Disrupted & altered biotic & abiotic environment
- Discarded basic principles governing ecosystems of biosphere
  - Environmental pollution

Environmental pollution

- Types of pollutant

1. Non-degradable pollutants

                  eg. DDT, mercury.....etc

2. Biodegradable pollutants

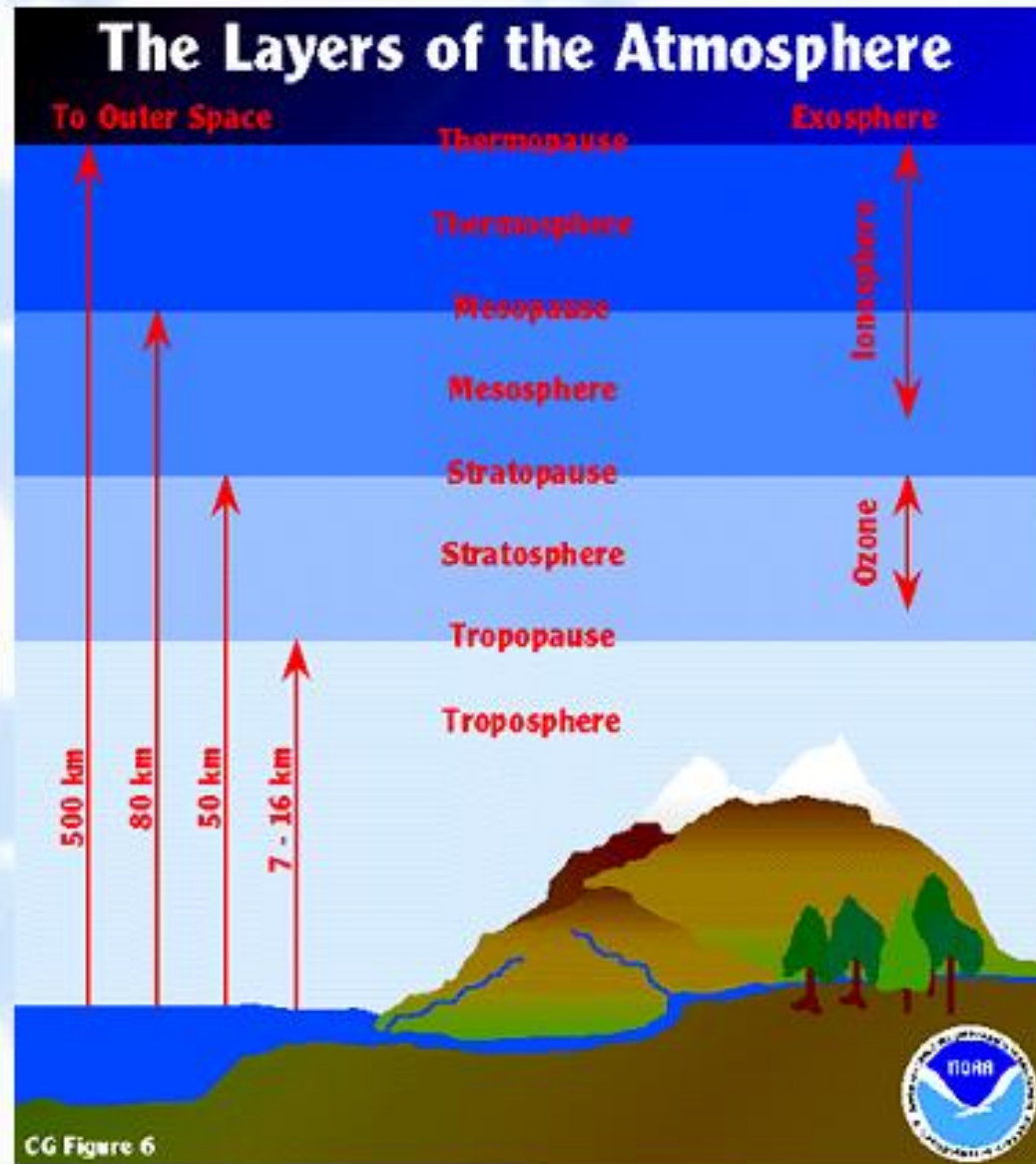   eg. Sewage, organic waste materials.....etc.

- **Primary pollutants**
- **Secondary pollutants**

AIR POLLUTION

The presence of chemicals in the atmosphere in quantities and duration that are harmful to human health and the environment.
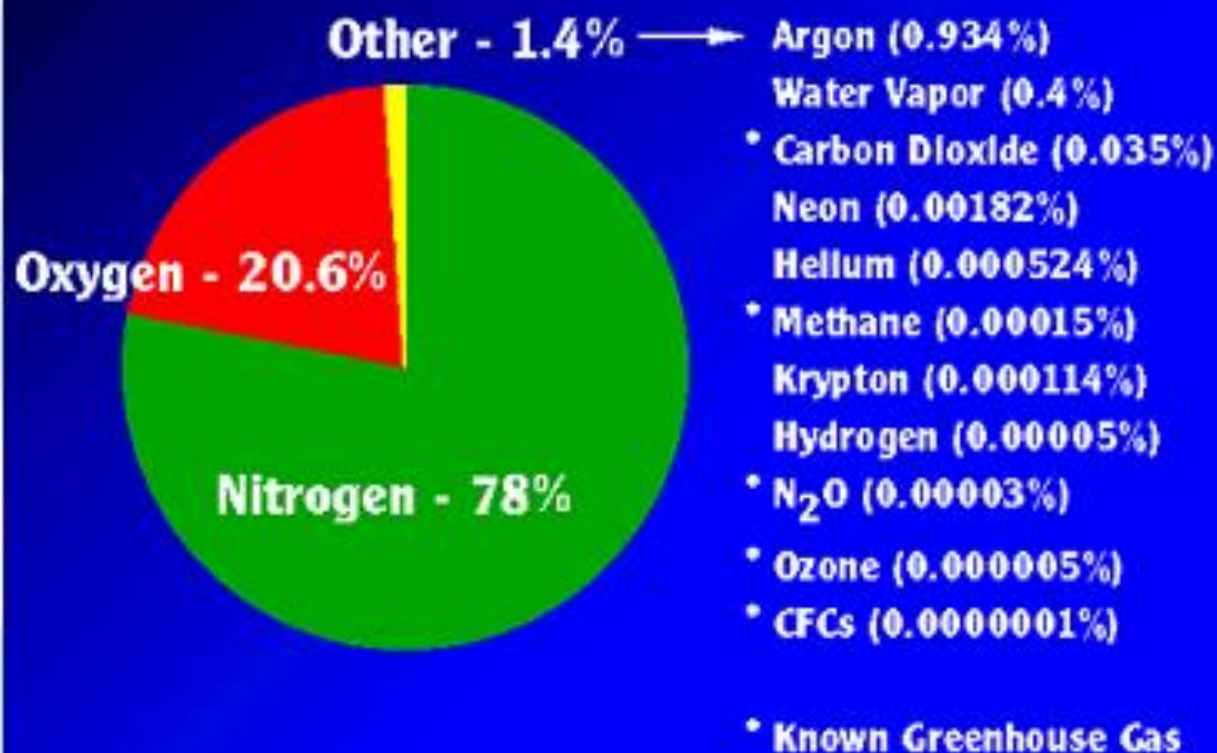
Earth's atmosphere:

- mixture of gases that forms a layer about 250 miles thick around the earth
- bottom 5 - 11 miles (7 - 16 km) contains most (75%) of the air

The Layers of the Atmosphere

To Outer Space

Exosphere

Thermopause

Thermosphere

Mesopause

Mesosphere

Stratopause

Stratosphere

Tropopause

Troposphere

Ionosphere

Ozone

500 km

80 km

50 km

7 - 16 km

CG Figure 6

- Composition of clean, dry air:

Composition of the Earth's Atmosphere
(Gases - Percent by Volume)

Other - 1.4% ⟶ Argon (0.934%)
Water Vapor (0.4%)
* Carbon Dioxide (0.035%)
Neon (0.00182%)
Helium (0.000524%)
* Methane (0.00015%)
Krypton (0.000114%)
Hydrogen (0.00005%)
* N_2O (0.00003%)
* Ozone (0.000005%)
* CFCs (0.0000001%)

* Known Greenhouse Gas

Oxygen - 20.6%

Nitrogen - 78%

CG Figure 7

Major Classes of Air Pollutants

Carbon oxides (CO & CO$_2$)

sources = incomplete combustion of fossil fuels

transportation, industry, & home heating.

Sulfur oxides (mainly SO$_2$)

source = combustion of coal & oil (esp. coal).

Nitrogen oxides NO (nitric oxide) & NO$_2$ (nitrogen dioxide)

source = motor vehicles & industry (burning fossil fuels)

Major Air Pollutants

Table 20.1 Major Air Pollutants

Pollutant	Composition	Primary or Secondary	Characteristics
Particulate matter			
Dust	Variable	Primary	Solid particles
Lead	Pb	Primary	Solid particles
Sulfuric acid	H_2SO_4	Secondary	Liquid droplets
Nitrogen oxides			
Nitrogen dioxide	NO_2	Primary	Reddish-brown gas
Sulfur oxides			
Sulfur dioxide	SO_2	Primary	Colorless gas with strong odor
Carbon oxides			
Carbon monoxide	CO	Primary	Colorless, odorless gas
Carbon dioxide*	CO_2	Primary	Colorless, odorless gas
Hydrocarbons			
Methane	CH_4	Primary	Colorless, odorless gas
Benzene	C_6H_6	Primary	Liquid with sweet smell
Ozone	O_3	Secondary	Pale blue gas with acrid odor
Air toxics			
Chlorine	Cl_2	Primary	Yellow-green gas

* Discussed in Chapter 21.
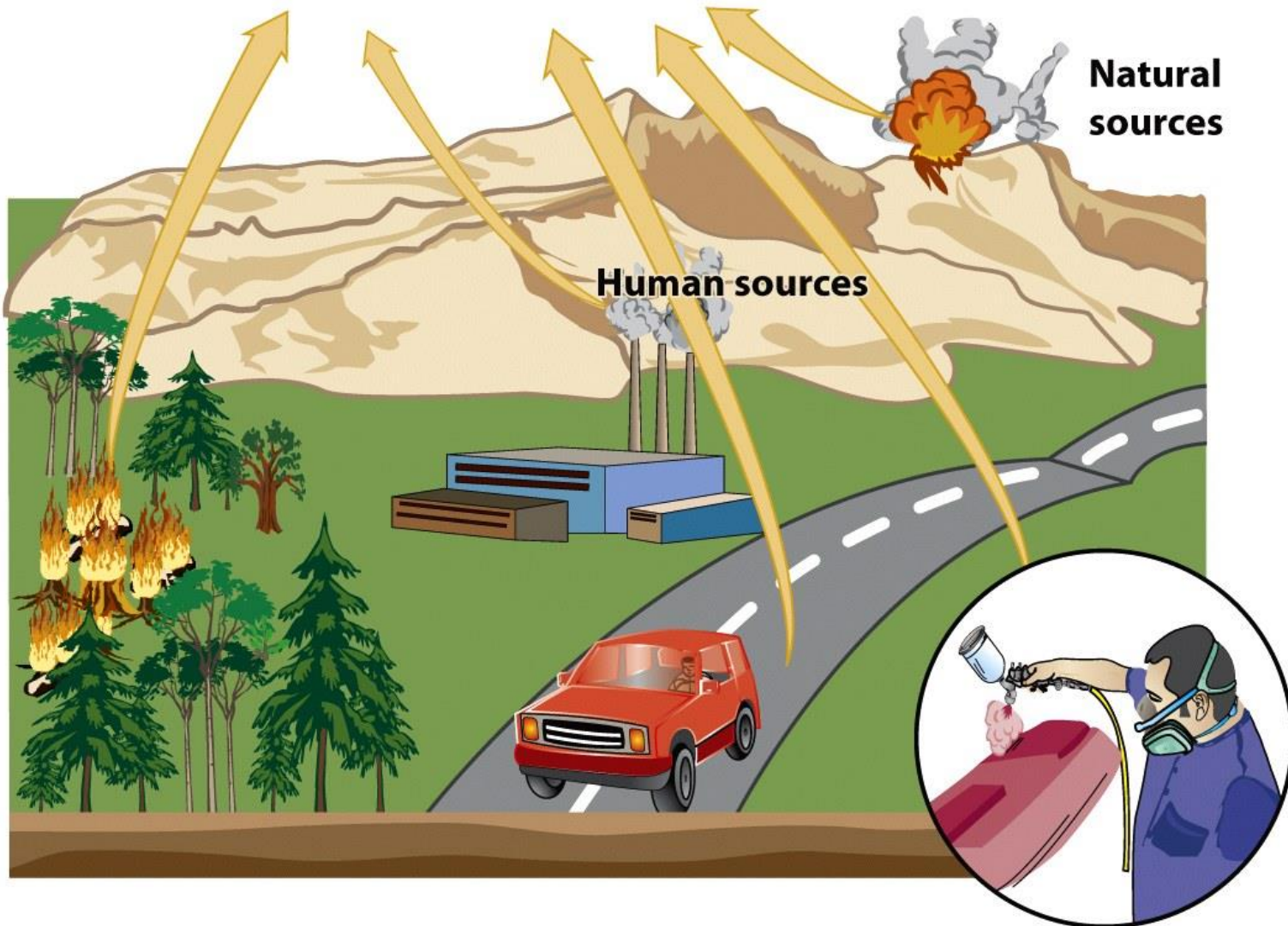*Source:* Environmental Protection Agency.

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

Traffic congestion on good road infrastructure is a daily reality of India's urban centers. Slow speeds and idling vehicles produce, per trip, 4 to 8 times more pollutants and consume more carbon footprint fuels, than free flowing traffic. This 2008 image shows traffic congestion in Delhi.

Cooking fuel in rural India is prepared from a wet mix of dried grass, fuelwood pieces, hay, leaves and mostly cow/livestock dung. This mix is patted down into disc-shaped cakes, dried, and then used as fuel in stoves. When it burns, it produces smoke and numerous indoor air pollutants at concentrations 5 times higher than coal.

A rural stove using biomass cakes, fuelwood and trash as cooking fuel. Surveys suggest over 100 million households in India use such stoves (chullahs) every day, 2–3 times a day. Clean burning fuels and electricity are unavailable in rural parts and small towns of India because of poor rural highways and limited energy generation infrastructure.
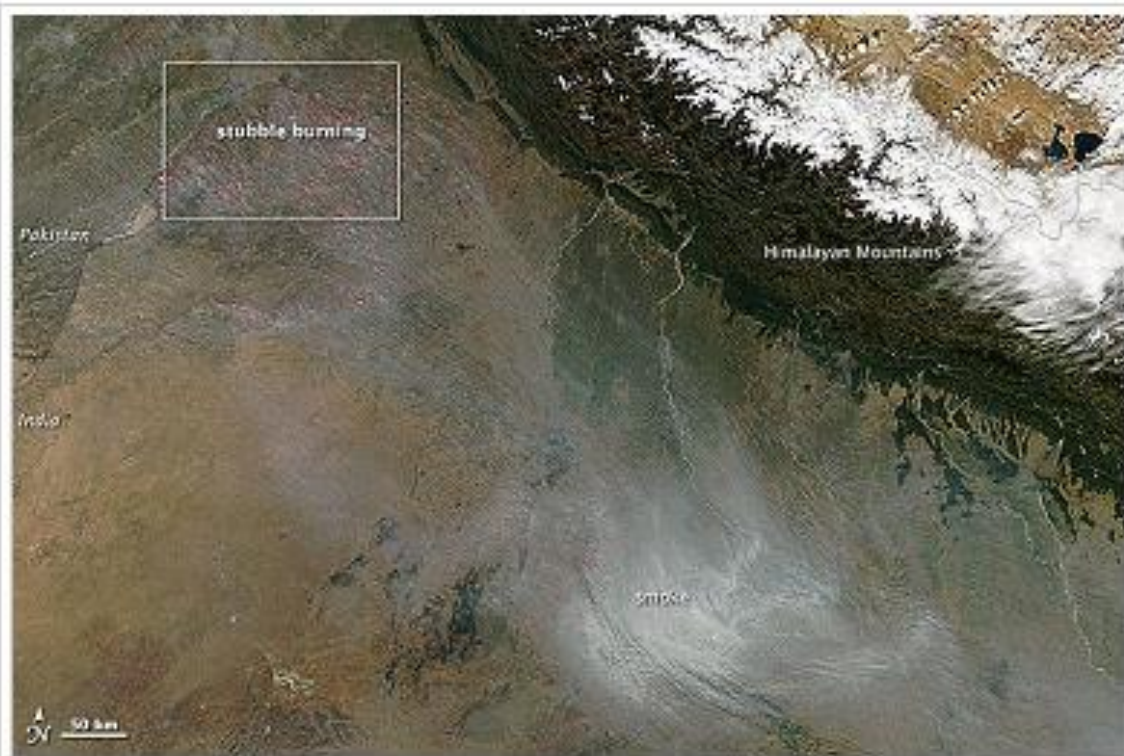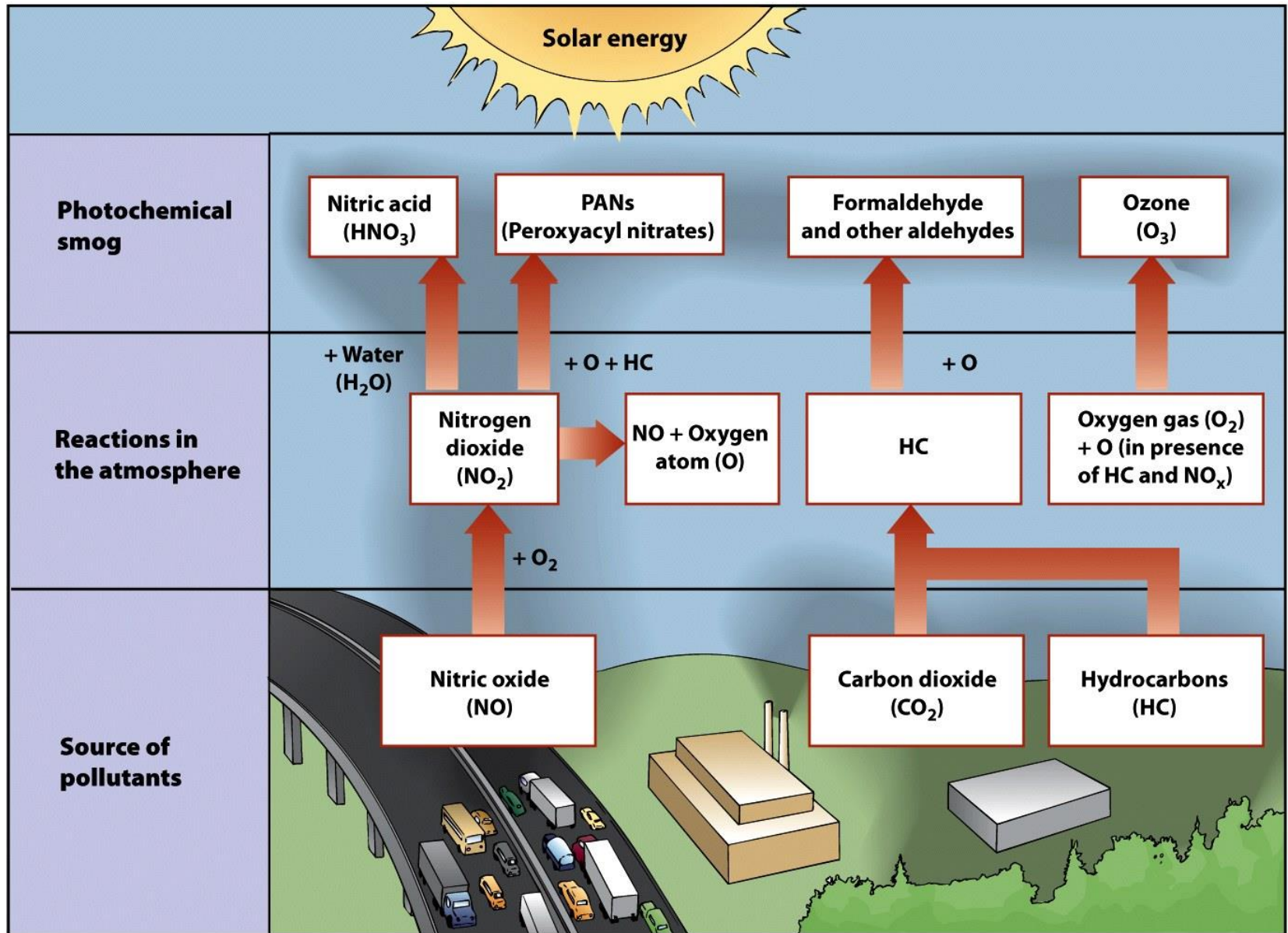

Aerial view showing India's annual crop burning, resulting smoke and air pollution. During the autumn and winter months, some 500 million tons of crop residue are burnt, and winds blow from India's north and northwest towards east.[2][17][18] Courtesy of NASA Satellites, imaged in November 2013.[3][19]

How Acid Deposition Develops
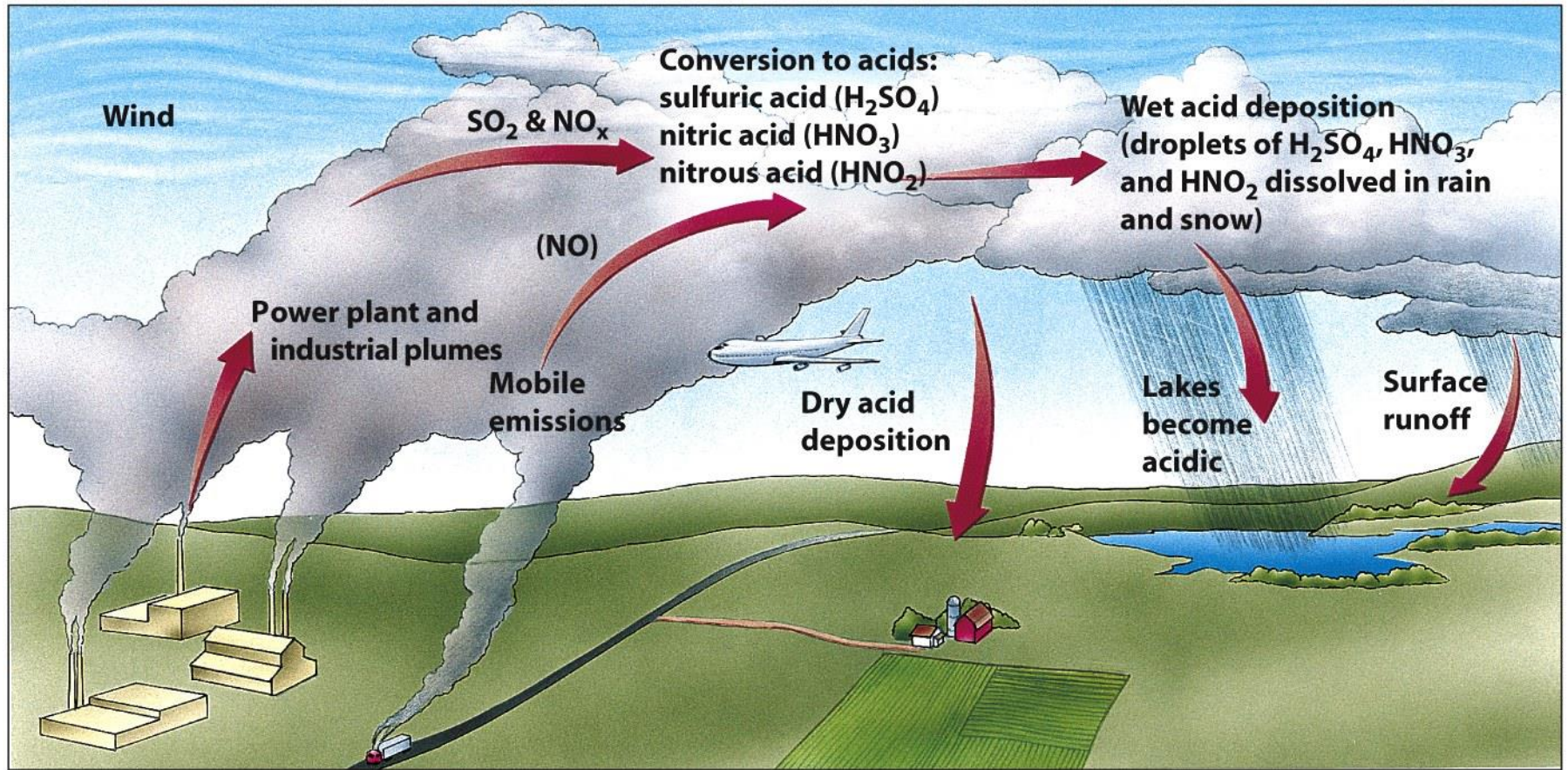
Formation of Photochemical Smog

Effects of Air Pollution

- Low level exposure
  - Irritates eyes
  - Causes inflammation of respiratory tract
- Can develop into chronic respiratory diseases

**Table 20.2 Health Effects of Several Major Air Pollutants**

Pollutant	Source	Effects
Particulate	Industries, electric power plants, motor vehicles, construction, agriculture	Aggravates respiratory illnesses; long-term exposure may cause increased incidence of chronic conditions such as bronchitis; linked to heart disease; suppresses immune system; some particles, such as heavy metals and organic chemicals, may cause cancer or other tissue damage
Nitrogen oxides	Motor vehicles, industries, heavily fertilized farmland	Irritate respiratory tract; aggravate respiratory conditions such as asthma and chronic bronchitis
Sulfur oxides	Electric power plants and other industries	Irritate respiratory tract; same effects as particulates
Carbon monoxide	Motor vehicles, industries, fireplaces	Reduces blood's ability to transport oxygen; headache and fatigue at lower levels; mental impairment or death at high levels
Ozone	Formed in atmosphere (secondary air pollutant)	Irritates eyes; irritates respiratory tract; produces chest discomfort; aggravates respiratory conditions such as asthma and chronic bronchitis

Health Effects of Air Pollution

- Sulfur Dioxide and Particulate material
  - Irritate respiratory tract and impair ability of lungs to exchange gases
- Nitrogen Dioxides
  - Causes airway restriction
- Carbon monoxide
  - Binds with iron in blood hemoglobin
  - Causes headache, fatigue, drowsiness, death
- Ozone
  - Causes burning eyes, coughing, and chest discomfort
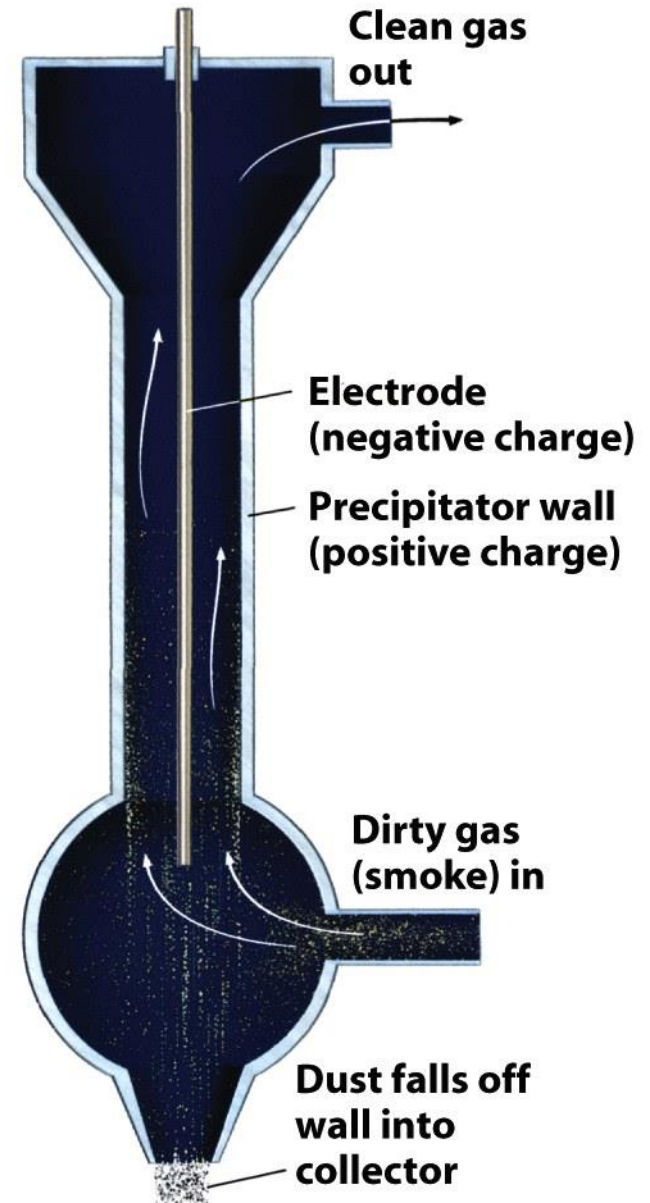
Controlling Air Pollution

- Smokestacks with electrostatic precipitator (right)
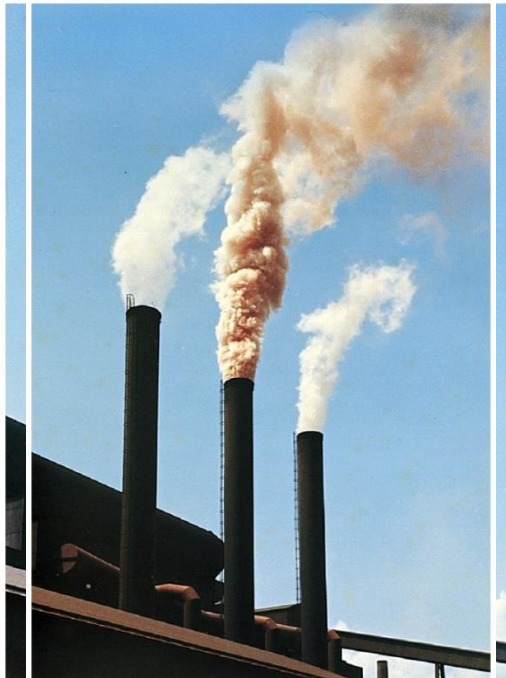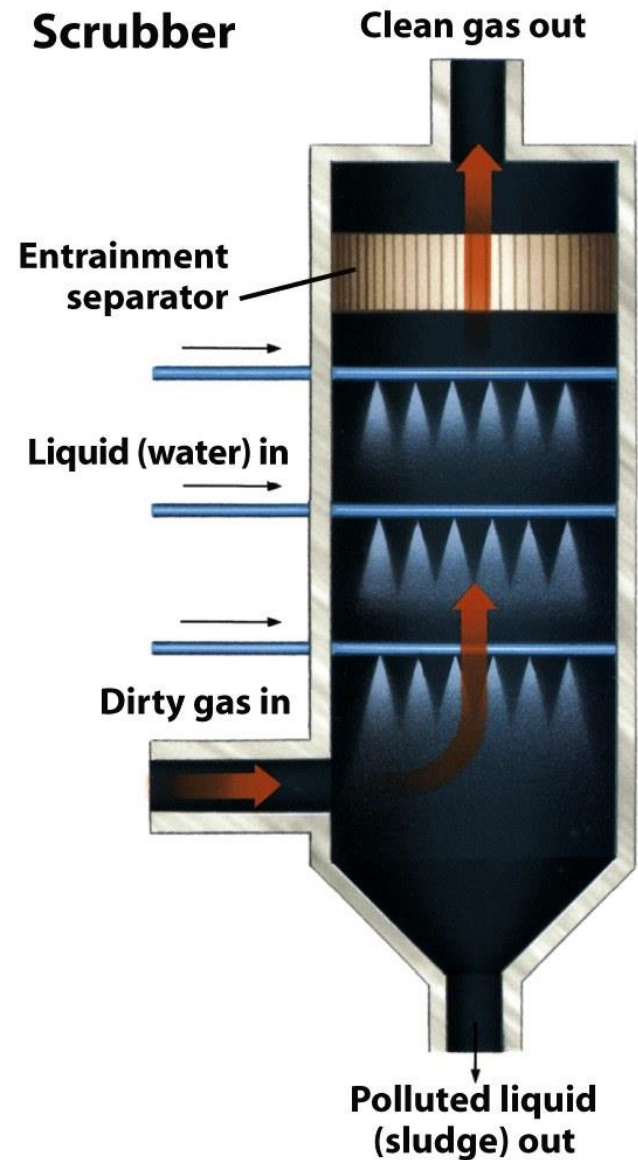

Without Electrostatic precipitator

With Electrostatic precipitator

Electrostatic precipitator

Clean gas out

Electrode (negative charge)

Precipitator wall (positive charge)

Dirty gas (smoke) in

Dust falls off wall into collector

Controlling Air Pollution

- Smokestacks with scrubbers (right)

Scrubber

Clean gas out

Entrainment separator

Liquid (water) in

Dirty gas in

Polluted liquid (sludge) out

Controlling Air Pollution

Vapor Recovery System for gasoline

Hose B (Vapor Tube)

Hose A (Gasoline Tube)

Vapor

Gasoline
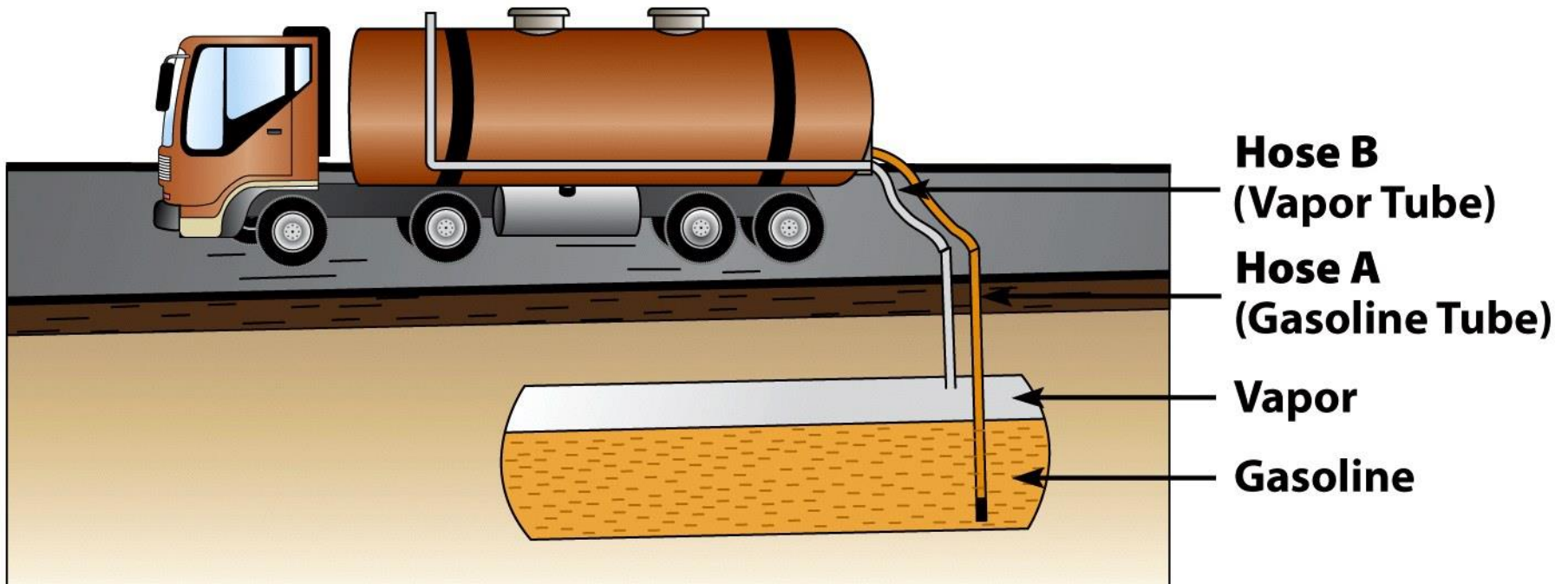
- Use of high chimneys
- Removal of air pollutants from fuel
- Control of exhaust pollution
- Proper treatment of organic wastes
- Development of green areas

WATER POLLUTION

Point and non-point sources of pollution

effluents discharged directly into water body

a drain pipe carrying industrial effluents discharged directly into water body

discharge of pollutants from diffused sources or from a larger area

runoff from agricultural fields,
grazing lands,
construction sites,
abandoned mines and pits,
roads and streets

Causes of water pollution in India

- Urbanization
- Sewage Water – Dissolved Oxygen(DO), BOD, COD
- Industrial waste - Inadequate industrial treatment of wastes
- Thermal and radiation pollution.
- Improper practices in agricultural sector
- Withdrawal of Water (Reduction in water quantity in rivers in plains)
- Social and religious practices- dumping dead bodies in water, bathing, throwing waste in water…etc.
- Oil leaks from ships
- Acid rain
- Global warming
- Eutrophication

Effects of water pollution in India

- polluted water is one of the major factors behind the general low levels of health in India, especially in the rural areas.

- Polluted water can lead to diseases such as cholera, tuberculosis, dysentery, jaundice, diarrhoea, etc.

- In fact, around 80% stomach ailments in India happen because of consuming polluted water.

- Bio accumulation & Biomagnification

Solution of water pollution in India

- Cleaning up waterways and beaches- water treatment

- Waste water reclamation- reuse for various purposes

- Harvesting of biomass

- Avoiding the usage of nonbiodegradable material like plastic

- Being more involved in various measures pertaining to preventing water pollution.

- **Riparian buffers**: a vegetated area ("buffer strip") near a stream.

- **Water hyacinth** (an aquatic weed) purify water by absorbing toxic materials and heavy metals from water.

- Oil spills cleaning by using **bregoli** (a by-product of paper industry resembling saw dust), oil zapper (mixture of five bacteria)…etc.

- eucalyptus trees absorb all surplus waste water rapidly and release pure water vapor into the atmosphere.

Bioremediation

- use of microorganisms (bacteria and fungi) to degrade the environmental contaminants into less toxic forms.

Phytoremediation

Flyash

- ejected mostly byproducts in coal burning operations (thermal power plants).

Composition

- Fly ash particles are **oxides** and consist of silica, alumina,, calcium, magnesium and toxic heavy metals (lead, arsenic, cobalt, copper).

- Major oxides - Aluminium silicate, silicon dioxide and calcium oxide, iron oxides.

Effects

- pollutes air and water (heavy metal pollution).
- affects vegetation.

Advantages

- Cement can be replaced by fly ash up to 35%, thus reducing the cost of construction, making roads, etc.
- Fly ash bricks are light in weight and offer high strength and durability.
- Use as a better fill material for road embankments and in concrete roads.
- Used in reclamation of wastelands.
- Abandoned mines can be filled up with fly ash.
- It can increase the crop yield and also enhances water holding capacity of the land.

Radioactive Pollution

Artificial Sources

- Accidents in nuclear power plants and nuclear waste.
- Nuclear weapon testing and explosion (Nuclear fallout; strontium-90, cesium-137, iodine-131…etc).
- Mining of radioactive material like Uranium, thorium…etc.
- Radiation therapy and direct exposures to radiation for diagnostic purposes (e.g. X-rays), chemotherapy…etc.
- Slow nuclear radiations originated from nuclear reactors, laboratories, hospitals… etc.

Natural Sources

- Cosmic rays from space
- Terrestrial radio-nuclides radium-224, uranium-238, thorium-232, potassium-40, carbon-14…etc.
- Some species of animals and plants preferentially accumulate specific radioactive materials. (oysters deposit 65Zn, fish accumulate 55Fe, marine animals selectively deposit 90Sr).

Effects of Radioactive pollution

Accidental leakage (Three Mile Island, Chernobyl and Fukushima) and Safe disposal of radioactive wastes.

- Continued small dose exposure to nuclear radiation can cause childhood leukemia, miscarriage, underweight babies, infant deaths, increased susceptibility to AIDS & other immune disorders.

- radioactive wastes pollute water and soil - enters food chain (detected even in the milk).

- various disorders; mutations – lethal being cancer.

Chlorofluorocarbons (CFCs)

- Chlorofluorocarbons (CFCs) - compounds with elements chlorine, fluorine and carbon.

- At room temperatures- colourless gases or liquids.

- They are generally unreactive and stable, non-toxic and nonflammable.

- CFCs - part of volatile organic compounds (VOCs).

Land or Soil pollution

defined as the changes in **physical**, **chemical** and **biological** conditions of the soil or land through man's intervention or misuse of land.

Natural factors:

volcanic eruptions,
changes in rainfall pattern,
earthquakes,
topographic changes,
wind and glacier movements

Human activities:

- Deforestation
- Faulty agricultural practices
- Excreta of birds, animals and humans
- Sewage used as manure
- Acid rains
- Toxic chemicals in the form of solid and liquid wastes
- Radioactive wastes

Harmful effects

1. Decrease in soil fertility and agricultural production.

2. Chemical pollutants (chemical fertilizers and pesticides, insecticides and herbicides) cause various diseases and several deaths.

3. Those bacteria which are transmitted to human-beings from soil infect causes dysentery, cholera, tuberculosis, typhoid and paratyphoid fever…etc.

4. The decomposition of various waste materials causes harmful gases and bad smell.

5. Clogging of micro-holes of the soil by particles in the sewage destroy the soil micro-organisms.

6. Land pollution is one of the main causes of air and water pollution.

Control

1. Soil erosion should be checked.

2. **Controlled and judicious use** of chemical fertilizers and biocides (pesticides, insecticides and herbicides).

3. **Proper disposal** of industrial and urban wastes.

4. After proper treatment the urban and industrial effluents should be used for irrigation purposes.
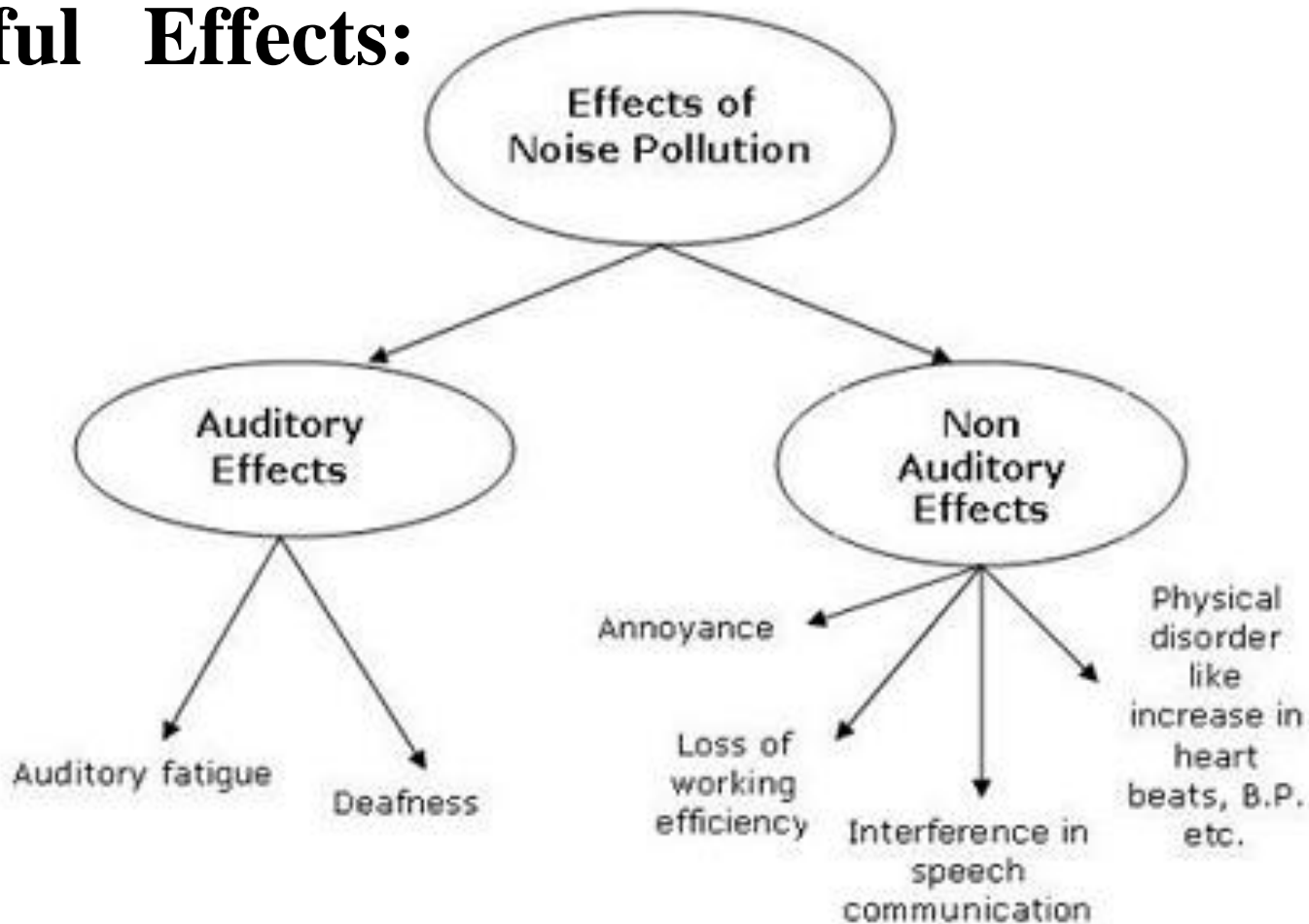
5. Proper land use and management.

Noise Pollution

Noise is defined as unwanted sound

Sources of Noise Pollution
1. Road Traffi c Noi se
2.   Air Craft Noise
3. Noise from rail roads
4. Construction Noise
5. Noise in Industry
6. Noise in building
7.   Noise from Consumer products

Harmful   Effects:

Effect on Vegetation - Poor quality of Crops
Effect on Animal damage in nervous system
Effect on Property   buildings, bridges and monuments.

Bioindicators

Classification of Bioindicators

1. Based on the aim of indicators.

• **Early Warning Indicators:** rapid and sensitive response to environmental changes

• **Diagnostic Indicators**: individual or sub organism used to investigate/measure observed environmental disturbances (biomarker).

• **Compliance Indicators:** The species are used to verify maintenance or restoration goals at the population, community or ecosystem levels to be achieved. eg. fish population

• **Accumulation Indicators**: They are distinguished for toxic effects bioindicator, with the effects being studied on different biological organisation level. eg. lichens, mussels...etc.

2. Based on the applications of indicators.

• **Environmental Indicators**: This is a species or group of species responding predictably to environmental disturbances or change -environmental policy making.

• **Ecological Indicators**: known to be sensitive to pollution, habitat fragmentation or other stresses. The response of the indicator is representative for the community.

• **Biodiversity Indicators**: Indicator for species richness of a community. However, the definition has been broadened to measurable parameter of biodiversity including e.g species richness, endemism, genetic parameter, population -specific parameter and landscape parameter.

TYPES OF BIOINDICATORS

Plant indicator

- Zooxanthellae are symbiotic algae

  - live in coral tissues and supplying nutrients and energy

  - sensitive to temperature changes- disappearing or leaving the corals

  - absence of algae in the corals causes bleaching phenomenon

- Lichens (symbiotic alga + fungi).

  - Lichens can live in extreme conditions, but they hate pollution.
  - The cleaner the air the bigger and more elaborate the lichen.

- The chlortic flakes of pine needle are good examples of ozone damages.

  - The collapse, glazing and bronzing of leaf cells due to

    peroxyacetyl nitrate (PAN) pollution.

Animal indicators

➢ An increase or decrease in an animal population

➢ monitoring the concentration of toxins in animal tissues

➢ monitoring the rate at which deformities arise in animal population

• **Earthworm** density and biomass are strongly influence by contamination.

• **Frogs -** accurate indicators of environmental stress and the health of biosphere as a whole.

• **Fish** is a good indicator of water pollution.

• **Macro invertebrates -** sensitive to pollution, excess nutrients, increased turbidity, chlorine...etc.

Microbial indicators

➤ found in large quantities and are easier to detect and sample.

➤ Specific microorganisms - particular type of pollution.

- **Bioluminescent bacteria**

  - to test water for environmental toxins.

  - toxins in water inhibited/disrupted the cellular metabolism

  - affects quality or amount of light emitted by bacteria

- **Cyanobacteria** (dry period)

  - abundance - excess nutrient loads (phosphate)

  - relatively high temperature

- Microorganisms stress proteins

  - when exposed to contaminants like cadmium and benzene.

Geoindicators
- ➢ environmental indicators that deal mainly with natural landscape change
- ➢ refer to processes that can operate without human interference
- ➢ assessing environmental change over periods of 100 years or less - magnitudes, frequencies, rates or trends of geological processes and phenomena that occur at or near the Earth's surface
- Geoindicators are high resolution measures of short term, dominantly abiotic (physical and chemical) changes in the landscape and geological environment
- irreversible ecosystem disturbance

  - rapid- catastrophic events (e.g. earthquakes, landslides, floods, eruptions)

  - more pervasive, slow onset changes - (e.g. erosion, stream sediment transport, dune movement, sea level).
- excluded event from consideration

  - plate tectonics

  - the compaction and subsidence of sedimentary basins

  - hydrocarbon and mineral formation