

## Unit 5: Environmental Pollution

- Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

# POLLUTION

## Definition

Pollution is an undesirable change in physical, chemical and biological characteristics of our land, air or water caused by excessive accumulation of pollutants (i.e. Substances which cause pollution).

## KINDS OF POLLUTION

The pollution is of four major types namely air pollution, water pollution, land pollution and noise pollution.

In terms of origin it may be natural or anthropogenic (man-made).



### MORE TO KNOW

Black Lung disease

It is common among coal miners due to the inhalation of carbon particulates which lead to Lung Cancer.



# AIR POLLUTION

Degradation of air quality and natural atmospheric condition constitute air pollution. The air pollutant may be a gas or particulate matter.

## Air pollutants and their effects

**Particulate matter** – it comprises of small suspended particles such as soot, dust, pesticides, etc., and biological agents such as spores, pollen and dust mites. It causes respiratory ailments such as asthma, chronic bronchitis, etc.,

**Carbon monoxide** – is a product of incomplete combustion of fossil fuels in automobiles. It is highly poisonous to most animals. When inhaled, carbon monoxide reduces the oxygen carrying capacity of blood.

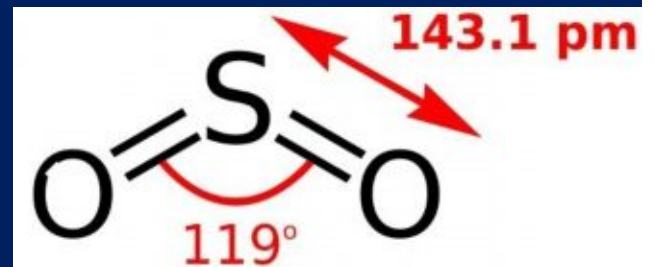
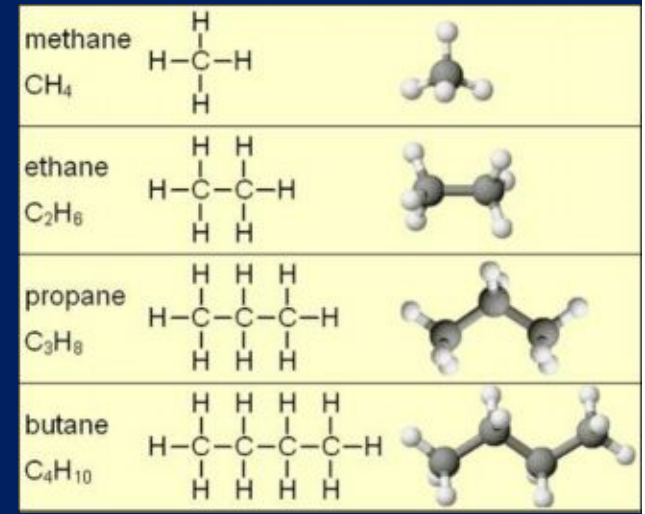


# Air pollutants and their effects

**Hydrocarbons** – hydrocarbons such as methane, are evolved from soil microbes (methanogens) in flooded rice fields and swamps. They are also generated during the burning of coal and petroleum products.

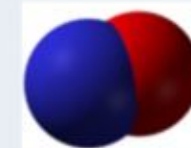
**Sulphur dioxide** – is released from oil refineries and ore smelters which use the sulphur containing fuels. It causes harmful effects on plants and animals. It causes chlorosis (loss of chlorophyll) and necrosis (localised death of tissues). In human, it causes health problems such as asthma, bronchitis and emphysema.

**Nitrogen oxides** – It causes reddish brown haze (brown air) in traffic congested city air which contributes to heart and lung problems.

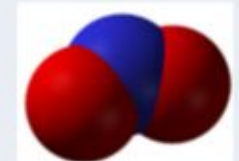


## NO<sub>x</sub> (Nitrogen Oxide)

Nitric Oxide  
(NO)



Nitrogen Dioxide  
(NO<sub>2</sub>)



# Secondary effects of air pollution

**Photochemical smog** – Smog is a mixture of smoke and fog. It is formed in the atmosphere under the influence of sunlight by the photochemical reactions of hydrocarbons, oxides of nitrogen and oxygen, resulting in the formation of PAN (Peroxy Acetyl Nitrate).

**PAN** damages the chlorophyll and thus reduces photosynthesis and growth. It also causes acute irritation of eyes and throat. Visibility of the surrounding is reduced due to smog.

**Acid rain** – gases such as Sulphur di oxide and Nitrogen oxides are oxidized to form sulphuric and nitric acids along with water, and precipitate as acid rain. It damages building materials, plants and animals. It also makes the soil acidic.

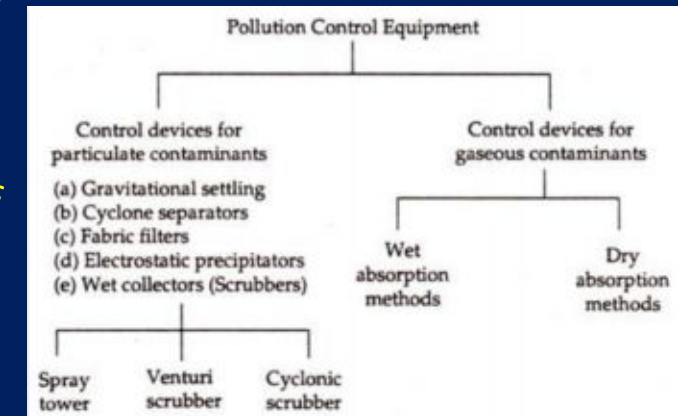
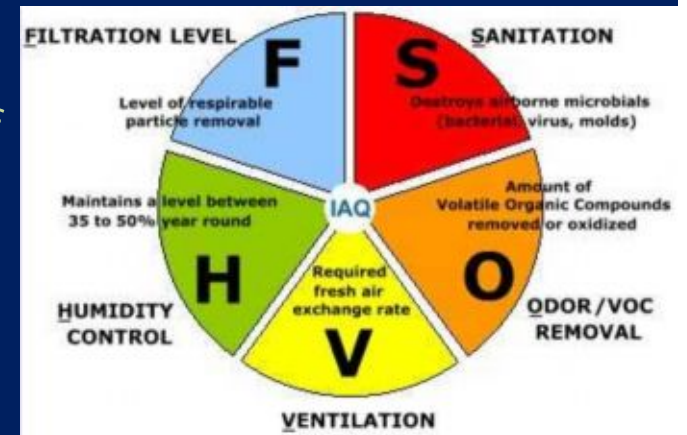


Sculpture affected by acid rain



# Control of air pollution

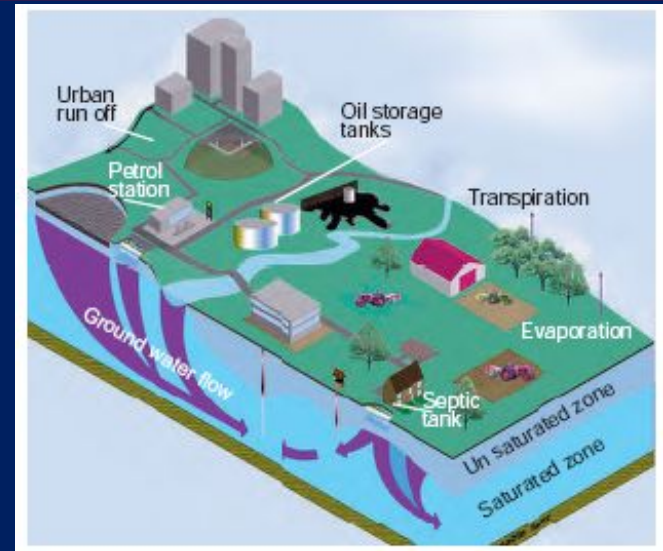
1. The particulates emitted by industries should be controlled by devices such as scrubbers, precipitators and filters.
2. Use of unleaded or low sulphur fuel is to be encouraged.
3. Shifting to non-conventional sources of energy (e.g solar energy, hydel energy, tidal energy, etc.,) in order to reduce the dependance of conventional sources.
4. Smoking in public places should be prohibited, because the cigarette smoke contains carcinogens such as benzopyrene. An average smoker runs the risk of developing heart and lung diseases.
5. Planting of trees along the road sides and around industrial areas.



# WATER POLLUTION

Water pollution is defined as the adding of unwanted substances or the change of physical and chemical characteristics of water in any way which makes it unfit for human consumption.

It is caused by waste products of industries (effluents), domestic sewage, oil spillage, agricultural and industrial run off etc.,



## MORE TO KNOW

### REVERSE OSMOSIS (RO)

It is the most efficient way of obtaining purified drinking water. During this process, pressure is applied on the solution which has more concentration. This reverses the natural direction of water flow and osmosis from high gradient to low gradient. This process involves energy expenditure. The membranes used for RO process have a dense barrier layer which allow only the water to pass through and prevents the passage of solutes. Hence, it is best suited for **desalination** of sea water (removal of salt).

# Sources and effects of water pollution

Industrial wastes –The industrial effluents containing heavy metals and chemicals such as arsenic, cadmium, copper, chromium, mercury, zinc, nickel, etc., are directly released into the water bodies such as lakes, ponds and rivers without proper treatment.

These wastes contaminate the water bodies and make them unsuitable for human consumption.

Hot water is another noted pollutant from industries.

## MORE TO KNOW

### MINAMATA DISEASE

Mercury poisoning due to the consumption of fish captured from mercury contaminated Minamata Bay in Japan was detected in 1952. Mercury compound in waste water are converted by bacterial action into extremely toxic methyl mercury which can cause numbness of limbs, lips and tongue. It can also cause deafness, blurring of vision and mental derangement.

## MORE TO KNOW

Biological magnification of DDT (Dichloro diphenyl trichloroethane) is seen in aquatic food chain. The concentration of DDT gradually increases at each trophic level. DDT inhibits calcium carbonate deposition in the oviducts of certain birds which result in the laying of thin shelled eggs. These eggs can easily break during incubation and the developing embryos are destroyed.



# Sources and effects of water pollution..

1. Many industries use water as a coolant for the machinery and release of hot waste water into the water bodies causing thermal pollution which affect both the plant and animal life.
2. The surface run off - the surface run off from agricultural land is contaminated with pesticides and residues of inorganic fertilizers.
3. The run off from urban and industrial are rich in organic and inorganic compounds. These pollutants contaminate both surface and ground water resources.



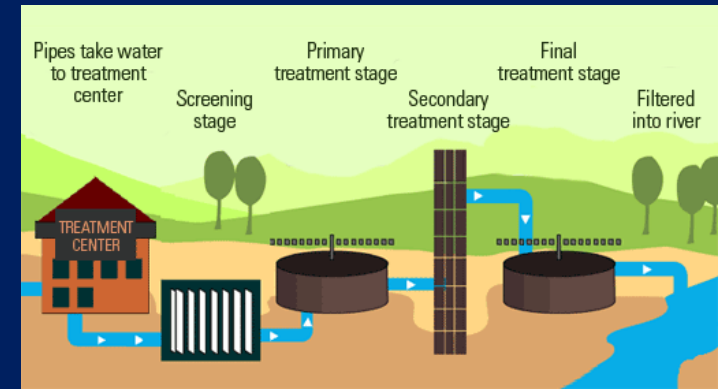
# Sources and effects of water pollution...

4. Oil spills – An oil spill is an accidental discharge of petroleum products in oceans and estuaries from capsized oil tankers, offshore drilling and exploration operations. It can cause drastic damage to the marine and coastal bio diversity.
5. Domestic Sewage – It is rich in organic matter and detergents. Decomposition of organic matter increases the nutrient content of the water bodies.
6. Availability of excess nutrients results in algal bloom on the surface of water resulting in the deficiency of oxygen content (BOD – Biological Oxygen Demand). This in turn leads to the death of aquatic organisms. This process is known as Eutrophication.



# Control of water pollution

1. Sewage treatment plants should be installed to treat sewage before releasing into water bodies.
2. Excessive use of pesticides, herbicides and fertilizers should be avoided.
3. Biological control of insect pests and organic farming is to be followed in order to reduce the dependence on pesticides and inorganic fertilizers.
4. By legislation and strict enforcement.
5. By creating social awareness among people about the water pollution and the need for pure water.



# SOIL POLLUTION

Soil pollution is the unfavorable alteration of soil by the addition or removal of substances which decrease soil productivity and ground water quality.

It usually results from different human activities like dumping of waste, use of agro chemicals, mining operations and urbanization.



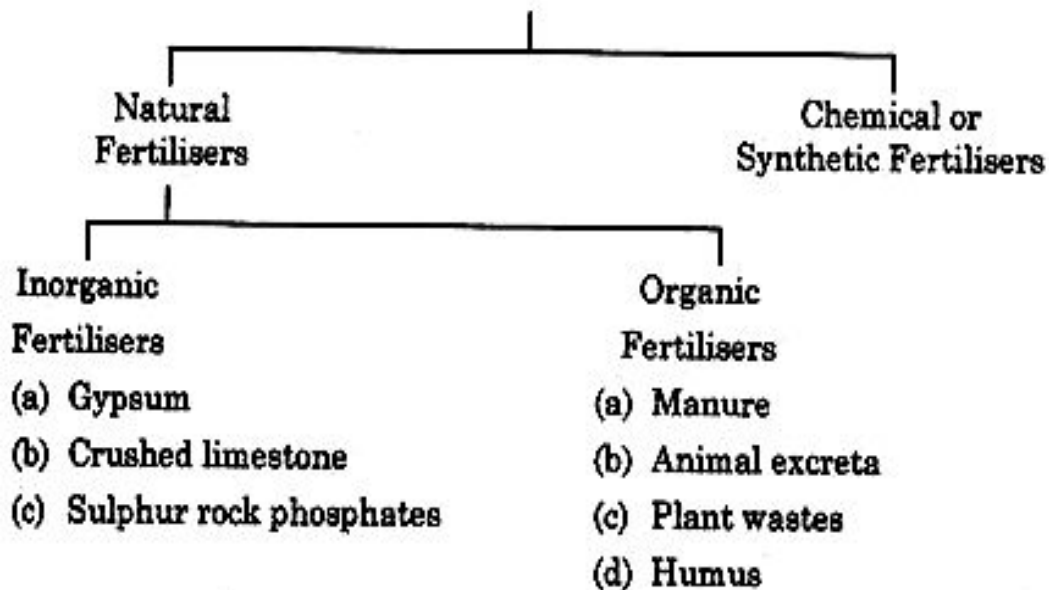
# SOIL POLLUTION : Causes and effects

- The industrial solid waste and sludge contain toxic organic and inorganic compounds as well as heavy metals.
- The radio active waste from nuclear power plants and nuclear explosions also contaminate the soil.
- Fly ash contains fine particulates which are released from thermal power plants. It settle on the ground and cause pollution.
- The domestic waste is rich in organic matter and undergo decomposition.
- The hospital waste contains a variety of pathogens that can seriously affect human health.



# SOIL POLLUTION : Causes and effects

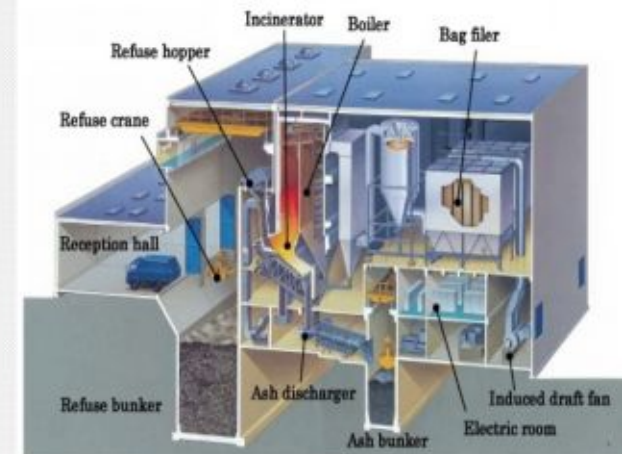
Agricultural chemicals such as pesticides, insecticides and inorganic fertilizers may pollute drinking water and can change the chemical properties of the soil adversely affecting the soil organisms.



# CONTROL OF SOIL POLLUTION

- Management of soil wastes include collection and categorization of wastes. Recovery of resources like scrap metals, plastics, etc., for recycling and reuse and safe disposal with a minimum environmental hazards is to be followed.
- Other notable methods of waste disposal include incineration (burning in the presence of oxygen) and pyrolysis (burning in the absence of oxygen).
- Afforestation and reforestation should be undertaken on a large scale to prevent soil erosion and loss of soil nutrients.

Methods to control Soil Pollution



# RADIOACTIVE POLLUTION

The emission of protons, electrons and electromagnetic radiations released by the disintegration of radioactive substances such as radium, thorium, uranium, etc., cause air, water and land pollution.

## Effects :-

- The ionising radiations can cause mutations.
- Strontium-90 accumulates in bones causing bone cancer.
- Iodine-131 can damage bone marrow, spleen, lymph nodes and can cause leukemia (blood cancer).



Nuclear explosion

## MORE TO KNOW

### Chernobyl disaster (Ukraine)

The explosion at the Chernobyl nuclear power station was undoubtedly the world's worst nuclear disaster. The deadly radioactive material was released into the atmosphere. The inhabitants of Chernobyl were exposed to radioactivity which was hundred times greater than Hiroshima bomb. Babies were born with infirmities and people suffered from serious diseases like thyroid cancer.



# RADIOACTIVE POLLUTION: PREVENTIVE MEASURES

- Care should be taken to prevent the leakage of radioactive substances from nuclear reactors.
- Radioactive wastes should be disposed off safely.
- Strict measures should be followed in the construction and maintenance of nuclear power plants to prevent nuclear accidents.
- Control or prevention of nuclear tests.

## Effects of Radio Active Pollution

- The Diseases include blood in cough
- Ulcer
- Swelling of bone joints
- Cancer
- Lung Cancer
- Skin Cancer
- Bone Cancer
- Eye Problems

### MORE TO KNOW

Various laws and rules have been promulgated by the government of India from time to time to control pollution. Some of them are 1974 - Water (prevention, control of pollution) Act.

1980 - Forest Act.

1981 - Air ( prevention, control of pollution) Act.

1986 - Environmental pollution Act.

1988 - Motor vehicles Act

# NOISE POLLUTION

- Noise may be defined as an unwanted and unpleasant sound that may have adverse effects on animals and humans.
- The unit of sound level is decibels (db).
- Noise level above 120 db is considered harmful to human beings.



## MORE TO KNOW

Jet Aircraft (take off)	145 db
Heavy city traffic	90 db
Vaccum cleaner	85 db
Window Air conditioner	60 db
Normal speech	60 db

# NOISE POLLUTION..

## Sources

- The different sources associated with noise pollution are industrial machinery, road, rail and air transport, loudspeakers, construction equipments, household appliances, crackers, etc.,



## Effects

- Noise seriously affects heartbeat, breathing, and can cause constriction of blood vessels.
- It can cause headache, sleeplessness, irritability and may seriously affect the productive performance of human.



# NOISE POLLUTION...

- Loud noises (above 130 db) can cause damage to the ear drum, hair cells of cochlea (organ of hearing) and thereby resulting in temporary or permanent loss of hearing.
- It can also seriously affect the concentration of students while learning.

Decibels	Sources	Intensity
170 – 200	stun grenades/space shuttle engine	shatters eardrum
140 – 170	jet engine/firearms/rock concert peak level	damage to eardrum
120 – 130	thunder/jackhammer/loud car stereo	damage to eardrum
90 – 110	train/motorcycles/chainsaw/marching band	extremely loud
80 – 90	most alarm clocks/vacuum cleaners	extremely loud
60 -70	street noise/conversation/dishwasher/AC	loud
50 – 55	rain/normal office or home noise/AC	medium
30 – 40	library/whispers/sleeping bedroom/PC	low
0 - 20	almost total quiet	

## Effects of noise pollution

- Generally, problems caused by noise pollution include stress related illnesses, speech interference, hearing loss, sleep disruption, and lost productivity.
- Rise in blood pressure
- Physical development of fetous.
- Reduce concentration.
- Causes serious mental disorders.



# NOISE POLLUTION: Control measures

- The industries should be established away from residential areas.
- Trees should be planted along roadside or highways to reduce noise levels.
- The industrial machinery and motor vehicles should be properly maintained in order to minimize the noise.
- The use of loudspeakers and bursting of crackers should be restricted.
- Effort must be made to create awareness among people about the harmful effects of noise and the need to control it.

## Remedial measures



- Planting trees
- Regular servicing of automobiles.
- Building can be designed with suitable noise absorbing materials for the walls, window and sealing
- Proper lubrication and maintains of machines.
- Workers should provided with ear plugs for hearing protection.
- Factories and industries should located far from residential area.

## Noise Pollution Control Measures



- Road noise:
  - Use of noise barriers, limitations on vehicle speed
  - newer roadway surface technologies
  - traffic control
  - limiting times for heavy duty vehicles
- Air line Noise:
  - Developing quieter jet engines
  - controlling take off and landing times
- Industrial Noise:
  - New technologies
  - Installations of noise barriers in the work place
- Residential Noise:
  - Regulate noise from power tools, garden equipment, loud radios

# Waste Generation in India

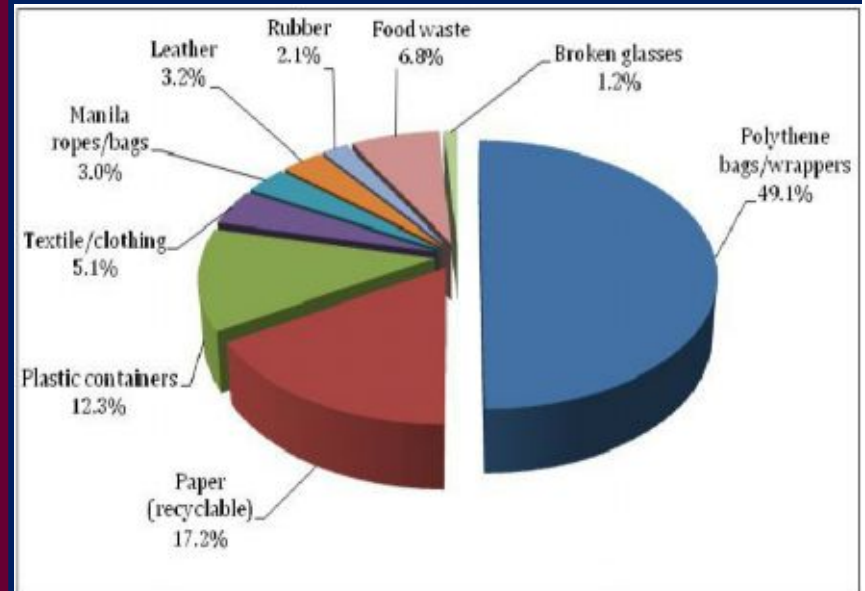
- India produces 55 million tons of municipal solid waste annually at present.
- Per capita generation of waste varies from 200 gm to 600 gm per capita / day.
- Average generation rate at 0.4 kg per capita per day in towns.
- Collection efficiency ranges between 50% to 90% of the solid waste are generated.

**4.7 million tonnes** of garbage  
generated daily in the world.

**55 million tons** of MSW is generated  
in India per year

The estimated annual increase  
in per capita

waste generation is about **1.33 % per year**



# WHAT IS SOLID WASTE?

- Solid or semi-solid material (including gases and liquids in containers) which are non soluble in nature are solid waste.
- Solid waste includes agricultural refuse, demolition waste, industrial waste, mining residues, municipal garbage, sewage sludge, etc.

**Bio-degradable:** can be degraded  
paper, wood, fruits and others)

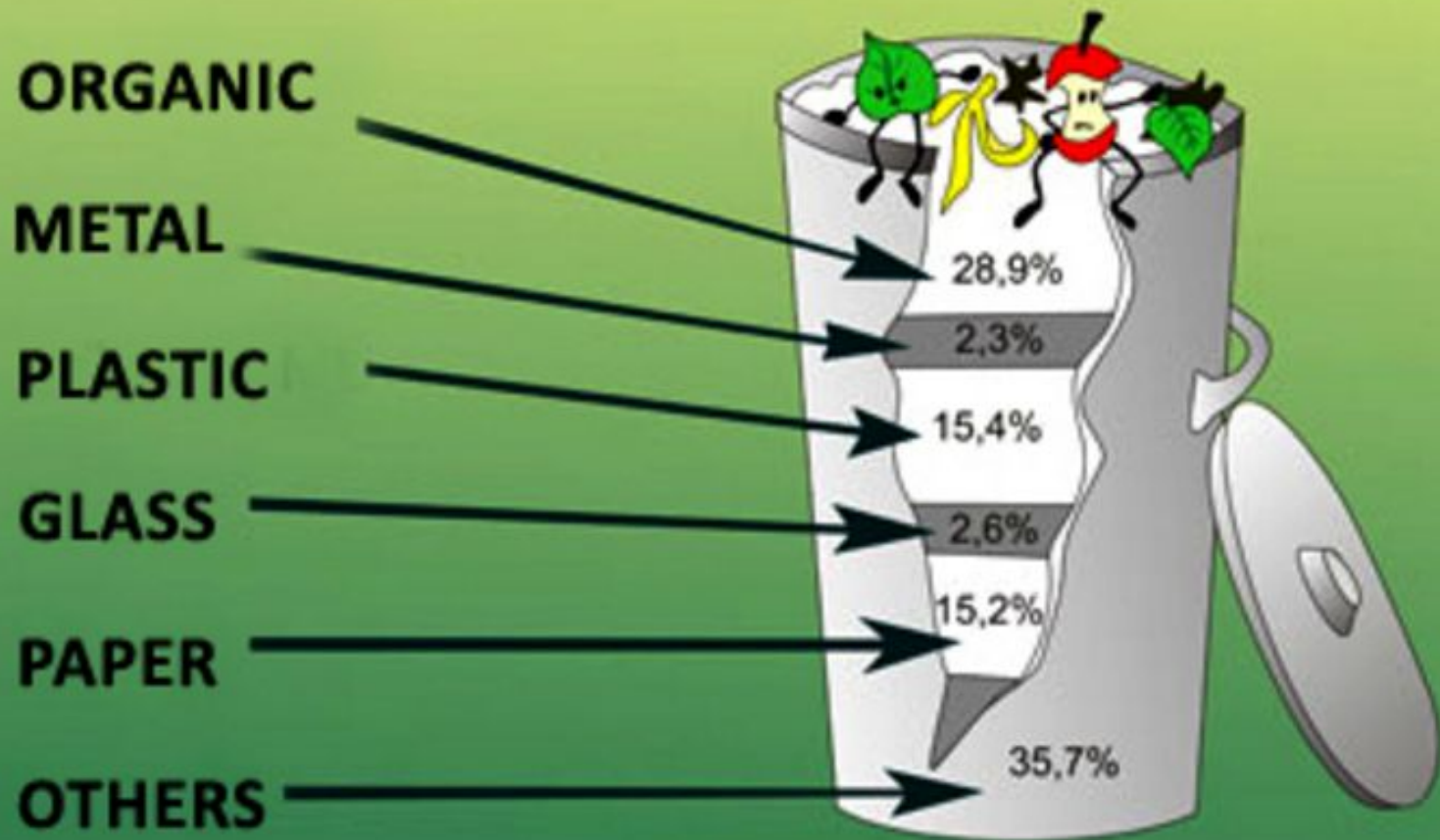
**Non-biodegradable:** cannot be  
degraded plastics, bottles, old-  
machines, containers and others)

WASTE is a any material,  
Thrown away" regarded as  
useless and unwanted  
(at a certain time and place)



# COMPOSITION OF HOUSEHOLD WASTE

*Organic waste is compostable!*





# TYPES OF SOLID WASTE

- Solid waste can be classified into different types depending on their source:
- **Household waste or municipal waste:** includes food, paper, cardboard, plastic, textiles, leather, glass, metal, ashes, electronics waste etc.
- **Industrial waste:** includes toxic chemicals, oil, debris from construction site, packaging waste, ashes etc.
- **Biomedical waste or hospital waste:** medicine bottles, expired medicines, syringes, medical instruments such as scissors, blades etc.



# TYPES OF SOLID WASTE

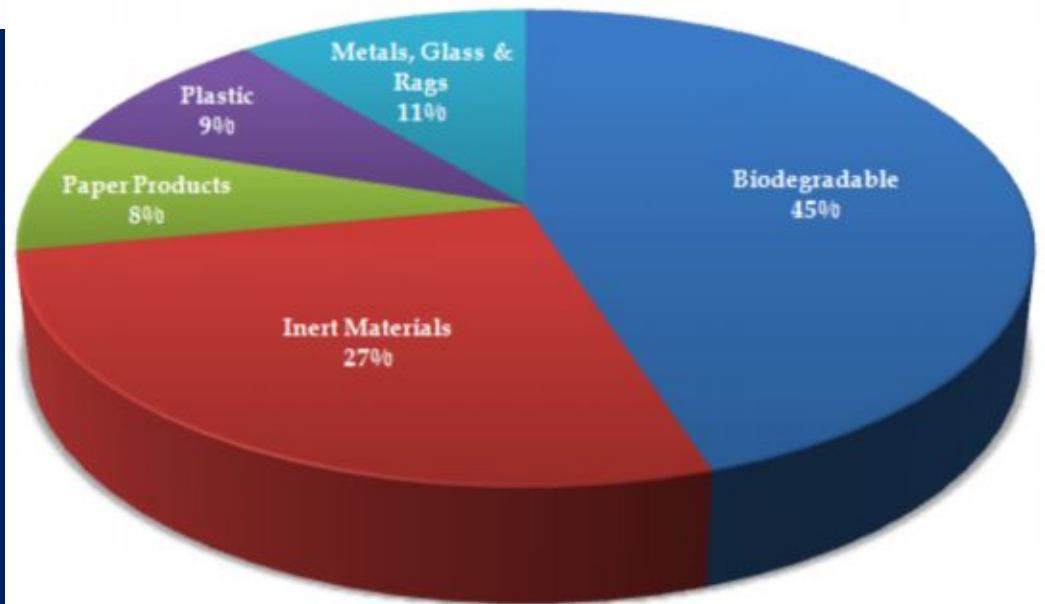
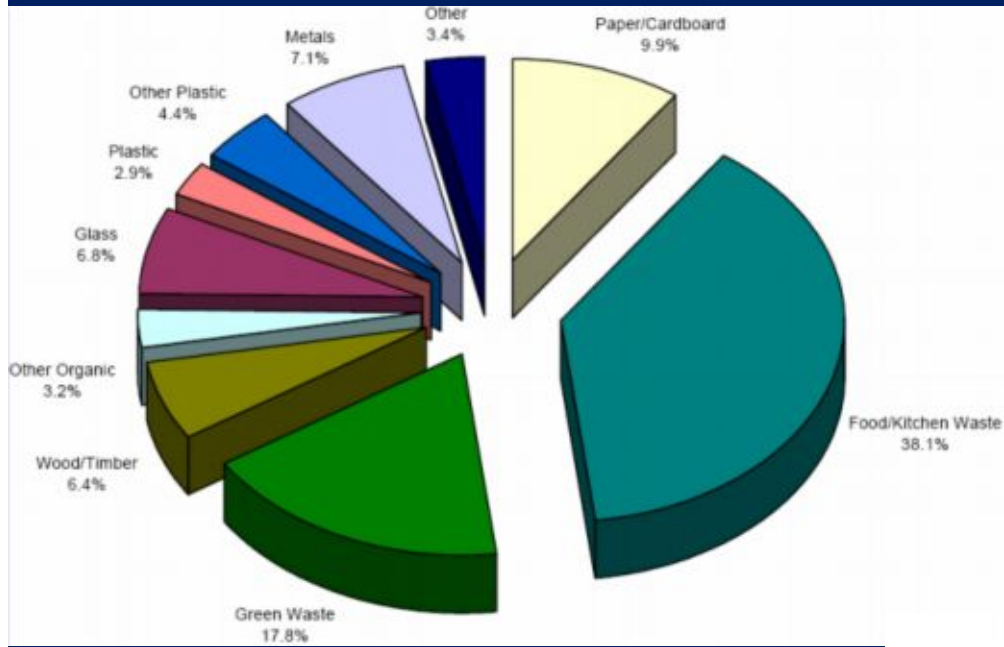
**Agricultural waste:** includes pesticides, crops, water coming from the fields also consists of small amount of toxic chemicals

**Nuclear waste:** includes radioactive substances coming from reactors, fuel (uranium, thorium, plutonium etc). Its highly dangerous and requires proper disposal.

**Hazardous waste:** includes toxic chemical, acids, corrosive, ignitable and reactive materials, gases etc.



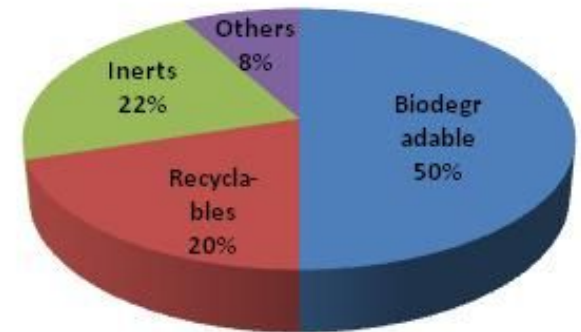
# SOLID WASTE COMPOSITION



# MAGNITUDE OF PROBLEM

- Per capita waste generation increasing by 1.3% per annum
- With urban population increasing between 3 – 3.5% per annum
- Yearly increase in waste generation is around 5% annually India produces 42.0 million tons of municipal solid waste annually at present.
- Per capita generation of waste varies from 200 gm to 600 gm per capita / day.
- Collection efficiency ranges between 50% to 90% of the solid waste generated.

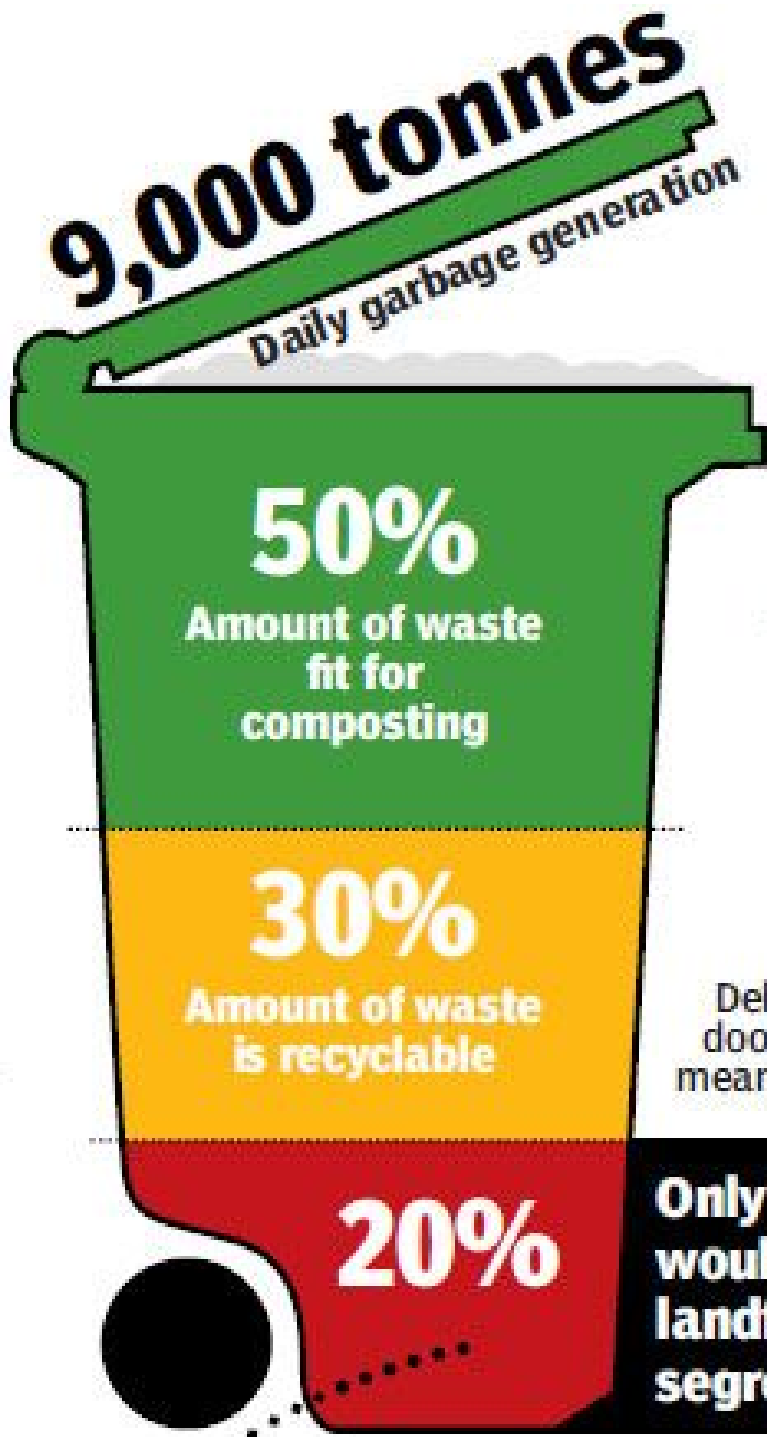
Composition of MSW in India



# Municipal Solid Waste in India

- **30% - 55% Compostable / Bio-degradable Matter (can be converted into manure)**
- **40% - 45% Inert material (to go to landfill)**
- **5% - 10% Recyclable materials (Recycling)**
- **These percentages vary from city to city depending on food habits**





### Kinds of waste generated in Delhi daily



Electronic waste  
**30 tonnes**



Biomedical waste  
**15 tonnes**



Construction/demolition waste  
**4,000 tonnes**



Plastic  
**800 tonnes**

**15%**

Delhi covered under formal door-to-door collection. This means the rest goes to landfill.

**Only 20 per cent waste would reach the landfills, if effective segregation is done**

## New Delhi: Capital of India



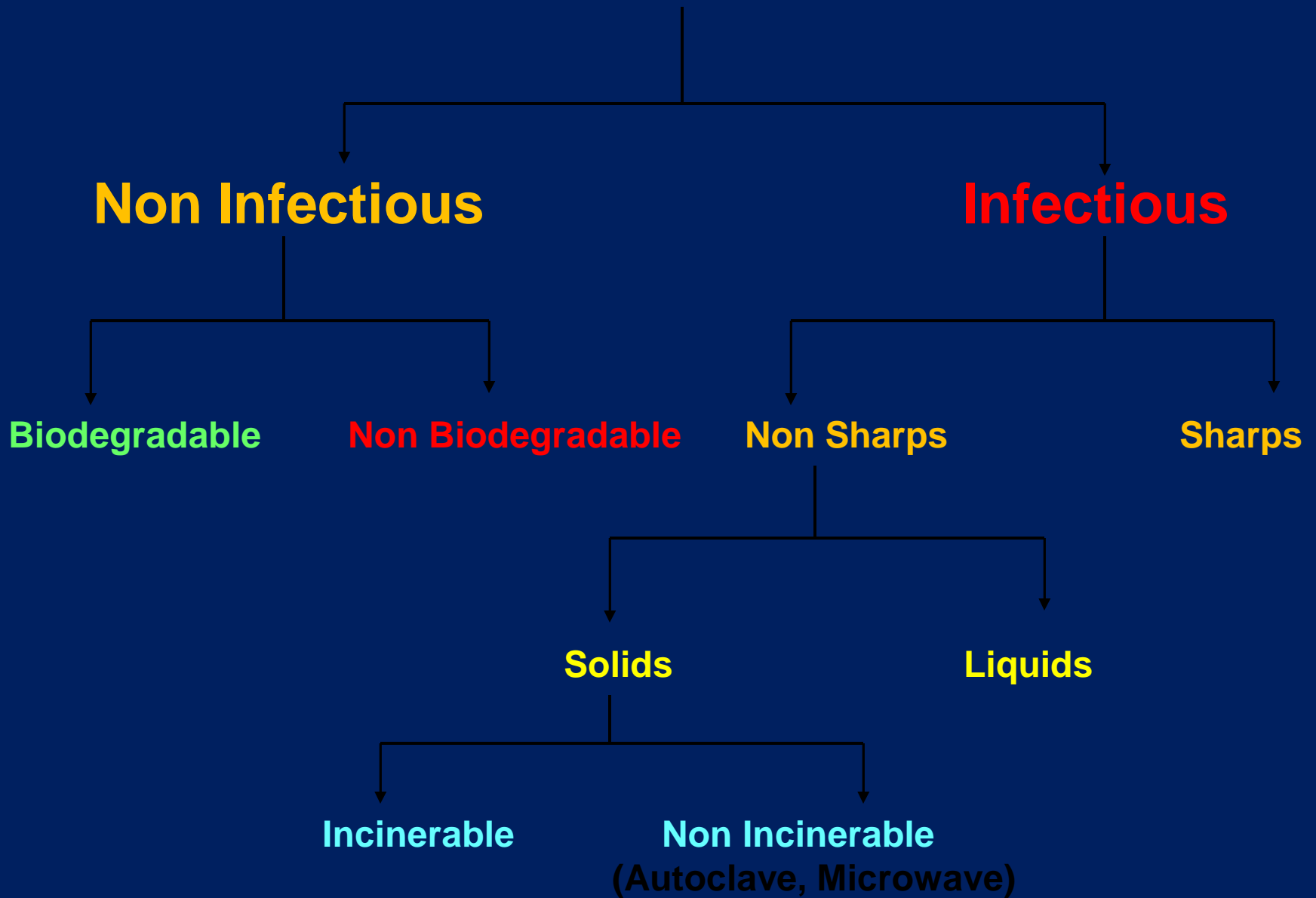
### Characteristics of waste in India



COMPONENT	PERCENTAGE BY WEIGHT
Vegetables and Leaves	40.15
Grass	3.80
Paper	0.80
Plastic	0.62
Glass and Ceramic	0.44
Metals	0.64
Stone and Ash	41.81
Miscellaneous	11.73

Graphic: Surej Patra

# HOSPITAL WASTES



## YELLOW BAGS

Infectious waste, bandages, gauze, cotton or any other objects in contact with body fluids, human body parts, placenta etc.

## RED BAGS

Plastic waste such as catheters, injection syringes, tubings, IV bottles

## BLUE BAGS

All types of glass bottles and broken glass articles, outdated & discarded medicines

## BLACK CARBOY

Needles without syringes, blades, sharps and all metal articles.

# COLOUR CODING

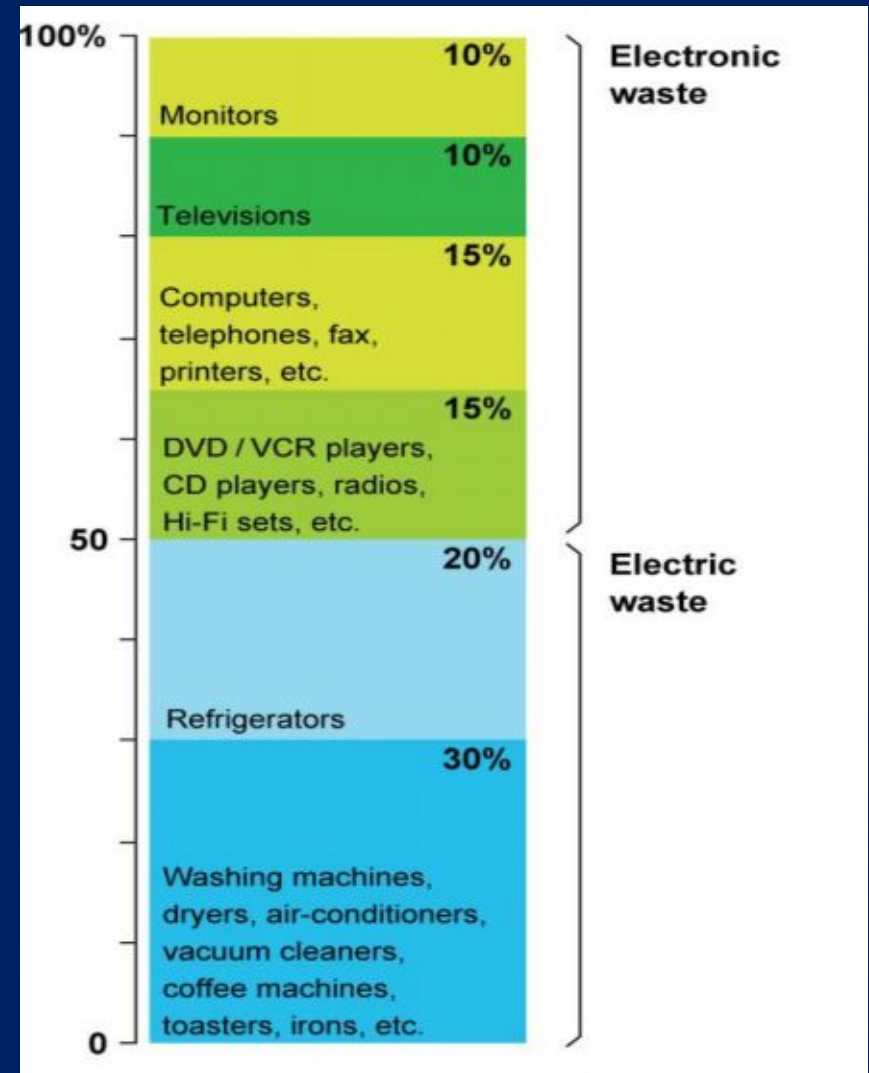


COLOUR CODING	TYPE OF CONTAINER	WASTE CATEGORY	TREATMENT OPTIONS as per Schedule I
Yellow	Plastic Bag	Cat.. 1, 2, 3 and 6	Incineration / deep burial
Red	Disinfected container / Plastic Bag	Cat. 3, 6, and 7	Autoclaving / Microwaving / Chemical Treatment
Blue / White Translucent	Plastic Bag / puncture proof container	Cat. 4, Cat. 7	Autoclaving / Microwaving / Chemical treatment and destruction shredding
Black	Plastic Bag	Cat. 5, 9 and 10 (Solid)	Disposal in secured landfill



# E-waste

- E-waste comprises of waste electronics goods which are not fit for their originally intended use.
- Such electronics goods may be television, telephones, radios, computers, printers, fax machines, DVDs and CDs etc.



# TOXIC CHEMICALS IN E-WASTE



- **Lead** – Affects Central and Peripheral Nervous system, Kidney Damage, Inhibits oxygen carrying capacity of blood
- **Cadmium** – Toxic, stores in Kidney, Neural damage
- **Mercury** – Chronic damage to brain, Respiratory and skin disorders
- **Chromium** – DNA disorders, Asthma
- **Barium** – Muscle weakness, kidney damage
- **Beryllium** – Lung cancer, beryllicosis, skin diseases
- **PVC** – Hormonal problems, Reproductive issues

## EFFECTIVE MANAGEMENT OF E-WASTE

- Massive awareness to consumers
- Setting up of more collection centers and collection points
- Manufactures responsibility to provide good standard materials and assurance for recycling
- Fair Trade principles
- More recycling units by providing subsidized financial supports
- Proper training to Workers dealing recycling units
- Ban on importing e-waste from other countries
- Proper monitoring and evaluation system by the regulators in all levels
- Sell or dump of e-waste only to government authorized recyclers
- Green and energy efficient devices by the manufactures
- Donate used electronics to charitable organizations
- Recovery of valuable metals like Cu, Al, Au, and Ag through recycling
- Use of available best strategies

# Methods of Waste Disposal

- Landfills
- Incineration
- Source reduction
- Composting
- Recycling



# Land filling

- Most municipal solid waste in India is deposited in landfills
- It is the most traditional method of waste disposal
- Source of groundwater pollution
- Waste is directly dumped into disused quarries, mining voids or borrow pits.
- It is generally used for domestic waste



# Incineration

- Prior to 1940, incineration was common in North America and western Europe.
- Many incinerators were eliminated because of foul odors and gritty smoke
- Currently, about 15% of municipal solid waste is incinerated.



# Incineration

## Pros:

- Reduce volume 90%, weight 75%
- Heat from burning converted to electricity

## Cons:

- Create air pollution
- Concentrates toxins in ash
- More costly than landfills, as long as space available



# Composting

- Harnessing natural decomposition to transform organic material into compost
- Materials such as plants, food scraps, and paper products can be decomposed into the organic matter.
- The organic matter that is produced from recycling can be agricultural uses.
- Usually this method of recycling is done by putting the materials in a container and let to stay there until it decomposes.





# OCEAN DUMPING

- Ocean dumping is the dumping or placing of materials in the ocean, often on the continental shelf.
- A wide range of materials is involved, including garbage, construction and demolition debris, sewage sludge, dredge material, waste chemicals, and nuclear waste.
- Sometime hazardous and nuclear waste are also disposed but these are highly dangerous for aquatic life and human life also.



## ADVANTAGES

- Convenient
- Inexpensive
- Source of nutrients for fishes and marine mammals.
- Vast amount of space is available.
- All type of wastes are disposed.

## DISADVANTAGES

- There are three main direct public health risks from ocean dumping:
- Occupational accidents, injuries and exposures
- exposure of the public to hazardous or toxic materials washed up on beach sand.
- human consumption of marine organisms that have been contaminated by ocean disposal.
- Highly dangerous for aquatic life.

# Recycling

- It is basically processing or conversion of a waste item into usable forms.
- Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics.
- But recycling is not a solution to managing every kind of waste material.
- For many items like plastic bags, plastic wrap, yogurt cups, margarine container etc. recycling technologies are unavailable or unsafe.



# Recycling

## Benefits

- Saves money, raw materials, and land.
- Encourages individual responsibility.
- Reduces pressure on disposal systems.
- Japan recycles about half of all household and commercial wastes.
- Lowers demand for raw resources.
- Reduces energy consumption and air pollution.

## The Waste Hierarchy



# Recycling Benefits, Incentives

- Recycling saves *money, energy, raw materials, and land space*, while also **reducing pollution**.
- Recycling *encourages* individual **awareness** and **responsibility**.
- **Japan** - probably the most *successful* recycling program in the world
- Creating **incentives** for recycling - public policies, consumer demand
- Some make a **living** by gathering up recyclables!!



Radioactive  
contaminants

Organic  
contaminants

Inorganic  
metal contaminants

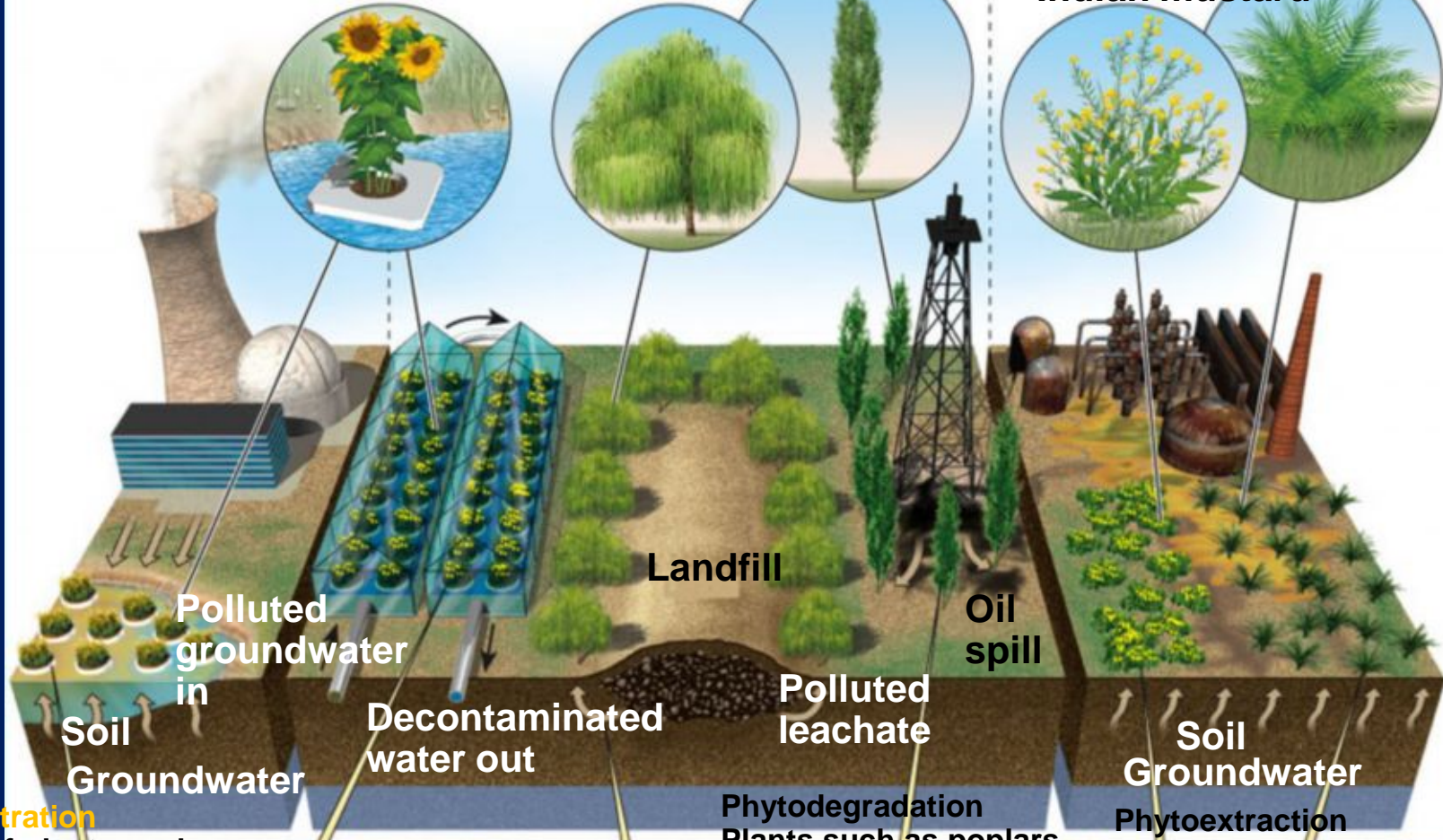
Sunflower

Willow tree

Poplar tree

Indian mustard

Brake fern



### Rhizofiltration

Roots of plants such as sunflowers with dangling roots on ponds or in greenhouses can absorb pollutants such as radioactive strontium-90 and cesium-137 and various organic chemicals.

**Phytostabilization**  
Plants such as willow trees and poplars can absorb chemicals and keep them from reaching groundwater or nearby surface water.

**Phytodegradation**  
Plants such as poplars can absorb toxic organic chemicals and break them down into less harmful compounds which they store or release slowly into the air.

**Phytoextraction**  
Roots of plants such as Indian mustard and brake ferns can absorb toxic metals such as lead, arsenic, and others and store them in their leaves. Plants can then be recycled or harvested and incinerated.

## MAIN ISSUES

- ABSENCE OF SEGREGATION OF WASTE AT SOURCE
- LACK OF TECHNICAL EXPERTISE AND APPROPRIATE INSTITUTIONAL ARRANGEMENT
- UNWILLINGNESS TO INTRODUCE PROPER COLLECTION, SEGREGATION, TRANSPORTATION AND TREATMENT / DISPOSAL SYSTEMS
- INDIFFERENT ATTITUDE OF CITIZENS TOWARDS WASTE MANAGEMENT DUE TO LACK OF AWARENESS
- LACK OF COMMUNITY PARTICIPATION TOWARDS WASTE MANAGEMENT AND HYGIENIC CONDITIONS