



ENVIRONMENTAL STUDIES & LIFE SCIENCES

Dr. Sasmitta Sabat
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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Basic Concepts of Ecosystems

Dr. Sasmita Sabat

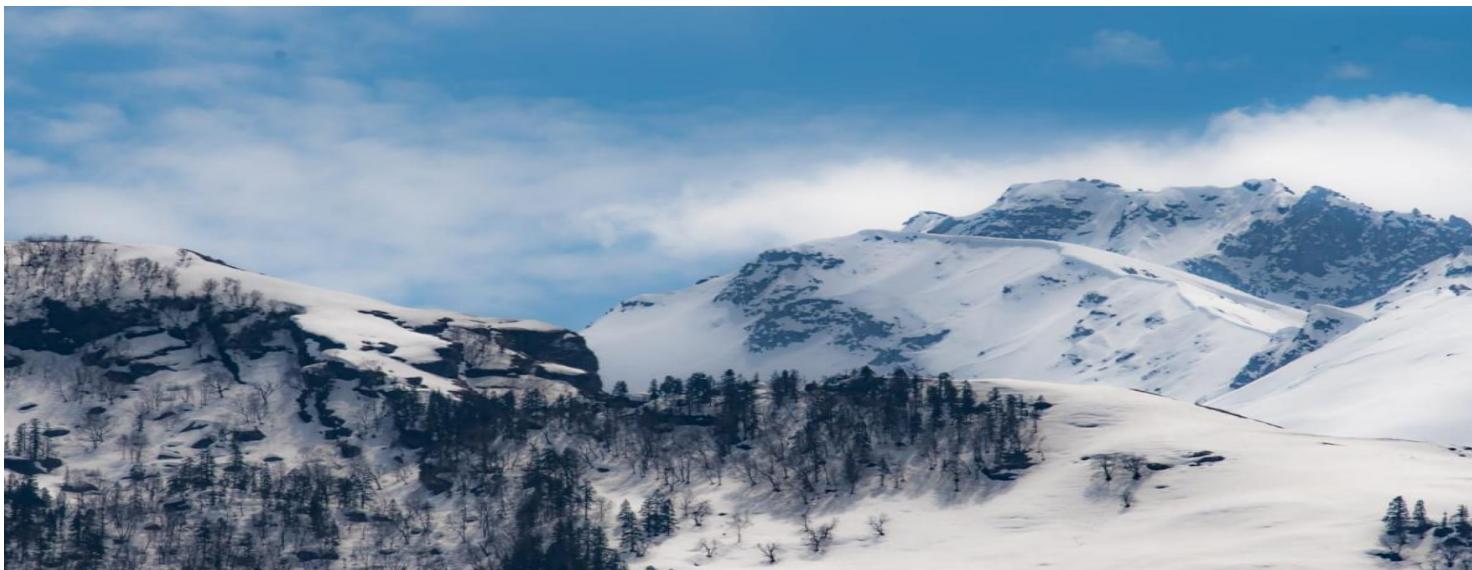
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- The meaning of the word **ecology** was given by German Biologist **Ernst Haeckel** in 1869.
- The term ‘Ecology’ was derived from two Greek words, OIKOS (means house) and LOGUS (means study of) to denote the relationship between the organisms and their environment.
- **Definition:** The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.

- Ecosystems are divided into terrestrial or land based ecosystems, and aquatic ecosystems in water.
- These form the two major habitat conditions for the Earth's living organisms:
 - At a global level the thin skin of the earth on the land, the sea and the air, forms the biosphere.
 - At a sub-global level, this is divided into biogeographical realms

At a national or state level, this forms biogeographic regions.

Eg. There are several distinctive geographical regions in India- the Himalayas, the Gangetic Plains, the Highlands of Central India, the Western and Eastern Ghats, the semi-arid desert in the West, the Deccan Plateau, the Coastal Belts, and the Andaman and Nicobar Islands.



At an even more local level, each area has several structurally and functionally identifiable ecosystems such as different types of forests, grasslands, river catchments, mangrove swamps in deltas, seashores, islands, etc.

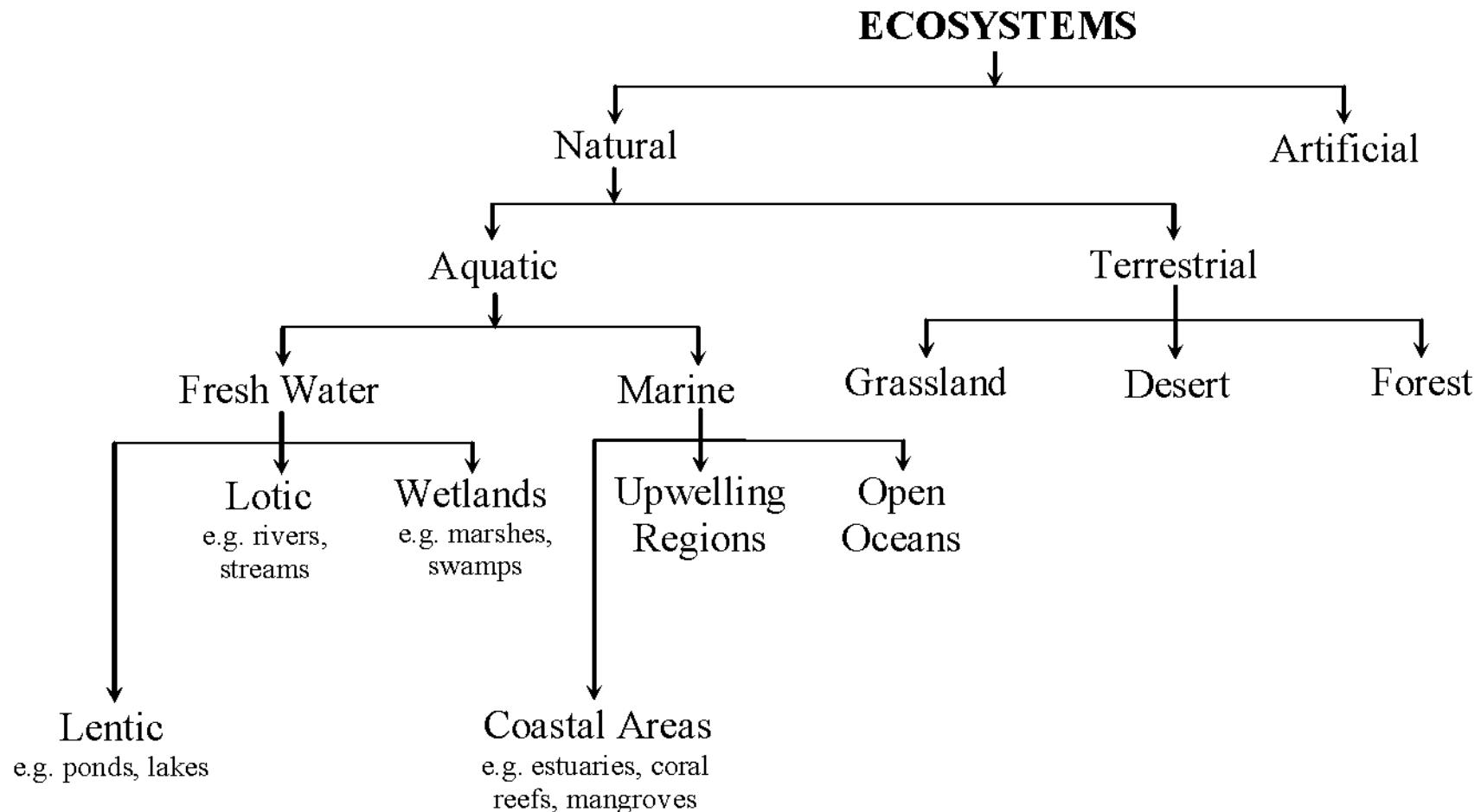


Based on study area:

1. Autecology : It deals with the study of an individual species of organisms and it's population. It is also called the Species ecology.
2. Syneiology : It deals with the study of communities, their composition, their behaviour and relation with the environment. It is further divided into 3 types:
 - a) Population Ecology
 - b) Community Ecology
 - c) Ecosystem Ecology

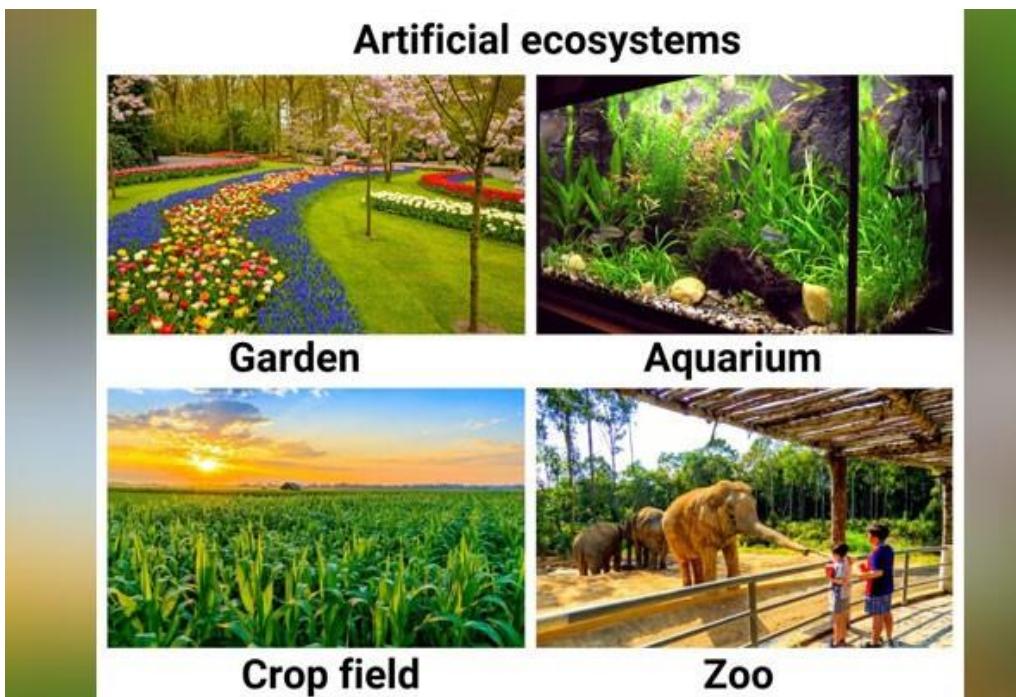
Classification of Ecology

Autecology	Synecology
It is the study of individual organism or individual species or a population in relation to their environment	It is the study of group of organisms or many species or communities in relation to their environment
It is also called as population ecology	It is also called as community ecology
The study is at the level of an individual, a population or an entire species	Synecology is concerned with study of the highest level of biological organization; many populations in an area (called as community) interacting with each other and also with the environment. It can even be the study of an ecosystem
Autecology is comparatively simple experimental and inductive.	Synecology is complex, philosophical and deductive. (Refer: Inductive vs Deductive)
Autecology studies can be accommodated in a laboratory setup and data is interpreted using conventional mathematical tools**	Synecology studies refers to the interaction of a whole system and that cannot be accommodated in a laboratory setup as the system is naturally formed after interactions of hundreds of years such as a forest ecosystem
Example: Study of Zebra population in relation to its environment (may be factors like rainfall, hunting, lion population etc in a grassland ecosystem) see the figure (in dotted black lines)	Example: Study of entire grassland ecosystem (including all the species or communities) see the figure (in green thick border)



Types of Ecosystem

- **Artificial (Man Engineered) Ecosystems:** These are maintained artificially by man where by addition of energy and planned manipulation, natural balance is disturbed regularly e.g., crop land ecosystem.



- Ecosystems are however frequently disrupted by human actions which lead to the extinction of species of plants and animals.
- Extinction occurs due to changes in land use, pollution from industry in urban areas. Forests are deforested for timber, wetlands are drained to create more agricultural land and semi arid grasslands that are used as pastures are changed into irrigated fields.
- Some species if eliminated seriously affect the ecosystem.

These are called ‘Keystone species’.

- In the 1960s, renowned ecologist Robert Paine disrupted a patch of Washington State coastline—and made a huge environmental breakthrough.
- In an effort to understand the food web in a tidal ecosystem in Makaw Bay, he removed all of a single starfish species in one area.
- Rapidly the entire ecosystem changed, leading him to the realization that certain species play outsize roles in the overall structure and function of their environment.

- While some creatures exert little influence on their ecosystem, others can topple a whole community of plants and animals with their absence.
- Paine coined a term for these critical organisms: keystone species.
- They are nearly always a critical component of the local food web. One of the defining characteristics of a keystone species is that it fills a critical ecological role that no other species can.

- EXAMPLES OF KEYSTONE SPECIES:
- Star fish- By keeping populations of mussels and barnacles in check, this sea star helps ensure healthy populations of seaweeds and the communities that feed on them.
- Sea otters- Role as a top predator in the nearshore marine ecosystem.
- Beavers- Builds well-maintained dams. These dams turn small streams into ponds and lakes which provide excellent areas for other animals to use and thrive.

- **Wolves**- By regulating prey populations, wolves enable many other species of plants and animals to flourish.
- **Bees**- It is predicted that if honey bees disappear, more than 50% of plant species will become extinct. Honey bees do not only produce cross-pollination which assists with genetic diversity of plants and possibly other animal species and accordingly biodiversity relates to healthy ecosystems.

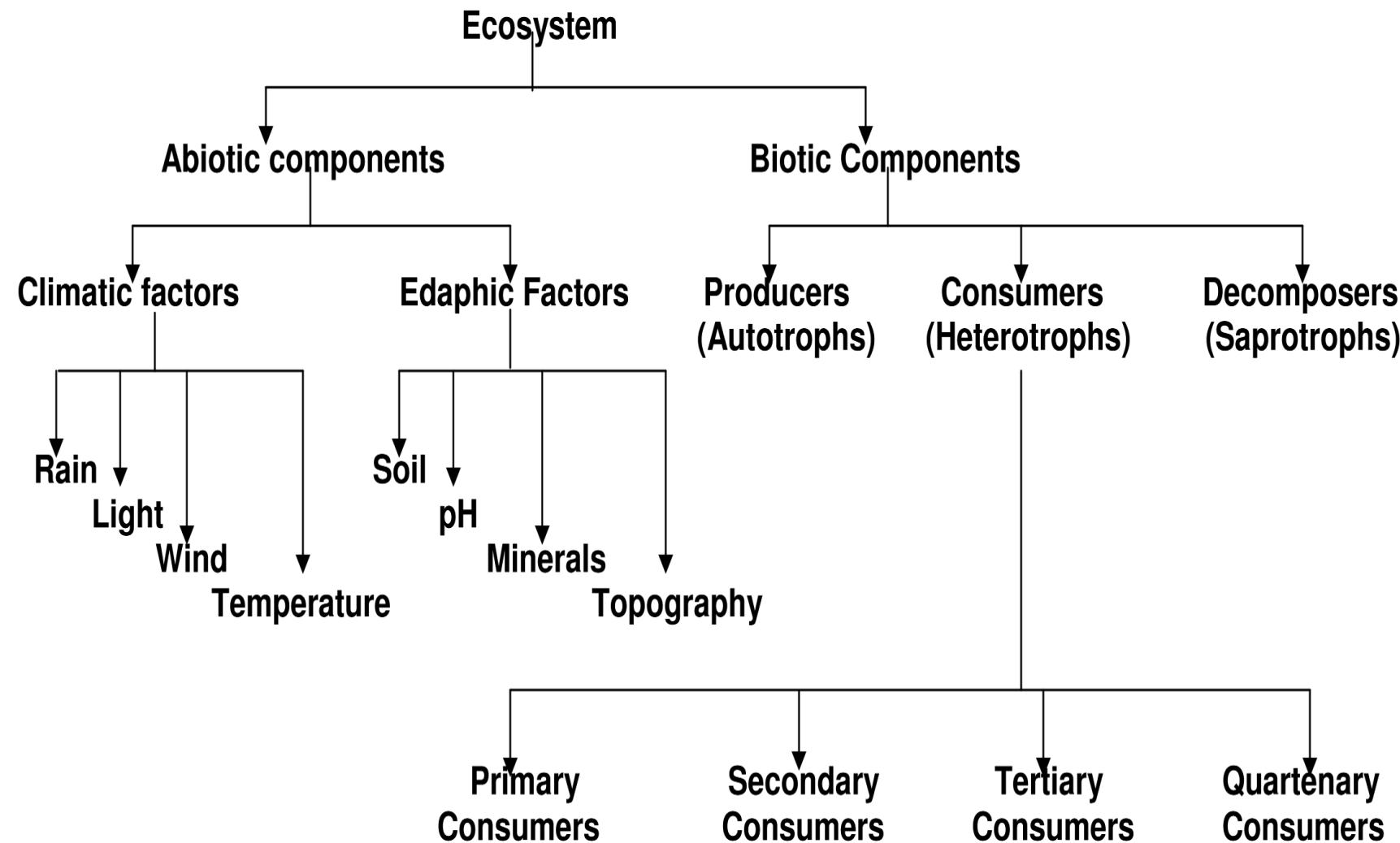
- Humming birds- Key agents of pollination and by doing so, aid in the growth and spread of certain plant species.
- American alligators- high level predators, it modifies their surroundings by their food consumption alone.
- Tiger sharks- control the populations of primary consumers, it is a top predator in the ocean.

- The non-living components of an ecosystem are the amount of water, the various inorganic and organic compounds, and climatic conditions such as rainfall and temperature, which depend on geographical conditions and location which is also related to the amount of sunlight.
- The living organisms in an ecosystem are inseparable from their habitat.

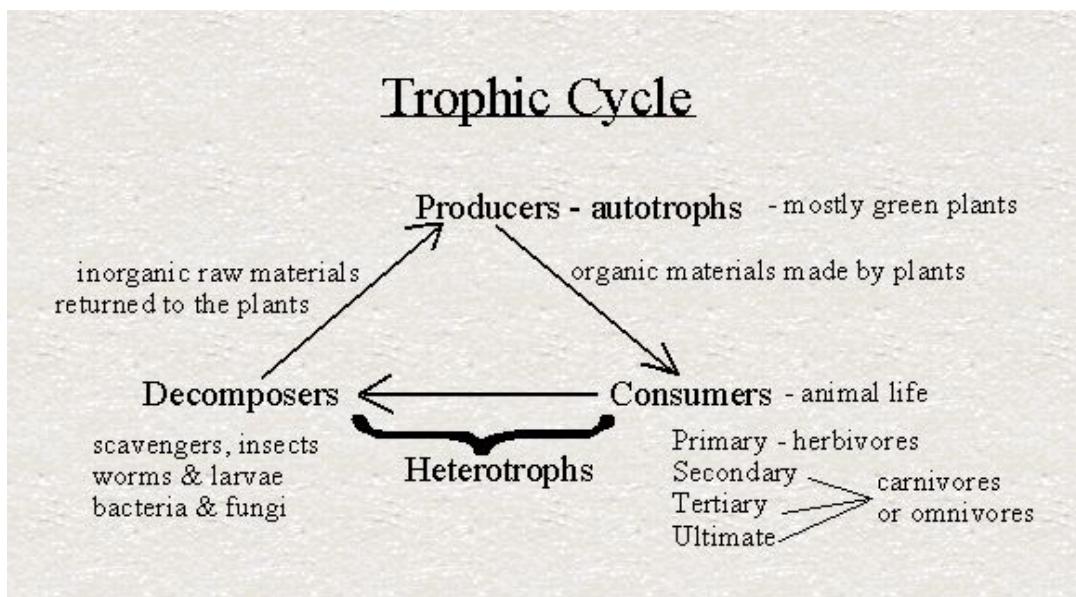
Components that make up the structural aspects of an ecosystem include:

- 1) **Inorganic aspects** – C, N, CO₂, H₂O
- 2) **Organic compounds** – Protein, Carbohydrates, Lipids – link abiotic to biotic aspects.
- 3) **Climatic regimes** – Temperature, Moisture, Light & Topography.
- 4) **Producers** – Plants.
- 5) **Macro consumers** – Phagotrophs – Large animals.
- 6) **Micro consumers** – Saprotrophs, absorbers– fungi.

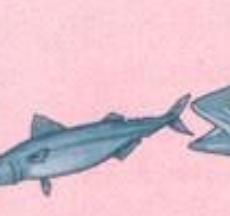
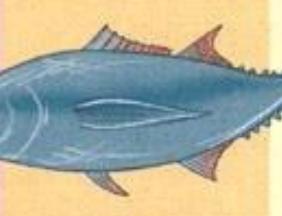
Components of Ecosystem



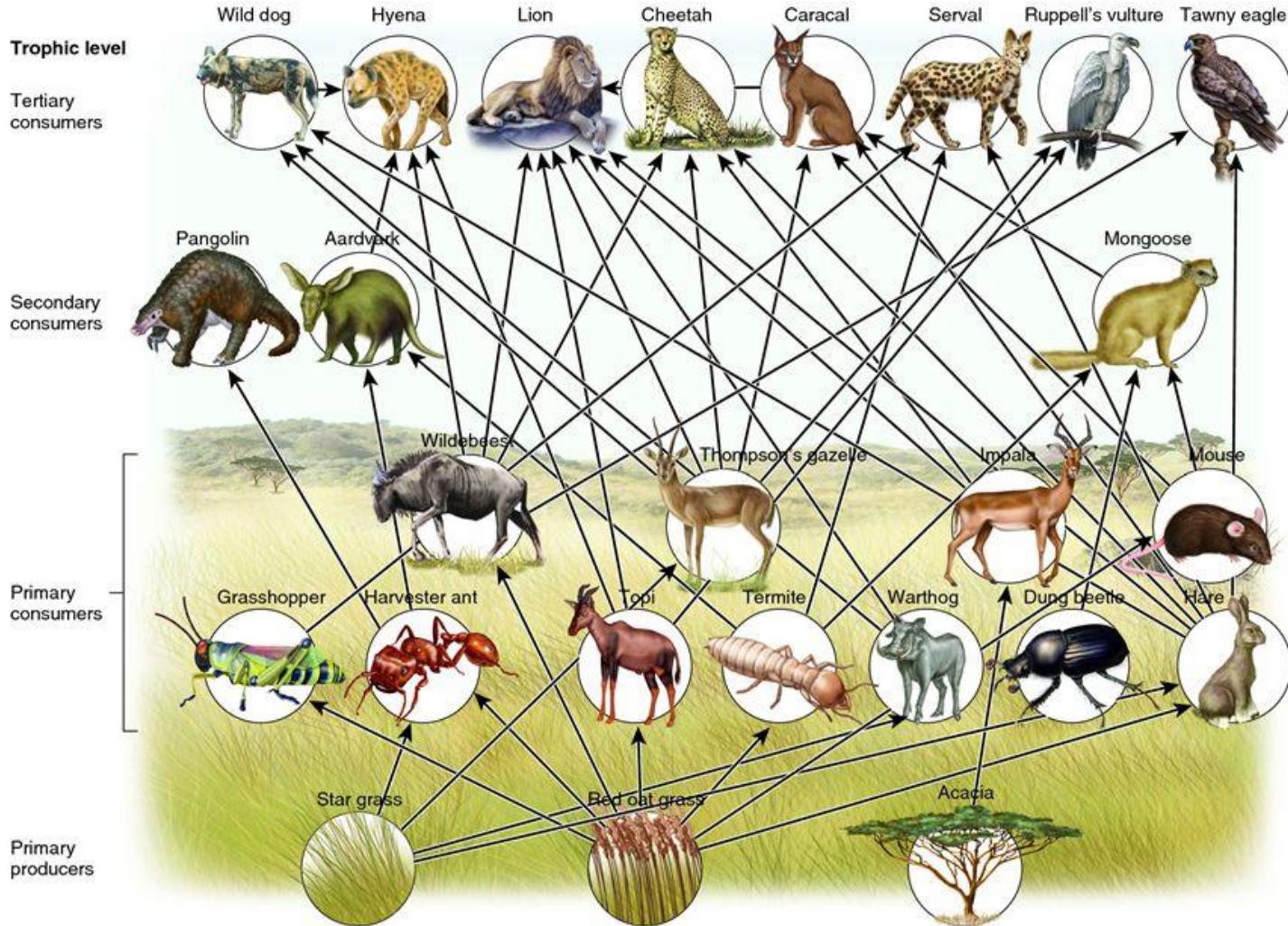
- Every living organism is in some way dependent on other organisms.
- Plants are food for herbivorous animals which are in turn food for carnivorous animals.
- Thus there are different trophic levels in the ecosystem.
- Some organisms such as fungi live only on dead material and inorganic matter.

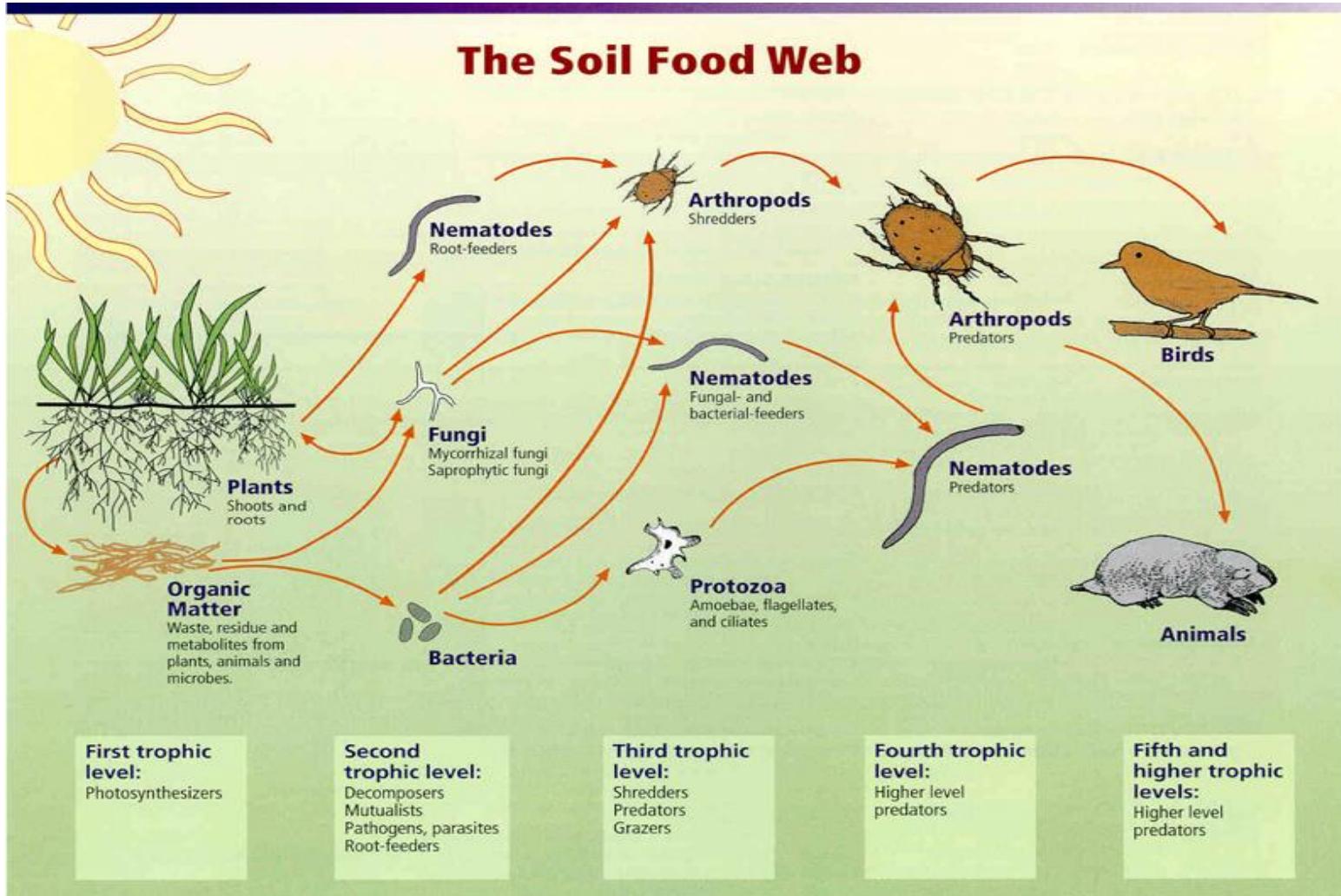


- A **food chain** is the sequence of who eats whom in a biological community (an ecosystem) to obtain nutrition.

Ecosystem	Autotrophs	Heterotrophs			
	Producers	Primary Consumers	Secondary Consumers	Tertiary Consumers	Decomposers and Detritivores
	First trophic level	Second trophic level	Third trophic level	Fourth trophic level	
Alpine meadow in High Sierra	 Plant	 Butterfly	 Raven	 Weasel	 Bacteria, fungi, dung beetles
Open ocean	 Phytoplankton	 Zooplankton	 Mackerel	 Tuna	 Marine worms

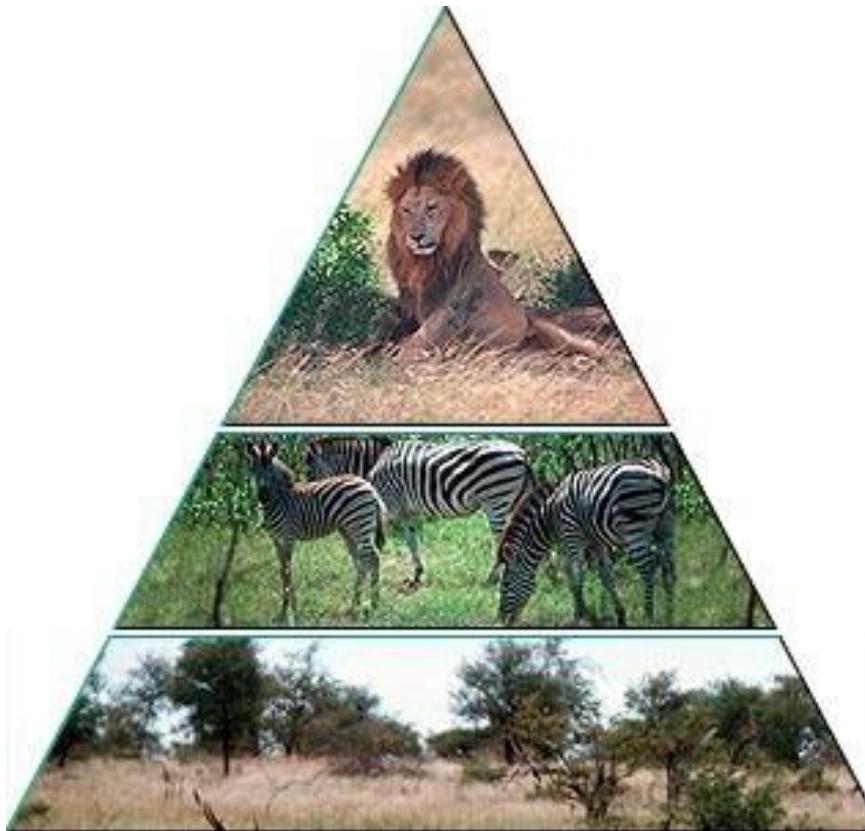
- A **food web** (or **food cycle**) depicts feeding connections (what-eats-what) in an ecological community and hence is also referred to as a consumer- resource system.
- The food web is a simplified illustration of the various methods of feeding that links an ecosystem into a unified system of exchange.
- Various food chains are often interlinked at different trophic levels to form a complex interaction between different species from the point of view of food.
- Food Web provides more than one alternatives of food to most of the organisms in an ecosystem and thus increases their chances of survival.





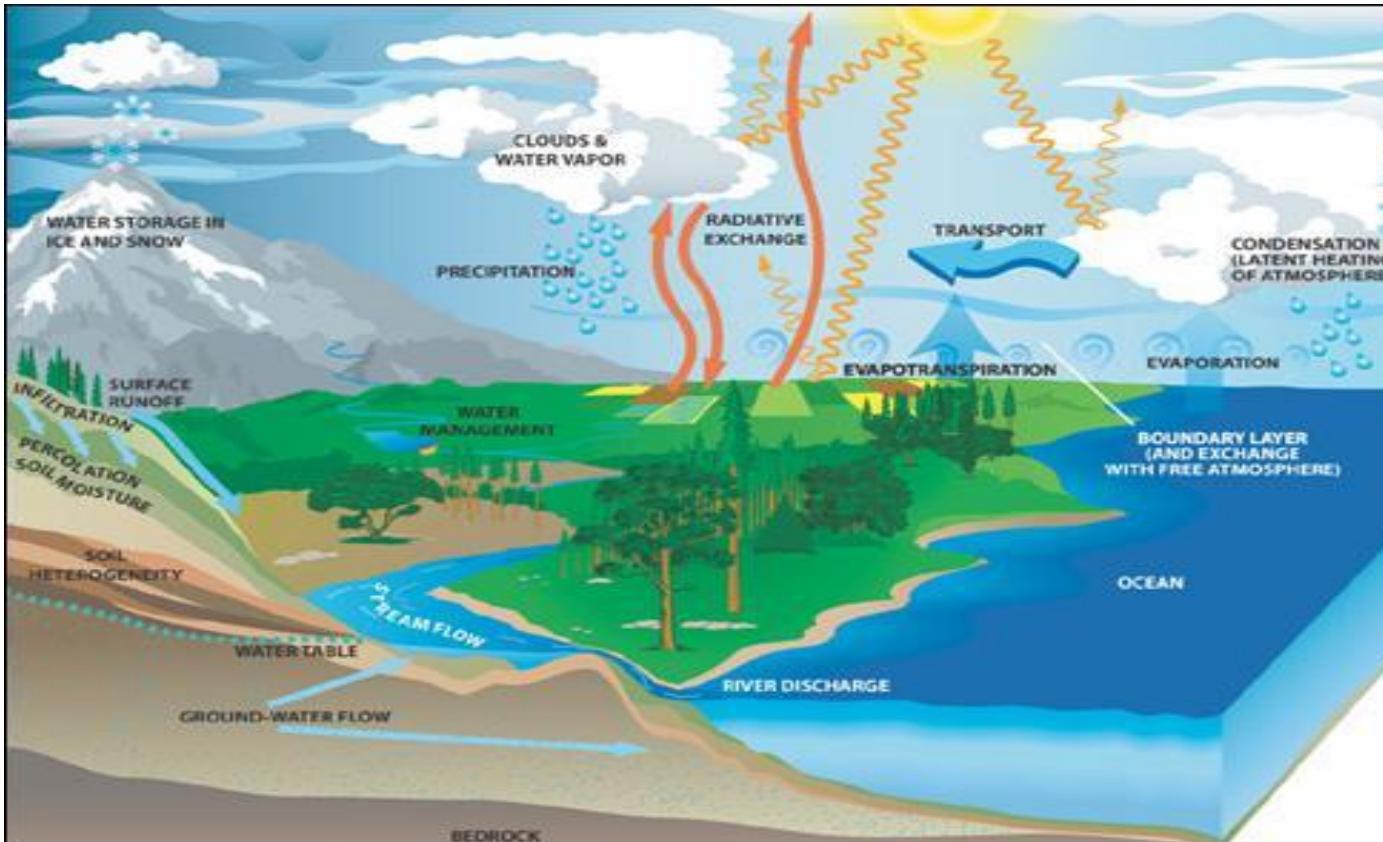
Ecological Pyramids

- Graphical representation of trophic structure & functioning of ecosystem starting with **producers** at the base & successive trophic levels forming the apex



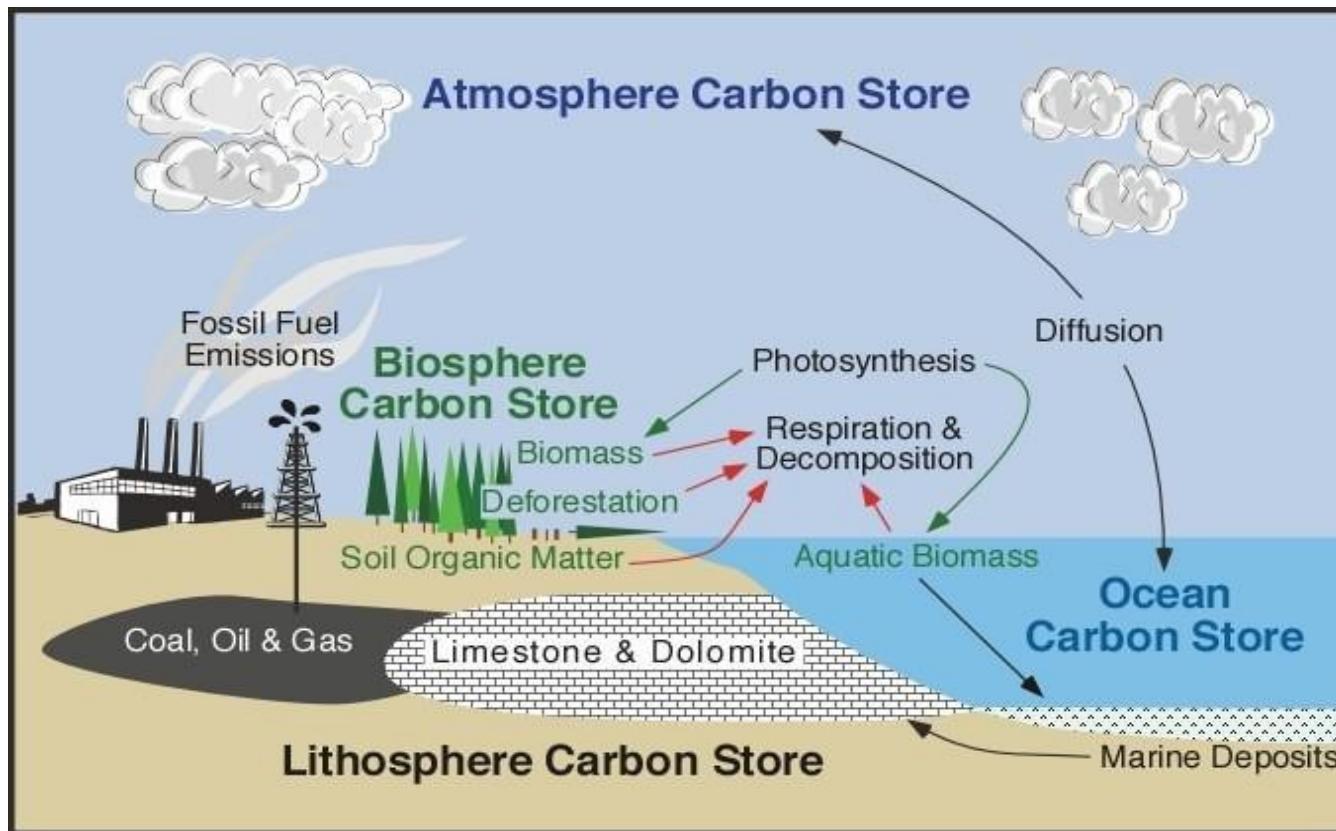
Energy flow in the Ecosystem

Every ecosystem has several interrelated mechanisms that affect human life. These are the water cycle, the carbon cycle, the oxygen cycle, the nitrogen cycle and the energy cycle.



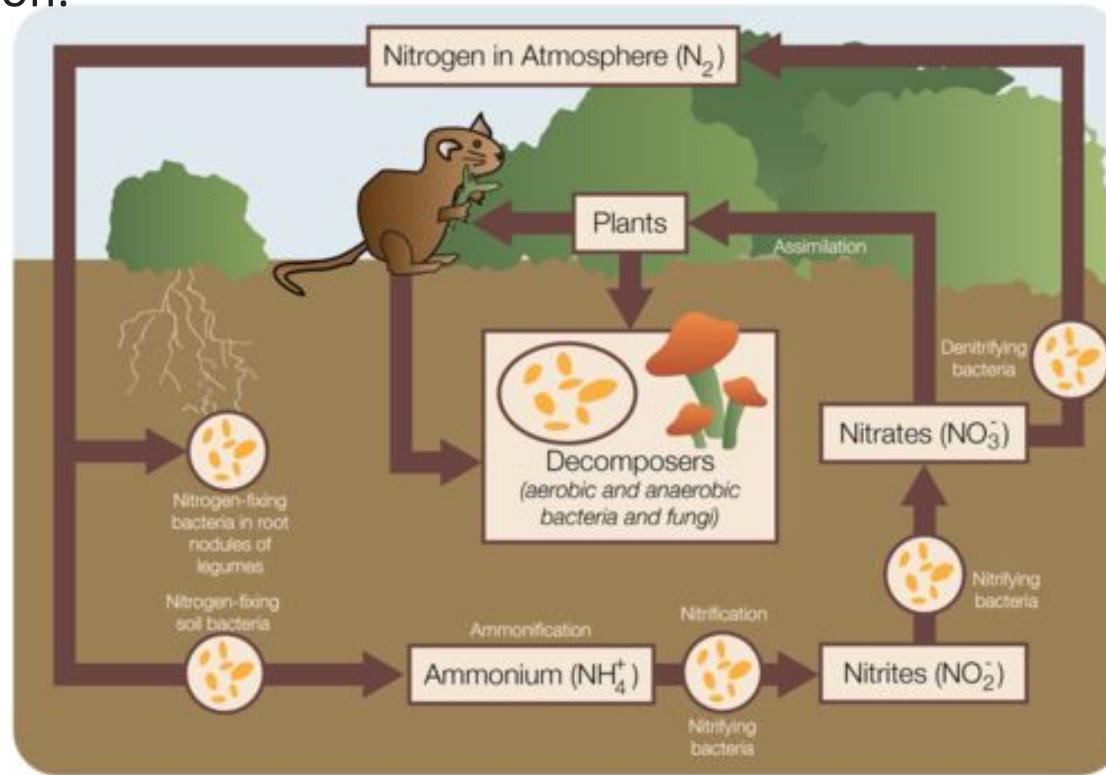
Carbon cycle

The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.

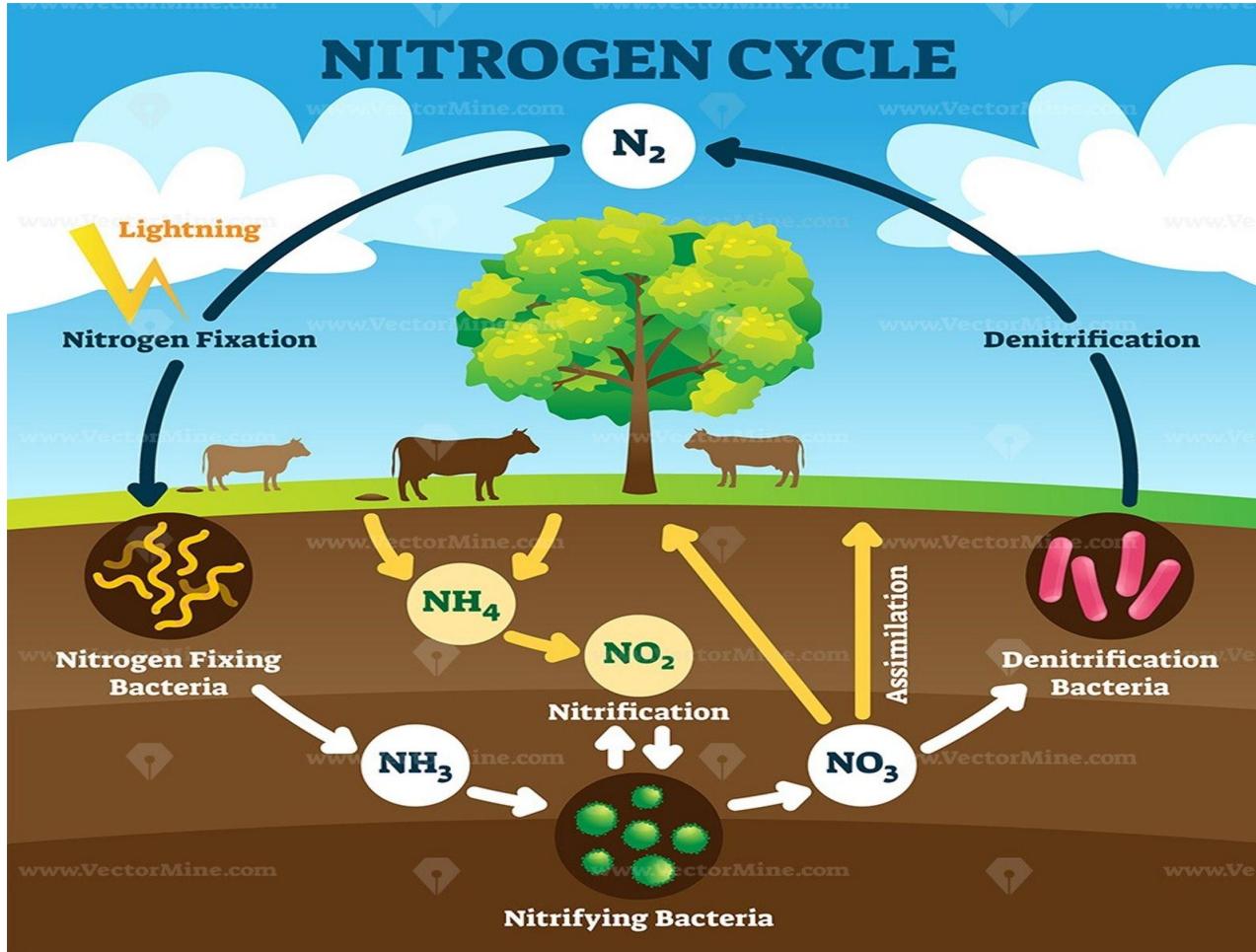


Nitrogen cycle

Nitrogen Cycle is a biogeochemical process through which nitrogen is converted into many forms, consecutively passing from the atmosphere to the soil to organism and back into the atmosphere. It involves several processes such as nitrogen fixation, nitrification, denitrification, decay and putrefaction.



Nitrogen cycle



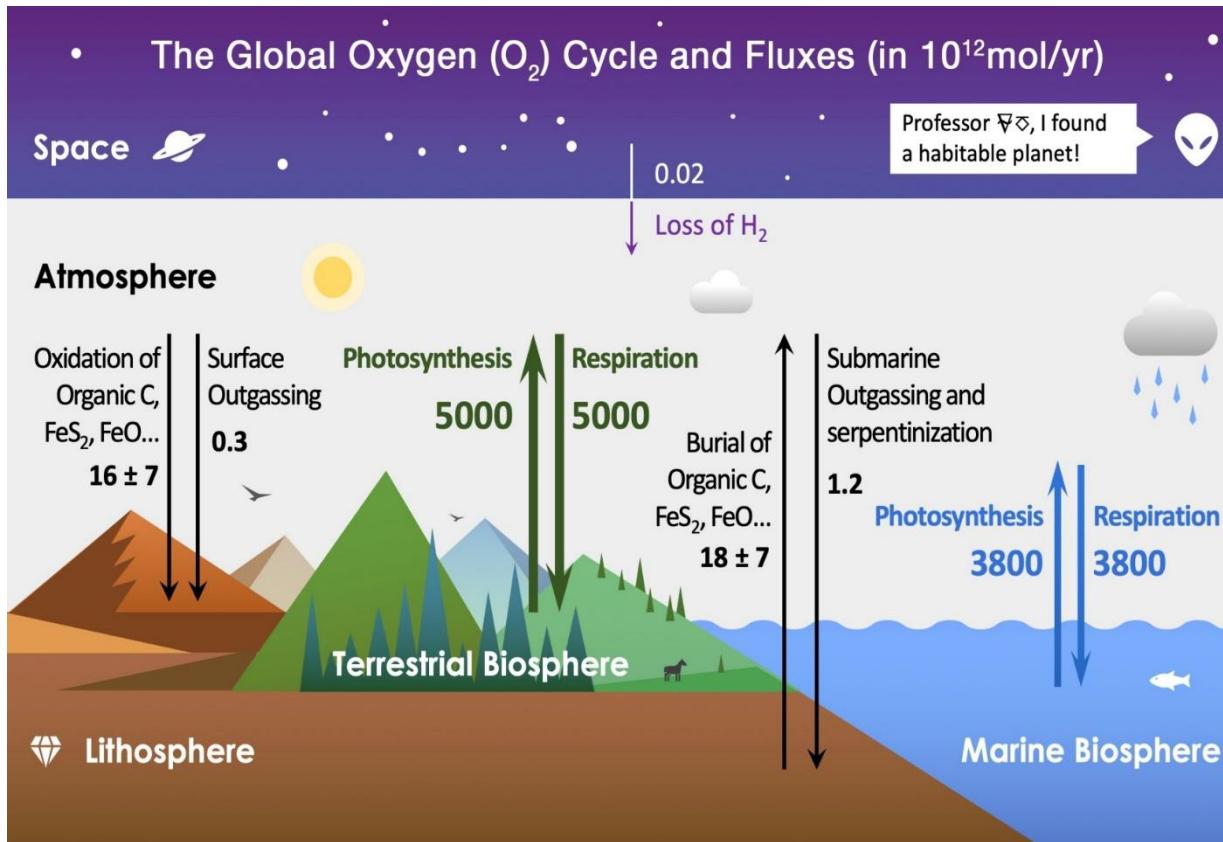
Excess nitrogen and phosphorus cause an overgrowth of algae in a short period of time, also called algae blooms. The overgrowth of algae consumes oxygen and blocks sunlight from underwater plants. When the algae eventually dies, the oxygen in the water is consumed.



(a) Nitrogen runoff into Lake Atitlán, Guatemala, caused an algae bloom in the normally clear blue mountain lake. (b) Fish killed by a lack of oxygen in the water.

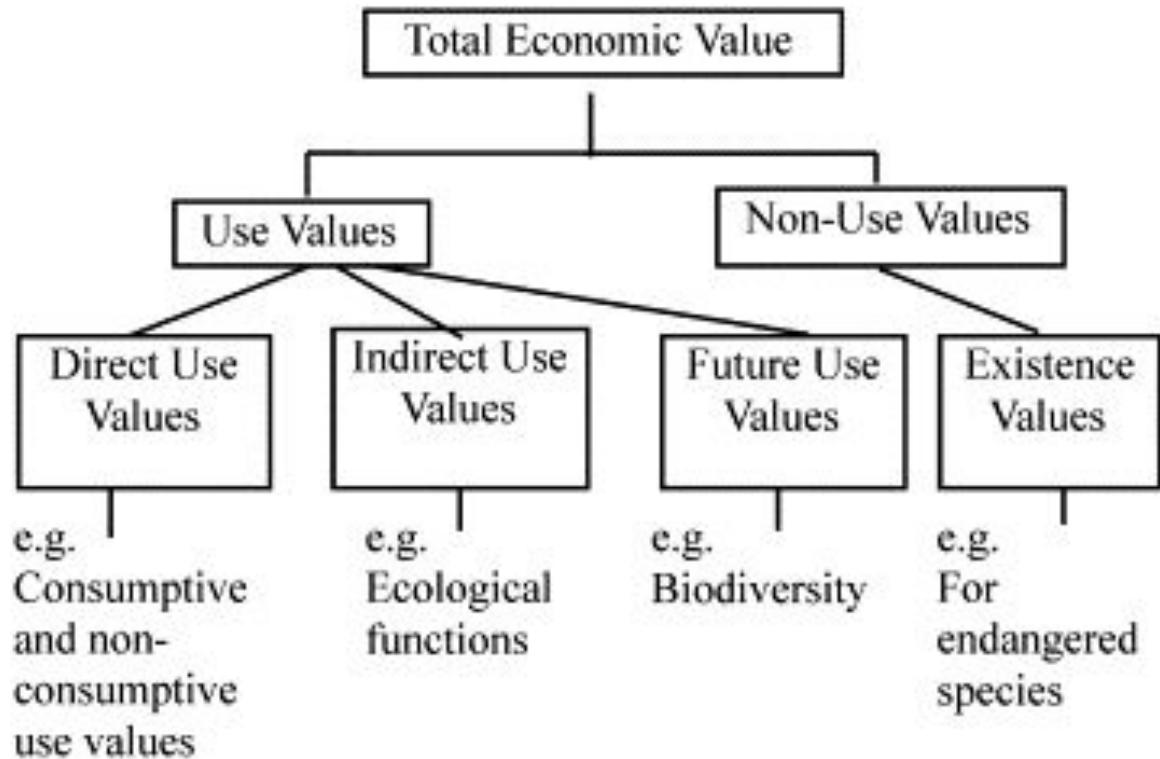
Oxygen cycle

Oxygen cycle refers to the movement of oxygen through the atmosphere (air), biosphere (plants and animals) and the lithosphere (the Earth's crust).



- **Direct and indirect use value of biodiversity**
- Direct values: Direct values can be consumptive or productive values. Plants provide an instant incentive towards sustainable development as they're the primary source of food that could be picked and spent legally.
Direct use values include the economic advantages derived from directly forest wood, fuelwood, edible plants, and so on.

- Indirect values: The indirect values are the social and cultural values, ethical values, aesthetic values, optional and environmental values. Aesthetic qualities are an unusual motivator for biodiversity because unique views in undisturbed areas are fascinating to see and give possibilities for leisure activities that promote the eco-travel sector.





THANK YOU

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Energy Resources

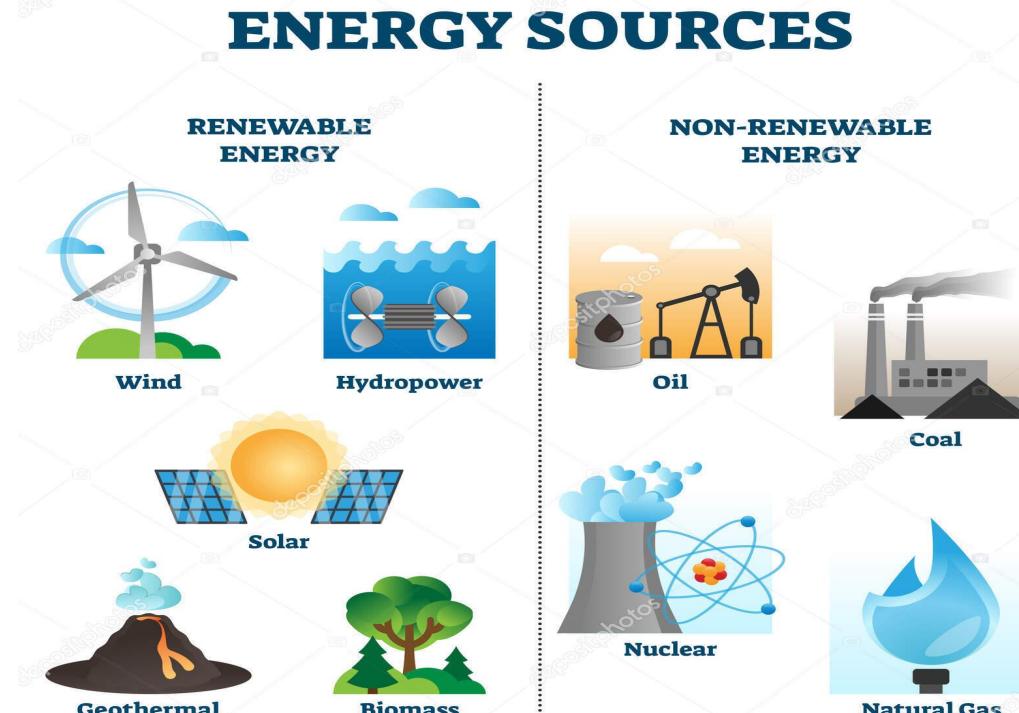
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- A natural resource that can be converted by humans into other forms of energy in order to do useful work
- ***Natural resource-*** any natural substance, organism, or energy form, living things use
 - The sun is our most important energy resource
- Energy has always been closely linked to man's economic growth and development

There are three main types of energy; those classified as

- a) *Non-renewable*
- b) *Renewable*
- c) *Nuclear energy*

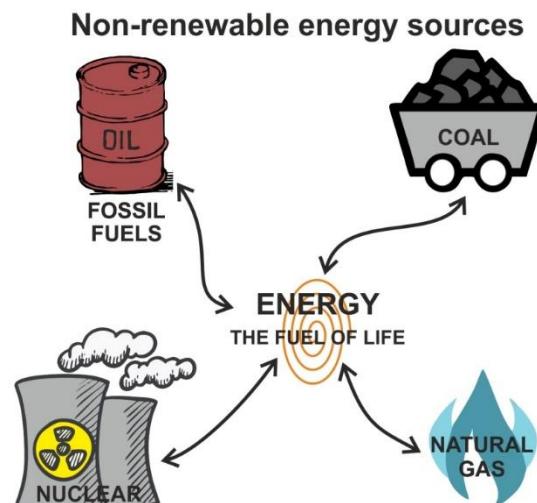


- Energy resources that cannot be replaced after they are used or can be replaced only over thousands or millions of years.
- The fuel is placed in a well contained area and set on fire. The heat generated turns water to steam, which moves through pipes, to turn the blades of a turbine. This coupled with electromagnetism, is used as energy resource.

Example- Fossil fuels

- These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests

- When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, all causes of air pollution.



1. **Coal** is obtained either by mining deep beneath the Earth's surface or by strip mining.

- Strip mining- a process in which rock and soil are stripped from the Earth's surface to expose the underlying materials to be mined.

2. **Petroleum and natural gas** are removed from the Earth by drilling wells into rock that contain these resources.

- Oil wells exist on land and in the ocean.



Strip mining

- Energy resources that formed from the buried remains of plants and animals that lived in swamps millions of years ago – **Coal, petroleum, and natural gas.** Originally received their energy from the sun.
- The United States' primary source of electrical energy is generated by burning fossil fuels
- For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century

Solid Fossil Fuels- Coal

Sources of Electricity in India by Installed Capacity



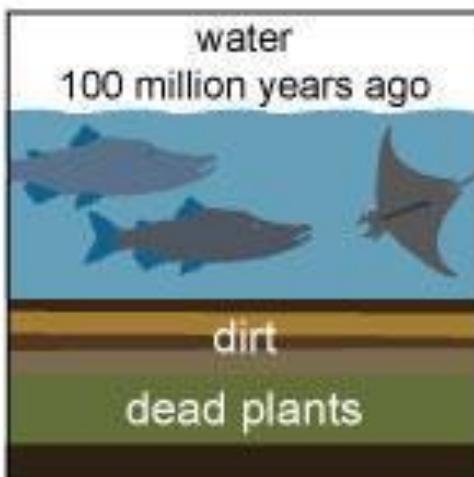
Based on Govt. of India's Central Electrical Authority Report dated 31-1-16

How coal was formed

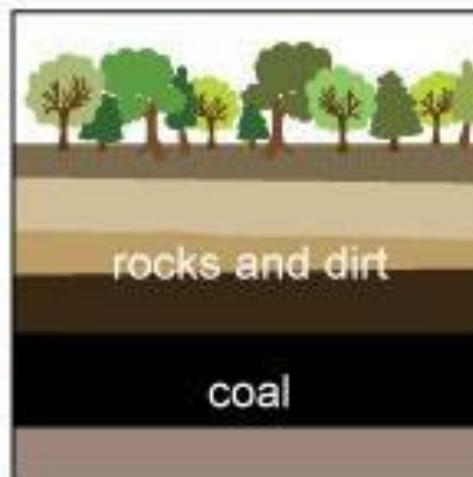
Before the dinosaurs, many giant plants died in swamps.



Over millions of years, the plants were buried under water and dirt.



Heat and pressure turned the dead plants into coal.

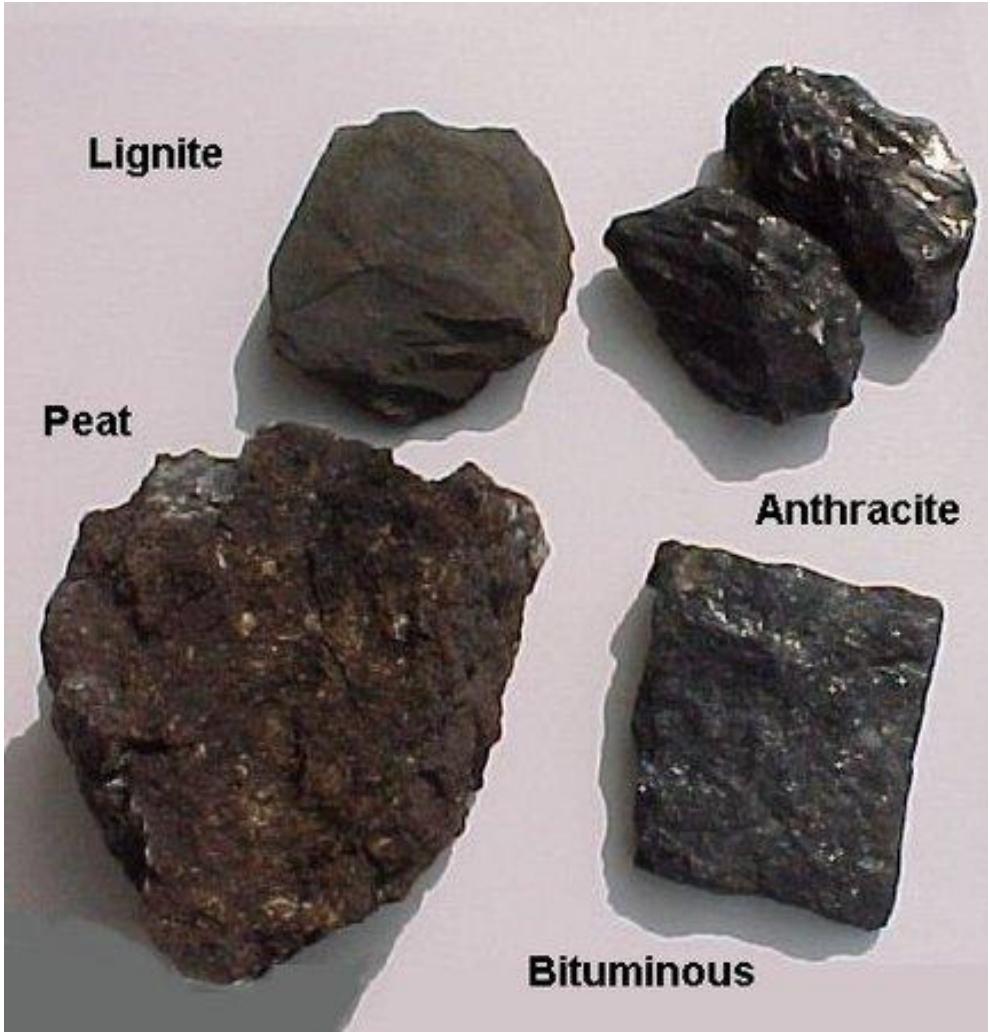


Source: Adapted from National Energy Education Development Project (public domain)

Coal – the remains of wetland plants that have been compressed over millions of years

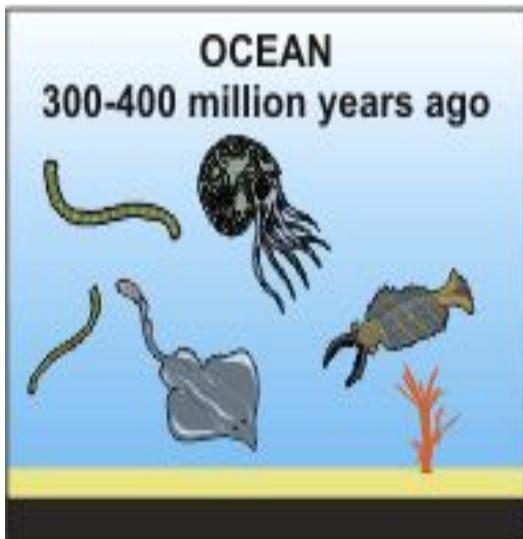
Different types –

1. **Peat** – about 50% carbon. The rest is water and contaminants.
2. **Lignite** (brown coal) – about 70% carbon.
3. **Bituminous** (soft coal) – about 85% carbon.
4. **Anthracite** (hard coal) – greatly than 90% carbon. This is the cleanest burning and least abundant.

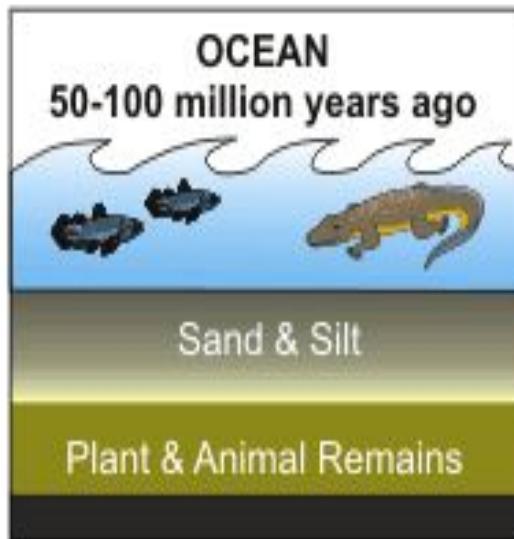


- Can be called **crude oil**
- An **oily mixture of flammable organic compounds** from which liquid fossil fuels and other products, such as asphalt, are separated
 - **Gasoline, plastics, and petrochemicals** (which are used to make synthetic fibers, such as rayon) are some of the products
 - **Formed from the remains of organisms that were in shallow prehistoric lakes and seas**

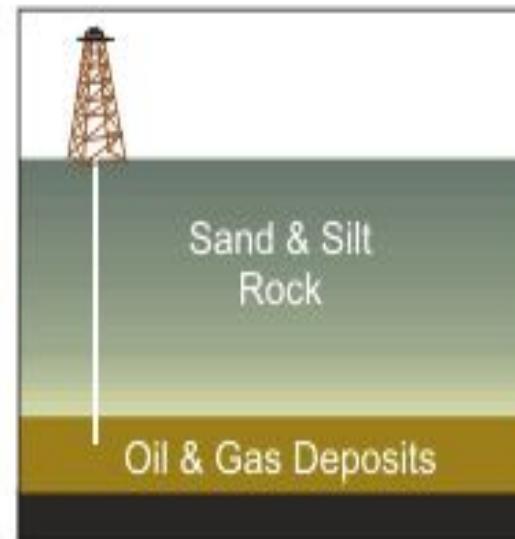
How are liquid fossil fuel formed?



Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.

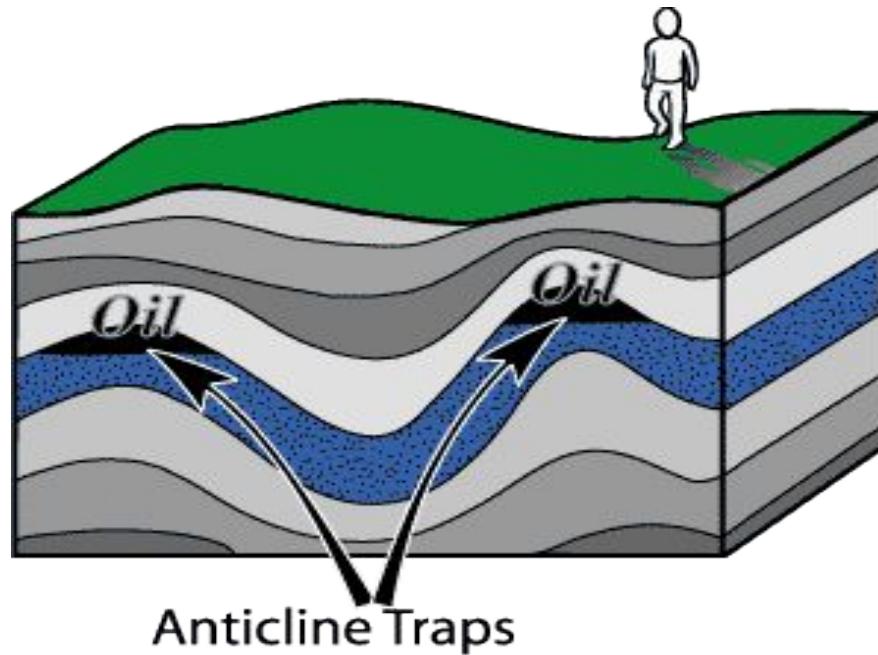


Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.



Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

How is oil formed?



In developing countries, the fossil fuels are fossilized wood, charcoal, and peat

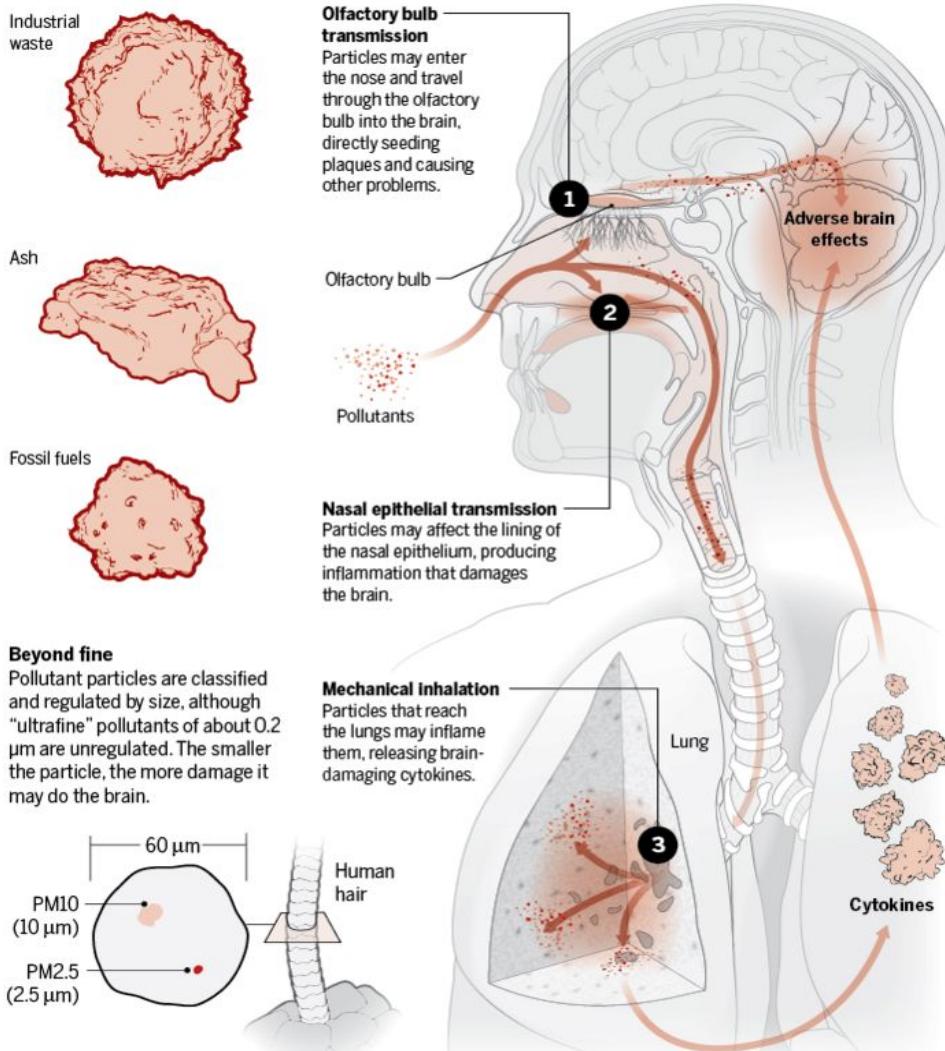
In developed countries, the fossil fuels are mainly coal, natural gas, and oil

- Used the most to heat in businesses and at homes as well as generating electricity;
- Stoves, ovens, and in vehicles as an alternative to gasoline
- Cleanest burning fossil fuel

We use them for energy because they provide a large amount of thermal energy per unit of mass

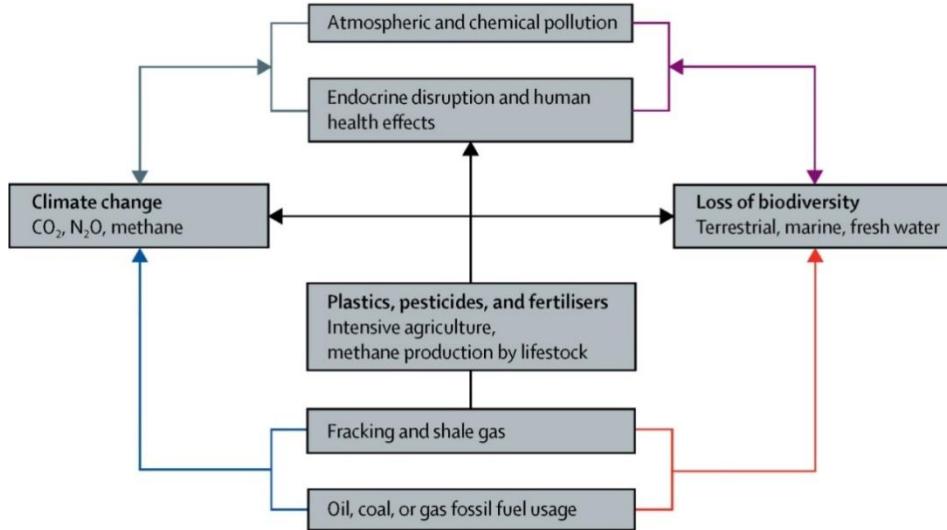
1. Acid precipitation from the burning of coal
2. Burning petroleum produces smog
3. Obtaining Coal: – Strip mining causes environmental damage
4. Coal mines can be hazardous for men and women working in them
5. Pollute water supplies, and cause the overlying Earth to collapse
6. Obtaining petroleum: – Oil spills can kill hundreds of thousands of animals and wildlife as well as damage the fishing industry

Problems With Fossil Fuels

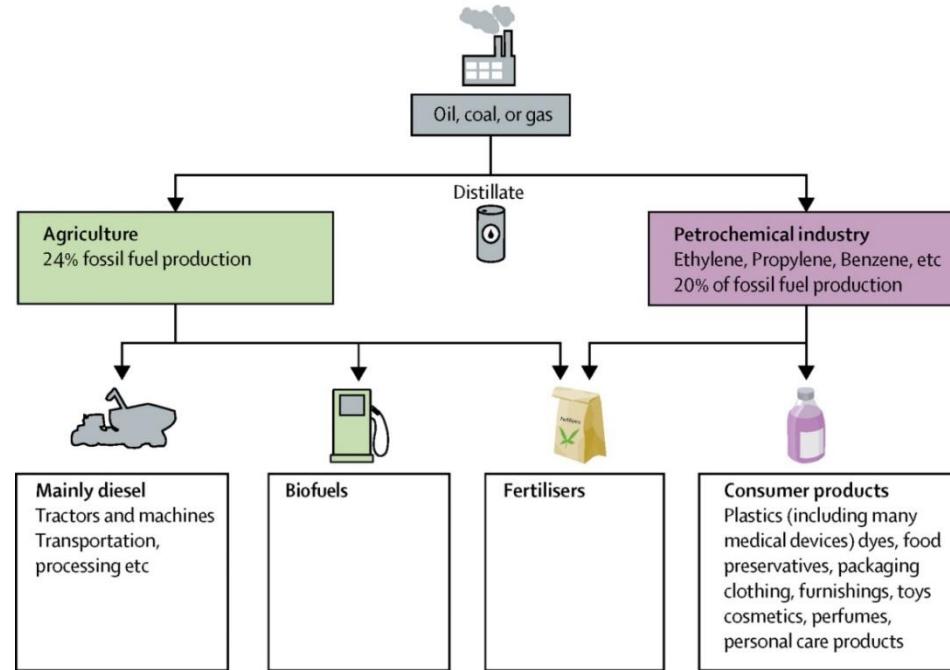


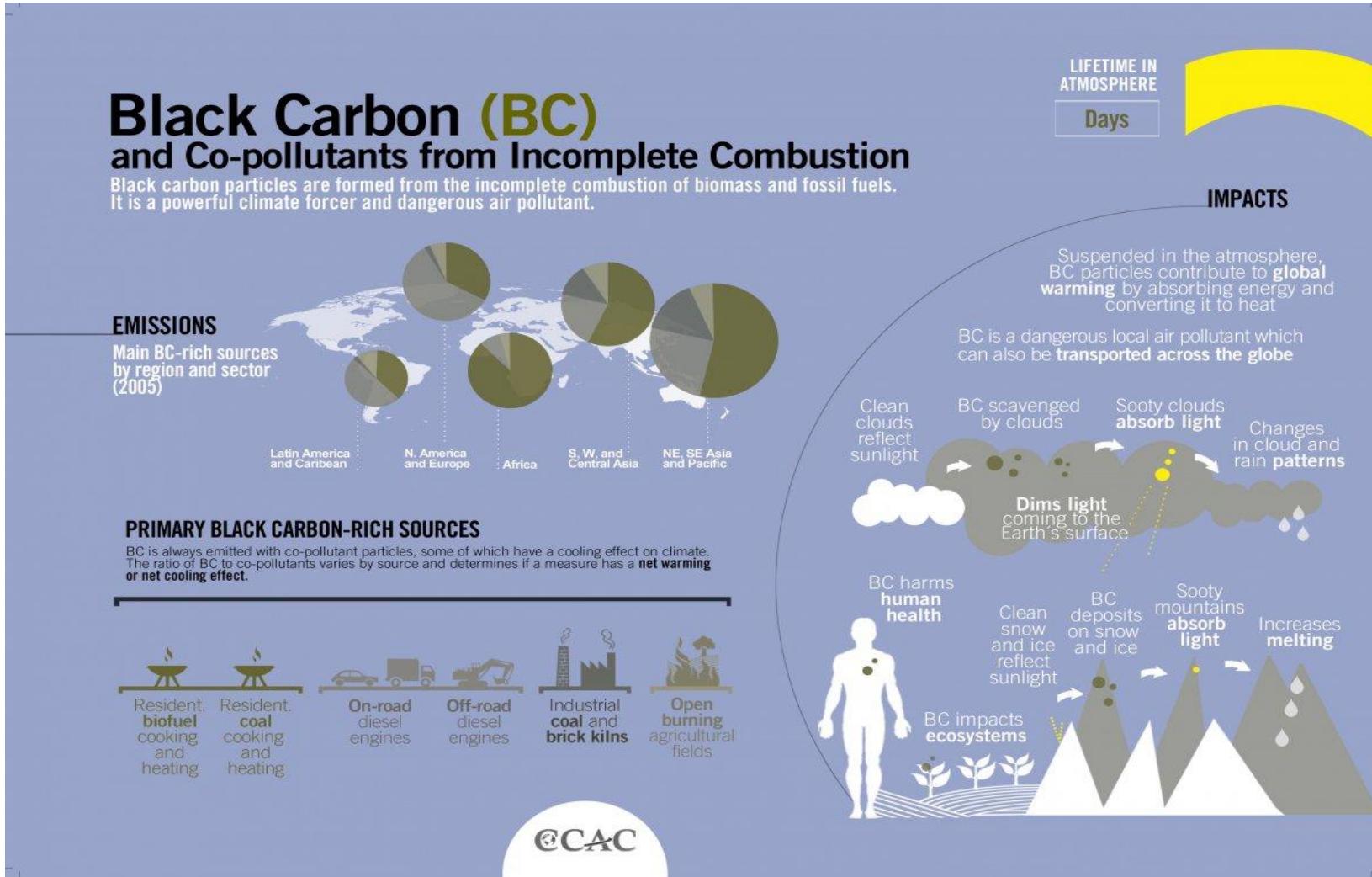
Problems With Fossil Fuels

A



B





- A natural resource that can be used and replaced over a relatively short time



Biomass – Organic matter that contains stored energy or

energy produced by heat within the Earth's crust

Ex: plants, wood, and waste

– Non-industrialized countries rely heavily on biomass for energy.

– Gasohol- Plant material that is changed into liquid fuel

Ex: Plants containing sugar or starch can be made into

alcohol. The alcohol is burned as a fuel or mixed with gasoline to form the gasohol.

Geothermal energy

- Harness heat from the Earth
- Ground water that seeps into hot spots near the surface of the Earth can form geysers. (Natural vents in which steam and water escape)
 - Example: Old Faithful (geyser) in Yellowstone National Park
 - The steam is used in power plants to generate electricity

Solar energy

- Energy from the sun
- 2 common ways (indirectly or directly):

Sunlight can be changed into electricity by the use of solar cells.

Example: solar calculator, solar panels (large panels made up of many solar cells wired together)

1. Solar collectors- dark-colored boxes with glass or plastic tops used to directly heat
2. Solar mirrors- mirrors that use sunlight to produce electricity for large-scale solar power

Hydroelectric energy

- Electricity produced by falling water
- Recycled through the water cycle
- Example: dams

Wind energy

- The energy in wind
- Uses wind turbines to convert kinetic energy into electrical energy by rotating a generator

1. Reduces fossil fuels usage
2. Solar – Almost limitless source of energy – Does not produce pollution
3. Water – Renewable – Does not produce air pollution – Dams produce no hazardous wastes.
4. Wind – Relatively inexpensive to generate – Does not produce air pollution
5. Geothermal – Almost limitless source of energy – Power plants land
6. Biomass – Renewable

1. Solar: – Expensive to use for large-scale energy production – Only practical in sunny areas
2. Water: – Dams disrupt a river's ecosystem. – Available only in areas that have rivers
3. Wind: – Only practical in windy areas (require strong, steady breezes to be effective), so there are limited locations for wind farms
4. Geothermal – Only practical in locations near hot spots (Hot spots are volcanic regions with a hotter mantle than most places.) – Waste water can damage soil
5. Biomass – Requires large areas of farmland – Produces smoke

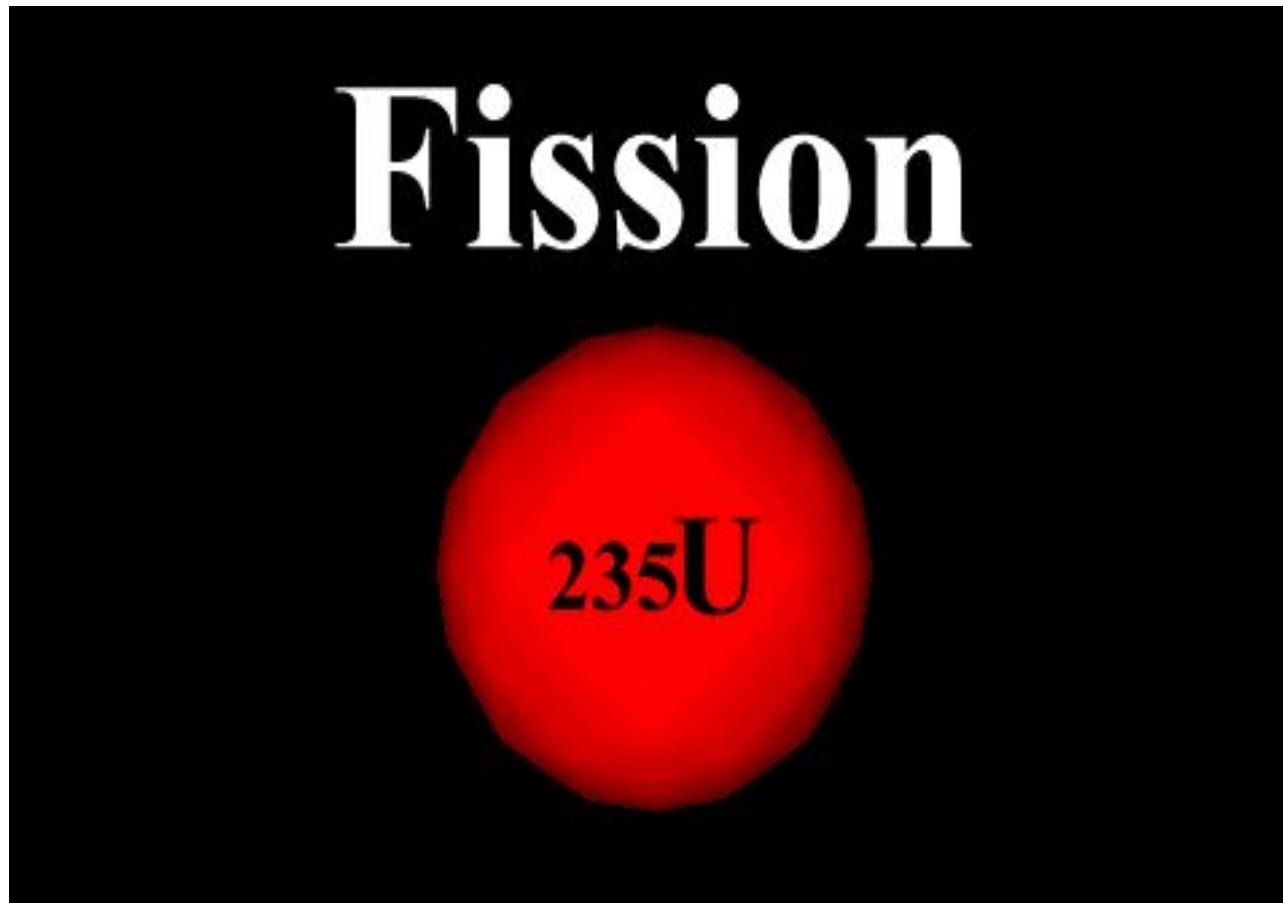
- Whether the natural resources we use are renewable or nonrenewable, we should be careful on how we use them
- Only use them when necessary
- Recycle! The process by which used or discarded materials are treated for reuse.

SAVE THE PLANET



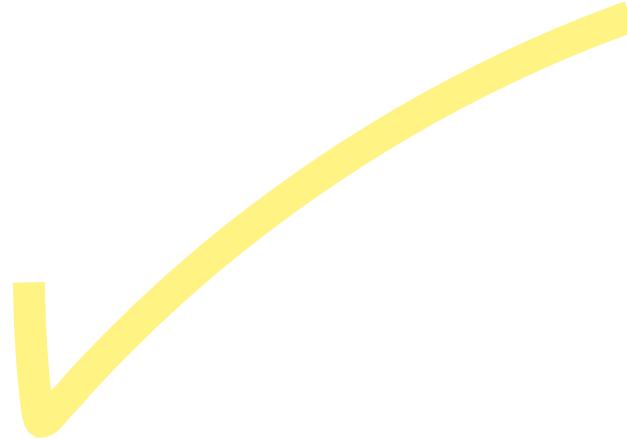
- An alternative source of energy that comes from the use of nuclear reactions
- A nuclear power plant generates thermal energy that boils water to produce steam.
 - Fossil fuel and nuclear power plants use steam to turn a turbine, which rotates a generator that converts kinetic energy into electrical energy.
 - Nuclear power plants provide alternative sources of energy without the problems that come with fossil fuels, but produce dangerous, radioactive wastes.

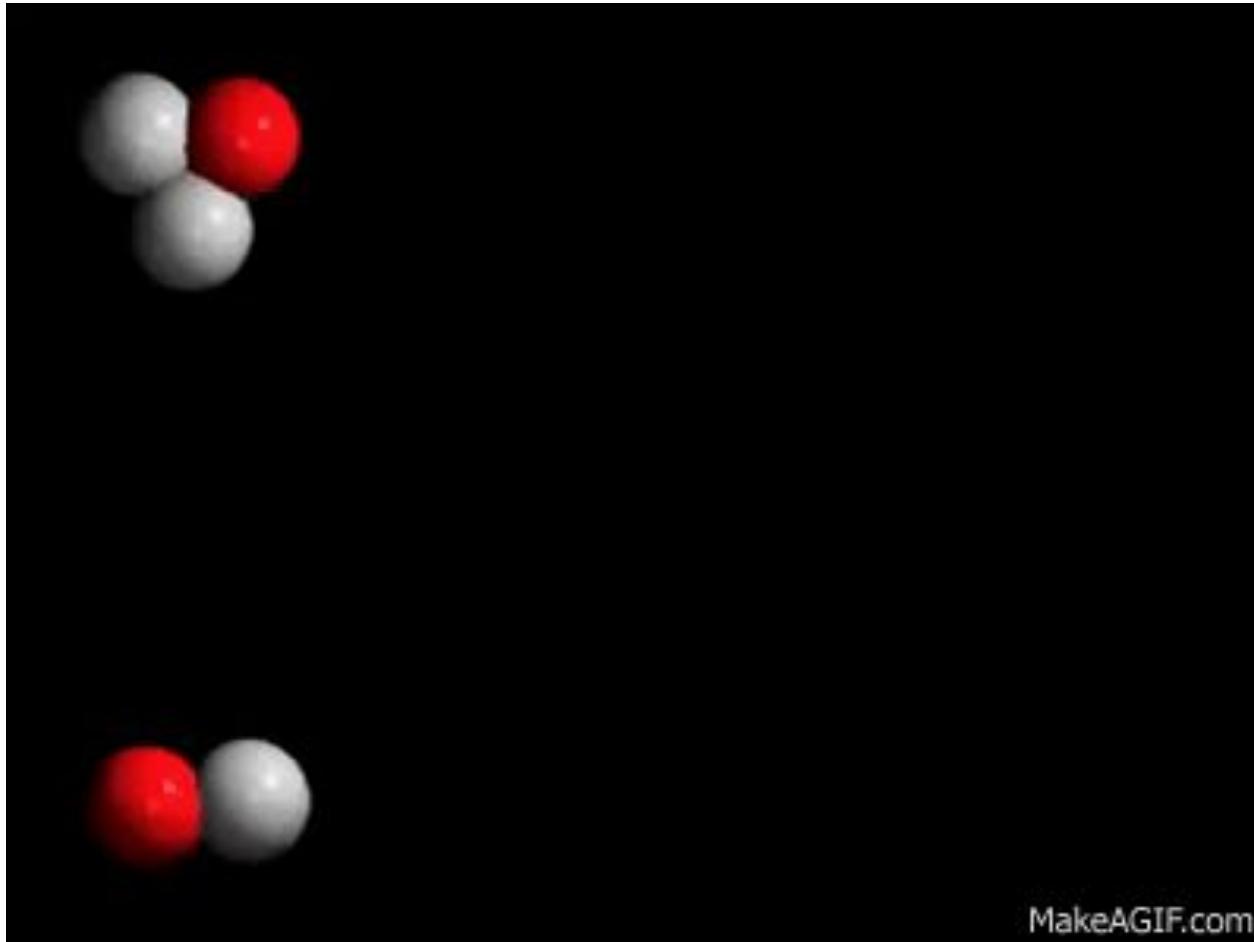
- Nuclear power can be obtained from nuclear fission, nuclear decay and nuclear fusion reactions.
- **Nuclear fission**- a process when the nucleus of a uranium atom is split into two smaller nuclei, releasing nuclear energy
- **Nuclear fusion**- the joining of nuclei of small atoms to form larger atoms
 - Produces few dangerous wastes, but very high temperatures are required for the reaction to take place



Nuclear Fission Chain Reaction

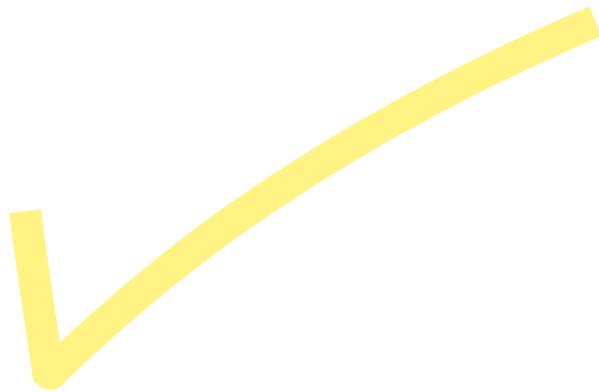
- — ^{235}U
- — Neutron
- — Fission Product





Proton-Proton Reaction

● — Neutron
● — Proton

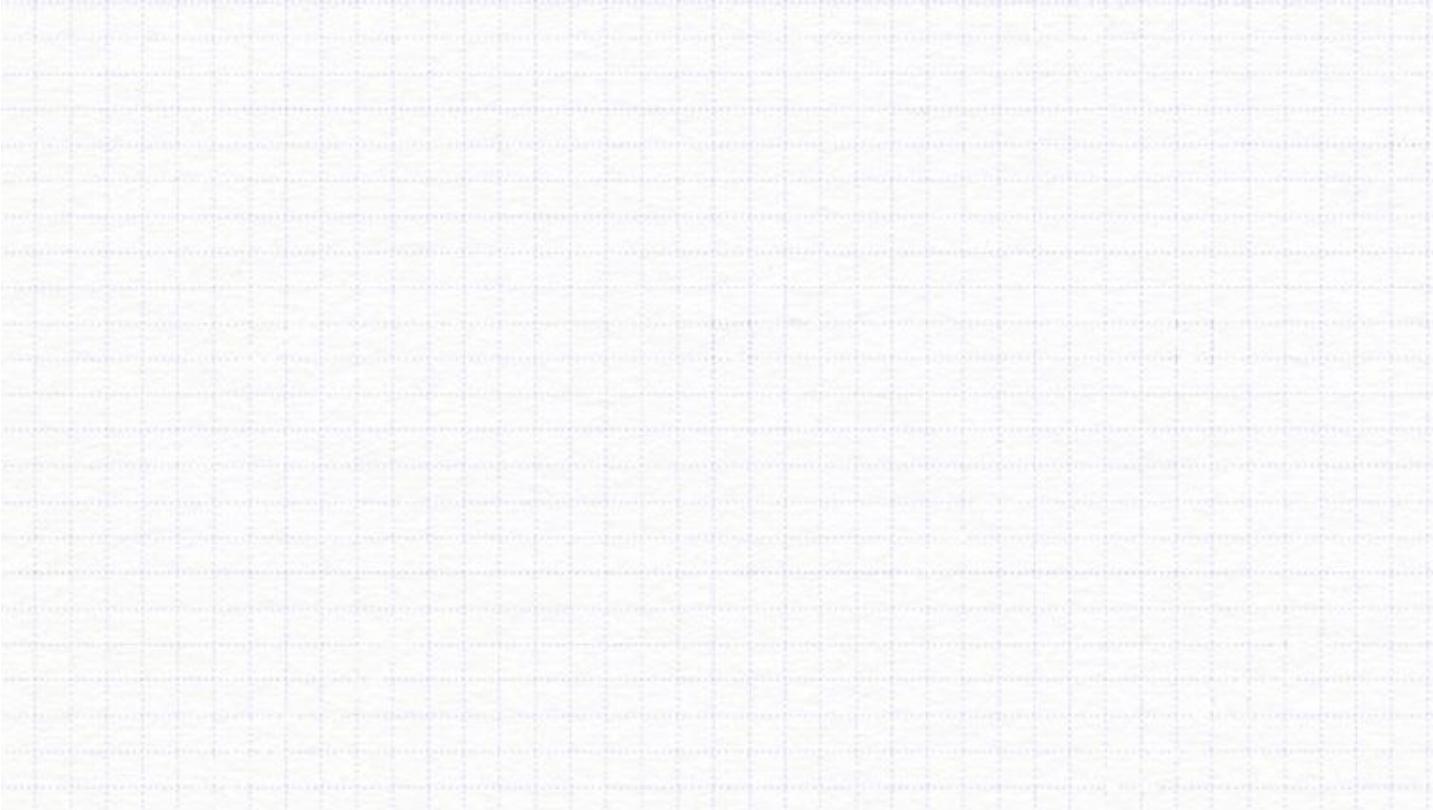


- As of March 2018, twenty two nuclear reactors are operational in 7 nuclear power plants that generate nearly 20 percent of the nation's electricity, all without carbon emissions because reactors use uranium, not fossil fuels.
- These plants are always: well-operated to avoid interruptions and built to withstand extreme weather, supporting the grid 24/7.
- All that power and potential from a tiny atom.

How do nuclear reactors work?

Three steps that reactors use to make clean electricity:

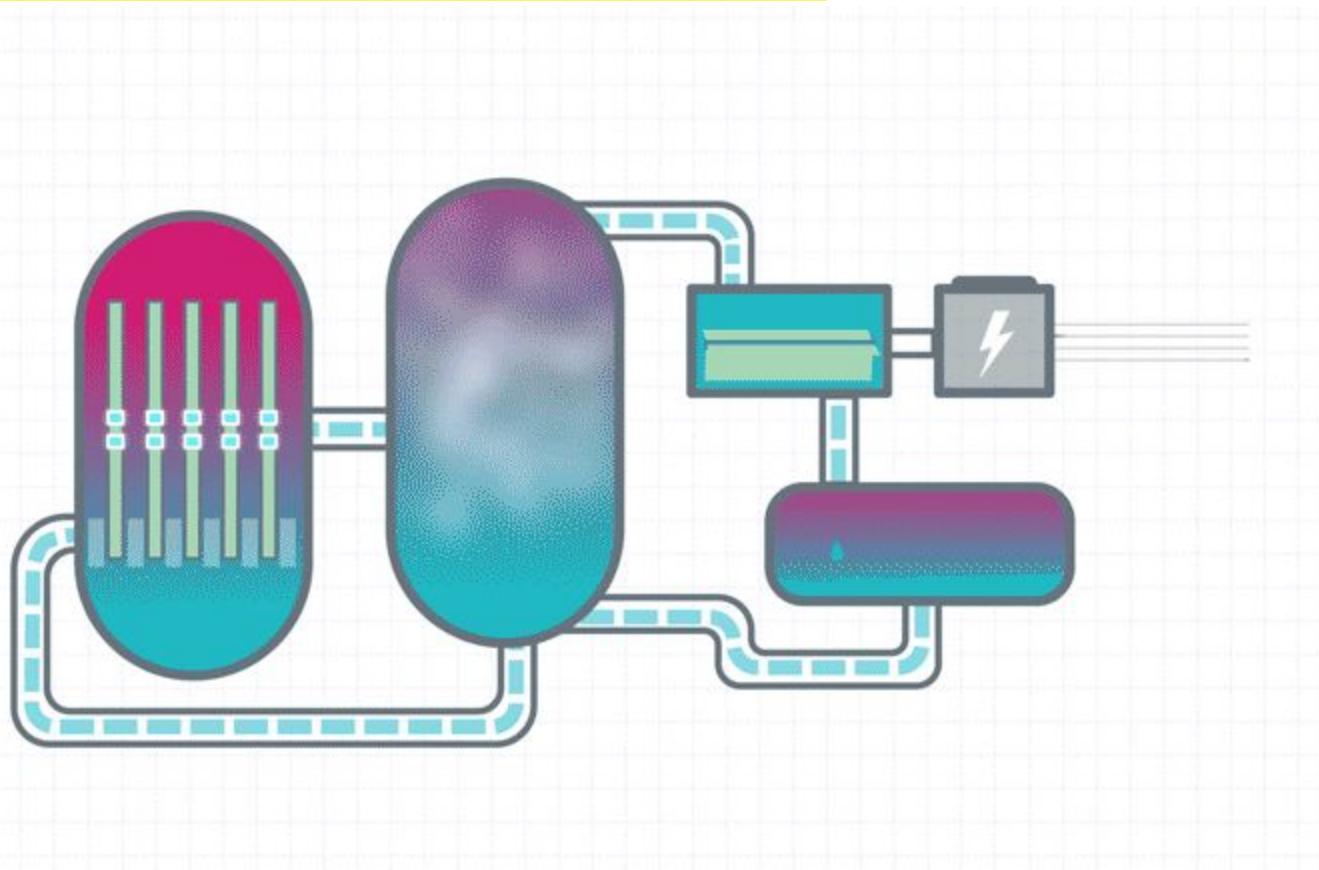
Step 1: Split Atoms to Create Heat



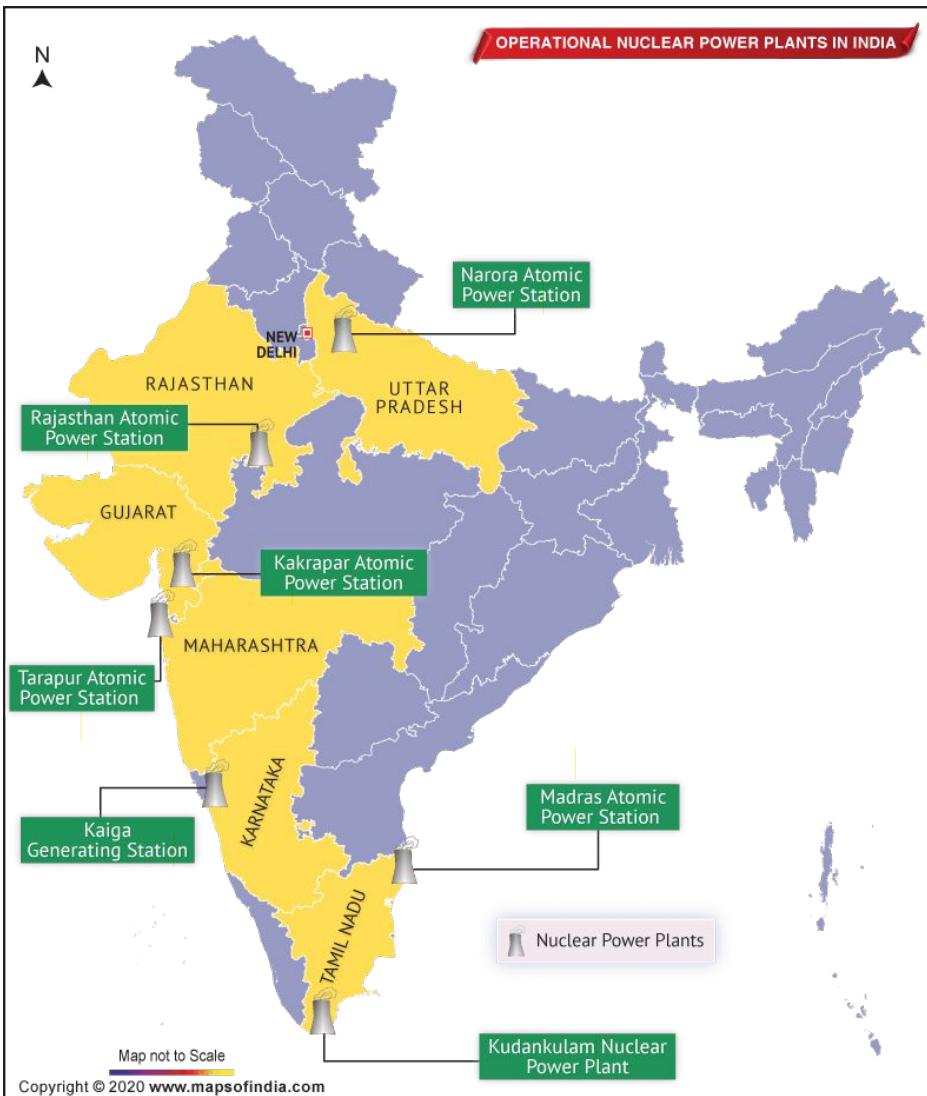
How do nuclear reactors work?

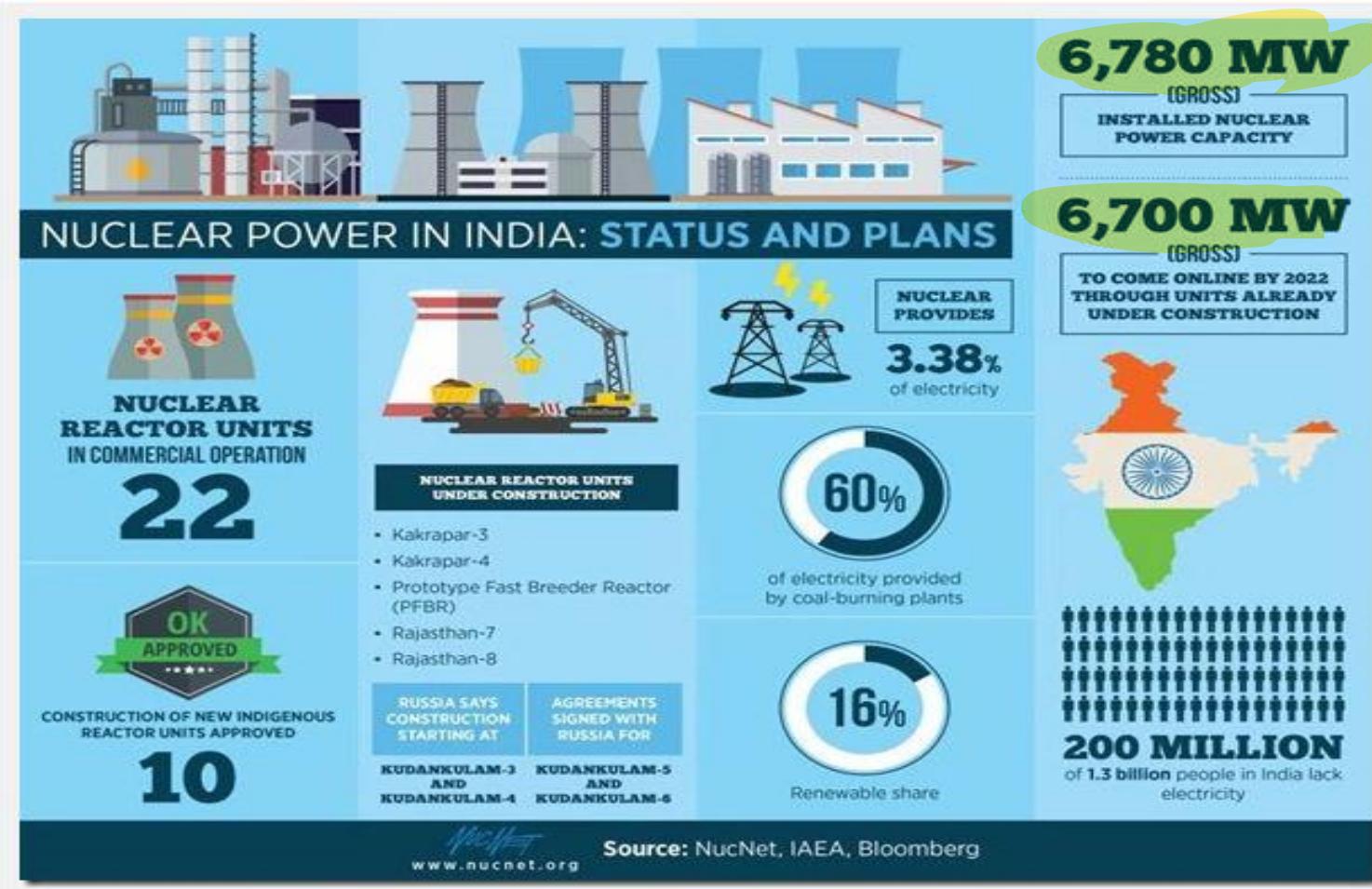
Step 2: Use the Heat to Make Steam

Step 3: Use the Steam to Turn a Turbine



1. Nuclear fights climate change-provides large amounts of 24/7 carbon-free electricity now, which is irreplaceable in protecting the environment
2. Nuclear protects our air-No trace elements like Nitrogen oxide, sulfur dioxide, particulate matter and mercury
3. Nuclear boosts international development- Nuclear energy helps developing nations meet sustainable development goals.
4. Nuclear powers electric vehicles- Electrified transportation promises to reduce carbon emissions.





Current Status of India's Nuclear Energy Program. Image courtesy of NucNet

Nuclear Power in India- 4th Kudankulam Nuclear Power Plant





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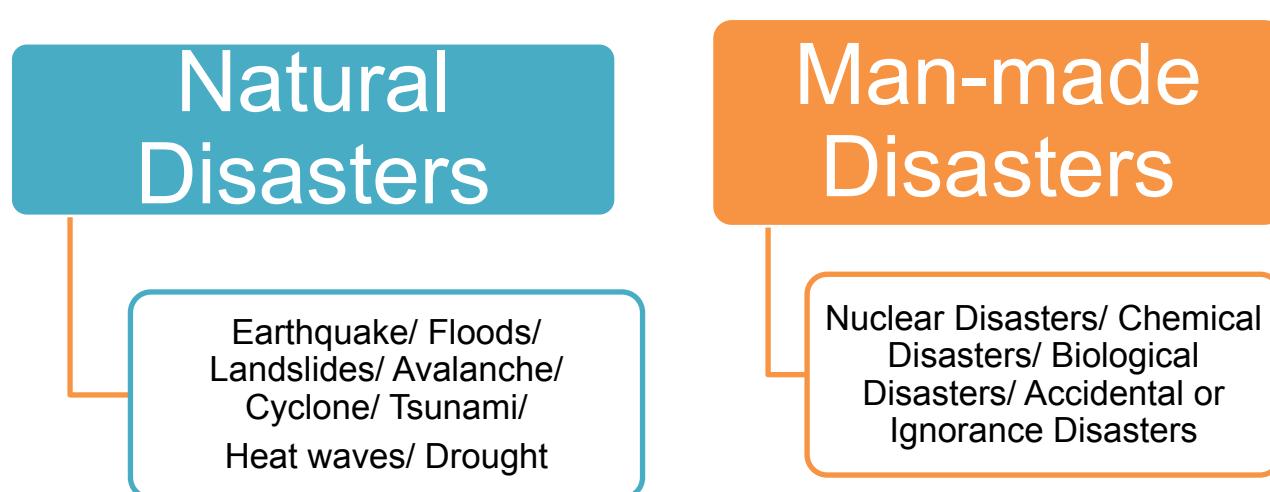
ENVIRONMENTAL STUDIES & LIFE SCIENCES

Natural and Man-made Disasters

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- A Disaster is a serious disruption of the functioning of a society involving widespread human, material, economic or environmental losses & impacts which exceeds the ability of the affected community or society to cope using it's own resources



- A Natural Disaster is a major adverse event resulting from natural processes of the Earth such as floods, volcanic-eruptions, earthquakes, tsunamis & other geological processes, such events lead to loss of life & property.
- The severity of such events depends on the affected population's ability to recover.

- An earthquake is the result of a **sudden release of energy** in Earth's crust that creates seismic waves.
- At the Earth's surface, earthquakes manifest themselves by shaking & sometimes displacement of the ground.
- **Seismic activity** of an area refers to the frequency, type & size of earthquakes experienced over a period of time & are measured using **seismometers**.
- Earthquakes are measured using observations from seismometer and moment magnitude is expressed in terms of **Richter scale**.

- A flood is an overflow of water that submerges land, may occur as an overflow of water from water bodies, such as a river or lake, in which the water overflows, resulting in some of that water escaping its usual boundaries or it may occur due to accumulation of rainwater on saturated ground in an areal flood.
- Flash floods can develop within hours of heavy rainfall.
- Deserts are vulnerable to flash floods. Wadis (Arroyos) are dry river beds that only flow during heavy rains.



- A landslide is a geological phenomenon that includes a wide range of ground movements, such as rock falls, deep failure of slopes & shallow debris flows.
- Landslides can occur in offshore, coastal & onshore environments.
- Landslides are caused by rain, earthquakes, volcanoes, or other factors that make the slope unstable.

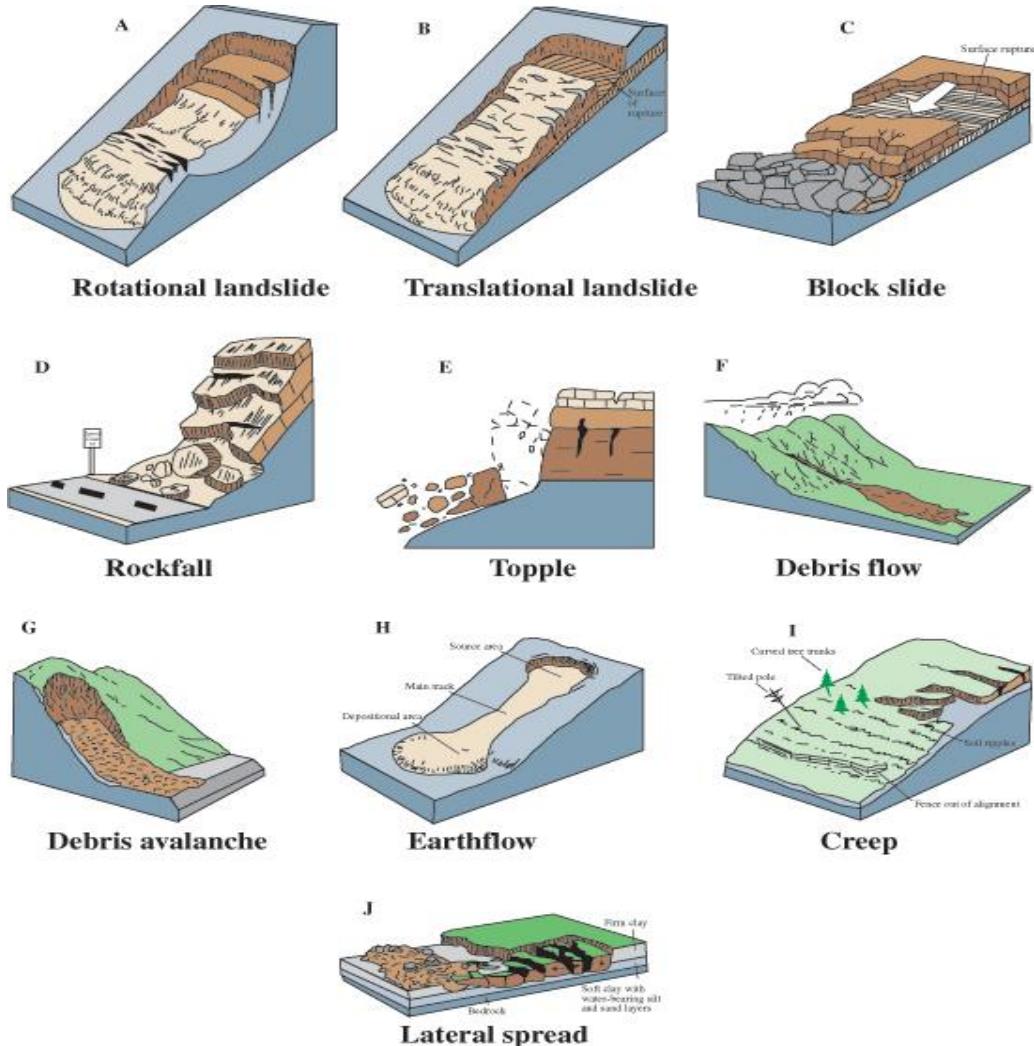
Landslide

A landslide near Cusco, Peru in 2018.



- There are several ways of describing how a landslide moves. These include falls, topples, translational slides, lateral spreads, and flows.
- Falls & topples-heavy blocks of material fall after separating from a very steep slope or cliff.
- In translational slides, surface material is separated from the more stable underlying layer of a slope.
- A lateral spread or flow is the movement of material sideways, or laterally.

Landslide Movement

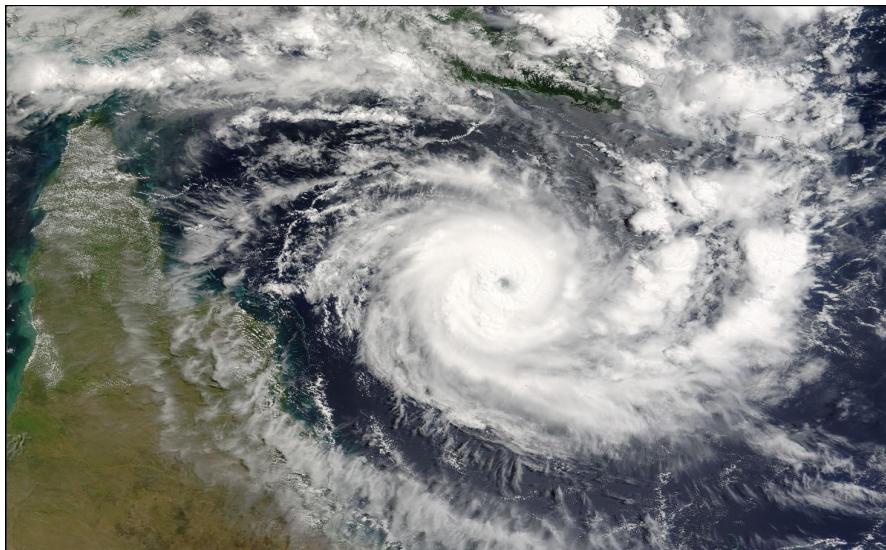


- An avalanche is a rapid flow of snow down a sloping surface. During an avalanche, a mass of snow, rock, ice, soil, and other material slides swiftly down a mountainside.
- There are two main types of snow avalanches—**sluffs** and **slabs**.
- Sluff avalanches occur when the weak layer of a snowpack is on the top. A sluff is a small slide of dry, powdery snow that moves as a formless mass
- A slab avalanche occurs when the weak layer lies lower down in a snowpack. This layer is covered with other layers of compressed snow. When the avalanche is triggered, the weak layer breaks off, pulling all the layers on top of it down the slope.



- A cyclone is an area of closed, circular fluid motion rotating in the same direction as the Earth.
- This is usually characterized by inward circular winds that rotate anti-clockwise in the Northern Hemisphere & clockwise in the Southern Hemisphere of the Earth.
- An anticyclone is the opposite of a cyclone. An anticyclone's winds rotate clockwise in the Northern Hemisphere around a center of high pressure. Air comes in from above and sinks to the ground.

- Most large-scale cyclonic circulations are centered on areas of low atmospheric pressure.
- There are two types of cyclones:
- Mid-latitude cyclones are the main cause of winter storms in the middle latitudes. Tropical cyclones are also known as hurricanes.



- In Japanese, *tsunami* means "harbor wave."
- A Tsunami also known as seismic sea wave, it is a series of water waves caused by displacement of a large volume of a body of water, generally an ocean or a large lake.
- Tsunamis race across the sea at up to 500 miles (805 kilometers) an hour—about as fast as a jet airplane. At that pace, they can cross the entire expanse of the Pacific Ocean in less than a day.

Tsunami

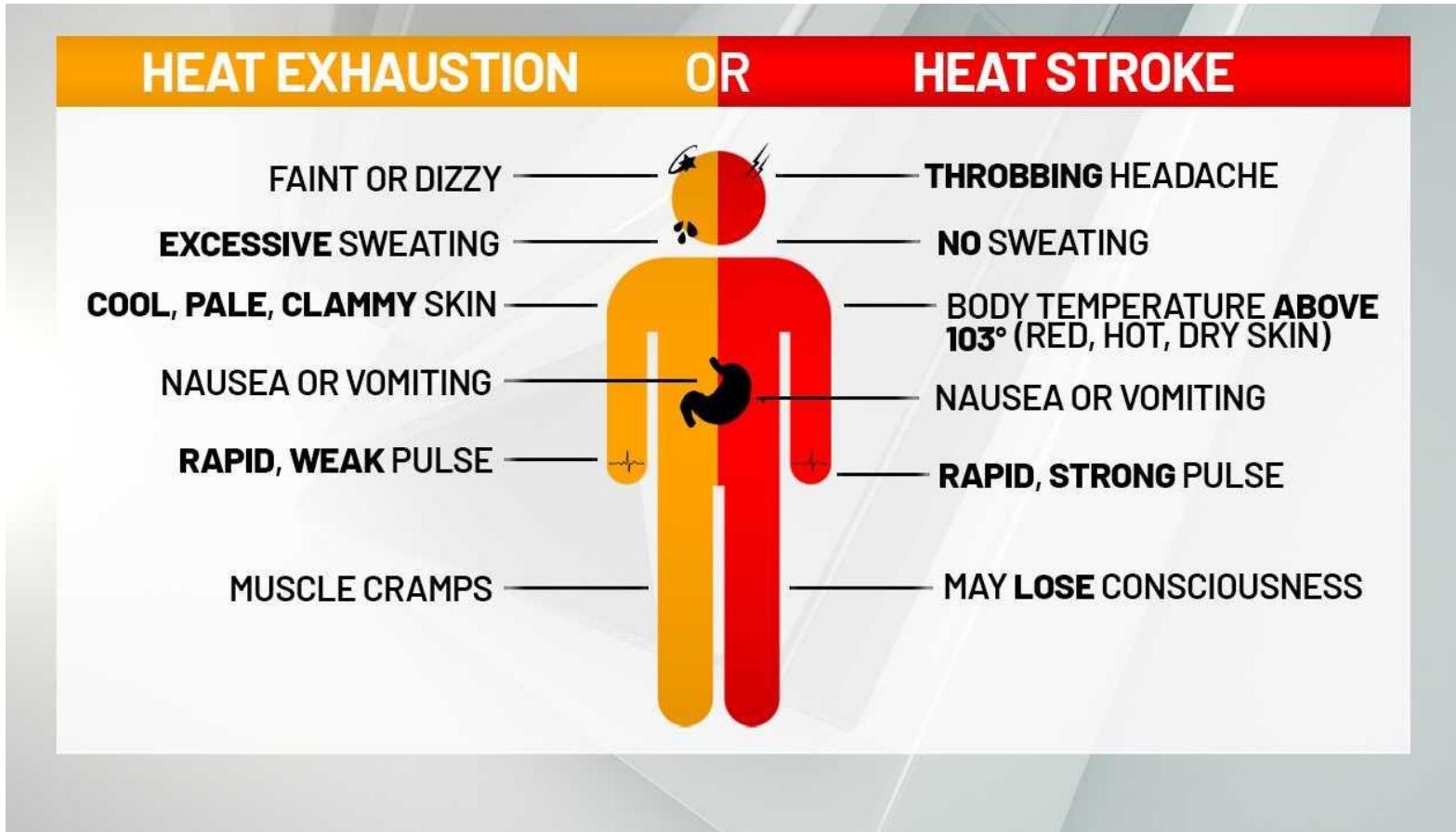


- Drought is an extended period when a region receives a deficiency in its water supply, whether atmospheric, surface or ground water.
- A drought can last for months or years, or may be declared after as few as 15 days, this occurs when a region receives consistently below average precipitation.
- A Drought can have a substantial impact on the ecosystem & agriculture of the affected region.

Drought



- A heat wave is a prolonged period of excessively hot weather accompanied by high humidity, especially in oceanic climate countries.
- It occurs during the summer season in the North-Western parts of India.
- The extreme temperatures and resultant atmospheric conditions adversely affect people living in these regions as they cause physiological stress, sometimes resulting in death.



- Disasters having elements of human intent, negligence, error, failure of human-made systems.
- Such events result in huge losses of life & property along with damage to people's mental, physical & social well-being.
- Such man-made disasters are Nuclear disaster, biological/chemical threat, accidental, terrorism, etc.
- The causes of man made disasters are: Ignorance, unawareness, illiteracy, carelessness

- Nuclear and Radiological Emergency/Disaster Scenarios:

1. An accident taking place in any nuclear facility of the nuclear fuel cycle including the nuclear reactor, or in a facility using radioactive sources, leading to a large-scale release of radioactivity in the environment.
2. A ‘criticality’ accident in a nuclear fuel cycle facility where an uncontrolled nuclear chain reaction takes place inadvertently leading to bursts of neutrons and gamma radiation (as had happened at Tokaimura, Japan).

3. An accident during the transportation of radioactive

material.

4. The malevolent use of radioactive material as Radiological

Dispersal Device (RDD) by terrorists for dispersing radioactive

material in the environment.

5. A large-scale nuclear disaster resulting from a nuclear

weapon attack (as had happened at Hiroshima and Nagasaki in

Japan) which would lead to mass casualties and destruction of

large areas and properties.

Nuclear Disaster



<https://sites.suffolk.edu/jstraka/2015/10/30/fukushima-daiichi-nuclear-disaster/>



<https://www.businessinsider.in/science/chernobyl>

- Chemical, being at the core of modern industrial systems, has attained a very serious concern for disaster management.
- Chemical disasters may be traumatic in their impacts on human beings and have resulted in the casualties and also damages nature and property.
- The elements which are at highest risks due to chemical disaster primarily include the industrial plant, its employees & workers, hazardous chemicals vehicles, the residents of nearby settlements, adjacent buildings, occupants and surrounding community.

Chemical disasters may arise in number of ways, such as:-

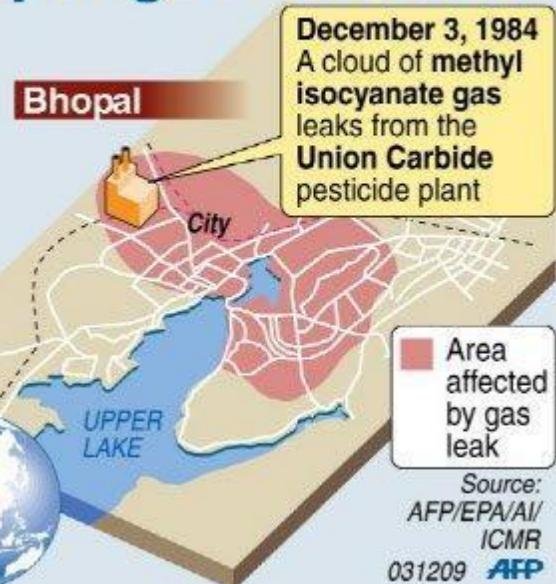
1. Process and safety systems failures
 - Human errors
 - Technical errors
 - Management errors
2. Induced effect of natural calamities
3. Accidents during the transportation
4. Hazardous waste processing/ disposal
5. Terrorist attack/ unrest leading to sabotage

- India has witnessed the world's worst chemical (industrial) disaster “Bhopal Gas Tragedy” in the year 1984.
- The Bhopal Gas tragedy was most devastating chemical accident in history, where over 2500 people died due to accidental release of toxic gas Methyl Iso Cyanate (MIC).
- India continued to witness a series of chemical accidents even after Bhopal had demonstrated the vulnerability of the country. Only in last decade, 130 significant chemical accidents reported in India, which resulted into 259 deaths and 563 number of major injured.

The 1984 Bhopal gas disaster

The human cost (estimates)

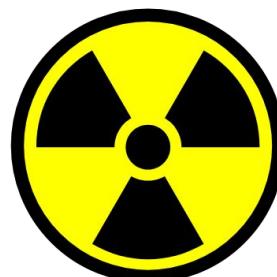
- ▶ Up to 10,000 deaths in first three days
- ▶ Additional 25,000 people died of related injuries by 1994



Bhopal Gas Tragedy



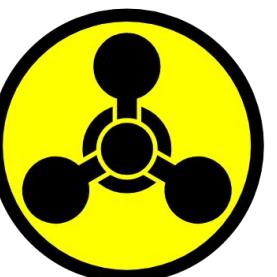
- Charles Baldwin developed the symbol for biohazard in 1966.
- Biological disasters are natural scenarios involving disease, disability, or death on a large scale among humans, animals, and plants due to micro-organisms like bacteria, or viruses, or toxins.



Atomic



Biological



Chemical

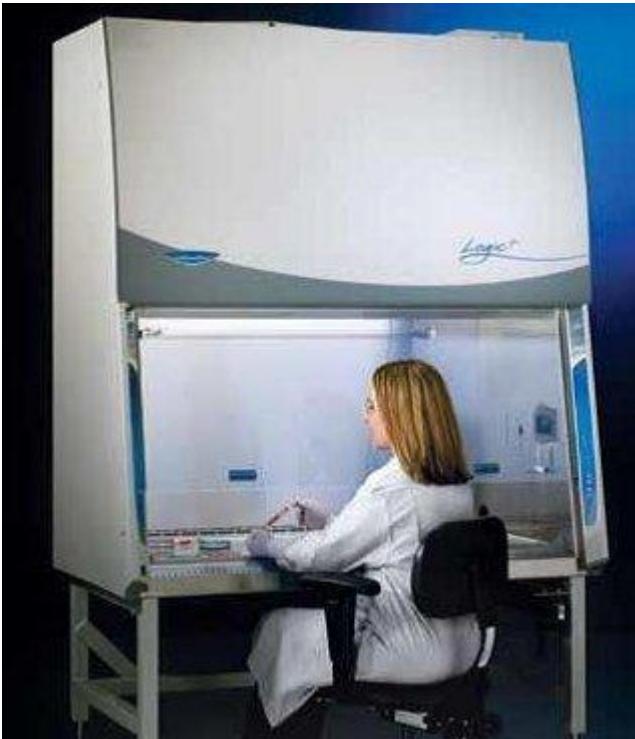
- The US Center for Disease Control classifies biohazards into four biosafety levels as follows:
 - **BSL-1:** Bacteria and Viruses including *Bacillus subtilis*, some cell cultures, canine hepatitis, and non-infectious bacteria. Protection is only facial protection and gloves.
 - **BSL-2:** Bacteria and viruses that cause only mild disease to humans, or are difficult to contract via aerosol in a lab setting such as hepatitis A, B, C, mumps, measles, HIV, etc. Protection – use of autoclaves for sterilizing and biological safety cabinets.

- **BSL-3:** Bacteria and viruses causing severe to fatal disease in humans. Example: West Nile virus, anthrax, MERS coronavirus. Protection – Stringent safety protocols such as the use of respirators to prevent airborne infection.

- **BSL-4:** Potentially fatal (to human beings) viruses like Ebola virus, Marburg virus, Lassa fever virus, etc. Protection – use of a positive pressure personnel suit, with a segregated air supply.

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Biological Disaster-Natural or Human-made?



Biological safety
cabinet BSL - 2



BSL - 3



BSL - 4



- **Disaster prevention and mitigation** refers to the activities which are undertaken to prevent or mitigate the adverse effects of a disaster in short and long term.
- On the one hand they include political, legal, administrative and infrastructural measures; while on the other hand it includes educating vulnerable communities influencing their lifestyle and behaviour in order to reduce their disaster risk.

- **Disaster Preparedness**
- The intention of Disaster preparedness is to prevent or minimize the losses and damage in case of a disaster.
- This would include the preparedness of all civic bodies such as civil administration, fire-brigade, hospitals, police etc. Preparedness denotes the third phase of emergency management.

- **Response, Recovery and Reconstruction**
- The response phase includes the search and rescue; fulfilling basic humanitarian needs of victims ; assistance by regional, national and international bodies etc. Recovery phase starts after the immediate threat to human life has subsided.
- The immediate goal of the recovery phase is to bring the affected area back to some degree of normalcy.

During reconstruction, the location or construction material of the property is considered.

- A biological attack, or **bioterrorism**, is the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops.
- **Biological warfare:** intentional use of microorganisms and toxins usually of microbial, plant or animal origin to produce disease and death among humans, live stock and crops.

- World War 1: Germany sent infected horses and mules into the Allied forces
- World War 2 : Japanese military unit 731 killed Chinese in the regions of Ping Fan, Manchuria using various agents including anthrax
- In September 2001, the American public was exposed to anthrax spores as a bioweapon delivered through the US postal system, called the case of the 'anthrax letters' in the aftermath of the World Trade Center attack.

- Ideal features of a Bioterrorist agent:
- Should consistently produce a given effect, death or disease, at low concentrations.
- Should be highly contagious,
- Have a short and predictable incubation period.
- The target population should have little or no immunity against the organism.
- Little or no prophylaxis or treatment should be available with the native population.

- The bioterrorist agents with highest priority are
- Anthrax (*Bacillus anthracis*),
- Botulism (*Clostridium botulinum*),
- Plague (*Yersinia pestis*),
- Smallpox (*Variola major*),
- Tularaemia (*Francisella tularensis*) and
- Viral haemorrhagic fevers (Filoviruses and Arena viruses).

	CRITERIA	EXAMPLES
Category A	High mortality, disseminate easily, needs special action	<i>Bacillus. anthracis,</i> <i>Yersinia pestis, Variola major,</i> <i>Francisella tularensis,</i> Filoviruses & Arenaviruses family
Category B	Moderately easy to disseminate, moderate morbidity	<i>Brucella species,</i> <i>Salmonella species,</i> <i>Escherichia coli O157:H7,</i> <i>Vibrio cholerae</i> Alphaviruses family
Category C	Easily produced, potential for high morbidity and mortality	<i>Mycobacterium tuberculosis*</i> Nipah virus, Hantavirus,

Delivery Mechanisms

- 1) **Aerosol spray** : easiest method of dispersal. Highest number of people victimized
- 2) **Food & Water contamination** : more cumbersome. People victimized are less & large quantities of agent required
- 3) **Spores** : Through envelopes (Anthrax) easy dispersal.
- 4) **Infected People/ Animals** : People or animals in the prodromal or latent illness where the organism can't be identified. Very difficult and very few people will be infected.

Bioterrorism Indicators

Clinicians to identify a bioterrorism attack :

- 1) Clustering of cases,
- 2) Disease in no-risk individuals
- 3) Atypical conditions like unusual age groups, or seasons



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ENVIRONMENTAL STUDIES & LIFE SCIENCES

Environmental Pollution and its types

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Pollution – Introduction

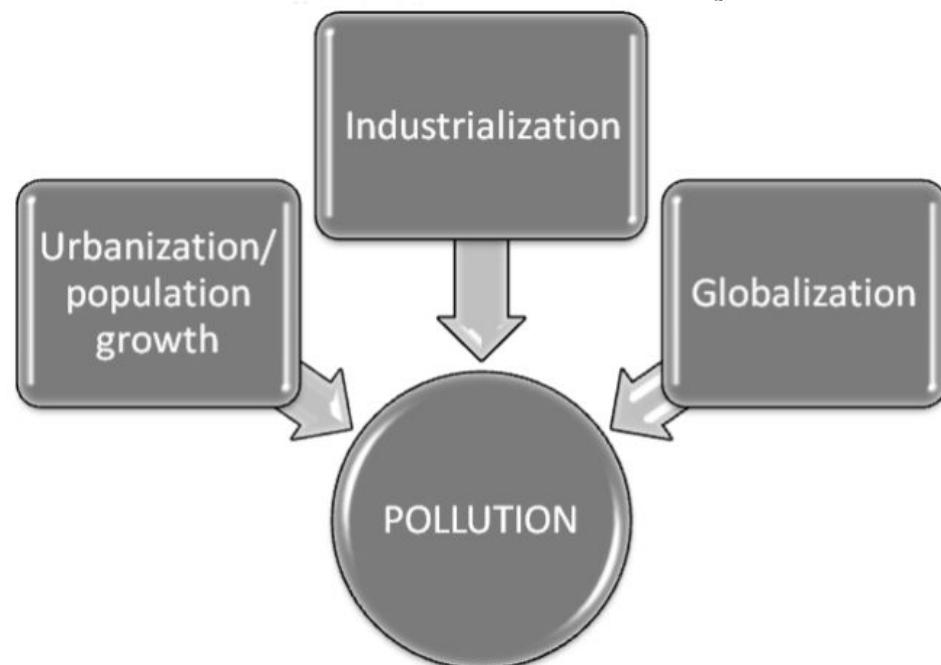
The term *pollution* can refer to both artificial and natural materials that are created, consumed, and discarded in an unsustainable manner.

Pollutant

Pollutant is defined as harmful material released into the environment that causes undesirable effects in the environment.

Pollutants are the elements, molecules and particles involved in pollution - life can be harmed when exposed to these materials, and the effects of them on humans and plants are well known.

Environmental pollution may destabilize development process and competitiveness of developing nations whose economies depends on natural resources.



The Fundamental Drivers of Pollution

<https://www.pide.org.pk/pdf/PDR/2016/Volume4/589-604.pdf>

- Industrialisation is the first fundamental cause of pollution.
- Among other things, industrialization set in motion the widespread use of fossil fuels (oil, gas and coal) which are now the main sources of pollution.
- Industrial pollution contribute majorly in emitting waste gases like carbon monoxide, sulphur oxides, and nitrogen oxides which are the waste products of industry and end up in the air as well as dumping of industrial waste into water, endangering human life

Overview on Pollution

- Any form of pollution that can trace its immediate source to industrial practices is known as industrial pollution.
- Most of the pollution on the planet can be traced back to industries of some kind.



<https://www.conserve-energy-future.com/causes-effects-of-industrial-pollution.php>

Types of pollution

The term "pollution" refers to any substance that negatively impacts the environment or organisms that live within the affected environment.

The five major types of pollution include:

- **Air pollution,**
- **Water pollution,**
- **Soil pollution,**
- **Light pollution,**
- **Thermal Pollution**
- **Radioactive Pollution and**
- **Noise pollution.**

TYPES OF POLLUTION



Water Pollution | Air Pollution | Land Pollution | Sound Pollution | Light Pollution

Air pollution

Sources: Urbanization/ Manmade- Outdoor pollution sources and Indoor pollution sources

- **Burning of fossil fuels** : The burning of fossil fuels contributes to the formation of smog, a dense layer of particulate matter that hangs like a cloud over many major cities and industrial zones.

- **Vehicle and factory emissions** : Carbon monoxide, sulfur dioxide and lead are typically released directly into the atmosphere from industrial activity and vehicles.

Ozone, is usually created from the chemical decomposition of nitrogen oxides released from automobiles. Nitrogen dioxide is the product of the oxidation of nitrogen oxides.

Indoor include carbon monoxide, methane, particulate matter (PM), polyaromatic hydrocarbons (PAH) and volatile organic compounds (VOC).

SPM is usually caused by dust, combustion,

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Air pollution and its effects

- Air pollution is the introduction of harmful chemicals into the atmosphere.
- The exhaust from vehicles for instance, is polluting the air with toxic chemicals such as carbon monoxide and formaldehyde.



<https://www.nationalgeographic.org/encyclopedia/pollution>

Air pollution

Sources:

Natural sources: Volcanic eruption, dust storm, forest fire, Carbon dioxide from humans during respiration, Methane from cattle during digestion, Oxygen from plants during Photosynthesis



Manmade



natural



Major Pollutants of air:

- Ozone
- particulate matter
- carbon monoxide
- nitrogen dioxide
- sulfur dioxide and
- lead
- Volatile organic compounds (VOCs)
- Chlorofluorocarbons (CFCs)
- Mercury (Hg)
- Peroxyacetyl nitrates (PANs)

Types of air pollutants:

It can be further divided into **Primarily and Secondary air pollutants** if we go deep.

Primarily air pollutants can be caused by primary sources or secondary sources. The pollutants that are a direct result of the process can be called Primary pollutants. Eg. sulfur-dioxide emitted from factories.

Secondary pollutants are the ones that are caused by the intermingling and reactions of primary pollutants. Smog created by the interactions of several primary pollutants is known as a secondary pollutant.

Classification of Air Pollution

Air pollution can be classified into two sections –

Visible air pollution, like smog over a city is an example of visible pollution.

Invisible air pollutants are less noticeable, but they can be more deadly. Good examples of invisible air pollutants are sulfur dioxide, carbon monoxide and nitrogen oxides

Effects of Air pollution

1. Respiratory and Heart Problems- Asthma, chronic bronchitis, emphysema, heart attacks and strokes along with cancer

2. Child Health Problems- Exposure to high air pollution levels during pregnancy causes miscarriages as well as premature birth, autism, asthma and spectrum disorder in young children. Brain development and pneumonia



3. Global Warming - With increased temperatures worldwide, an increase in sea levels and melting of ice from colder regions and icebergs, displacement, and loss of habitat have already signaled an impending disaster if actions for preservation and normalization aren't undertaken soon.

Environmental effects of air pollution

4. Acid Rain

Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to humans, animals, and crops.



5. Depletion of the Ozone Layer

Ozone exists in the Earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays. Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydrochlorofluorocarbons in the atmosphere.

Smog

- **Smog** is air pollution that reduces visibility.
- Ex: New Delhi 2019.
- Shanghai smog, The great smog of London (1952)
- Higher levels of smog are associated with a wide range of diseases such as chronic obstructive pulmonary disorder, heart disease, stroke and lung cancer.



<https://www.insider.com/new-delhi-smog-air-pollution-photos-2019-11>

Solutions To Air Pollution

1. Use the Public Mode of Transportation
2. Better Household Practices
3. Conserve Energy
4. Understand the Concept of Reduce, Reuse and Recycle
5. Use Energy-Efficient Devices

Health effect of air pollution

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

<https://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution>

Water pollution

- Water pollution happens when toxic substances enter water bodies such as lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed.
- This degrades the quality of water.



<https://www.britannica.com/explore/savingearth/water-pollution>

Pollutants or contaminants which enter a body of water can be further divided into:

Degradable (non-conservative) pollutants: impurities which eventually decompose into harmless substances or which may be removed by treatment methods; that is, certain organic materials and chemicals, domestic sewage, heat, plant nutrients, most bacteria and viruses, certain sediments

Non-degradable (conservative) pollutants: impurities which persist in the water environment and do not reduce in concentration unless diluted or removed through treatment; that is, certain organic and inorganic chemicals, salts, colloidal suspensions

Hazardous waterborne pollutants: complex forms of deleterious wastes including toxic trace metals, certain inorganic and organic compounds

Radionuclide pollutants: materials which have been subjected to a radioactive source.

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Water pollution and its Environmental effect

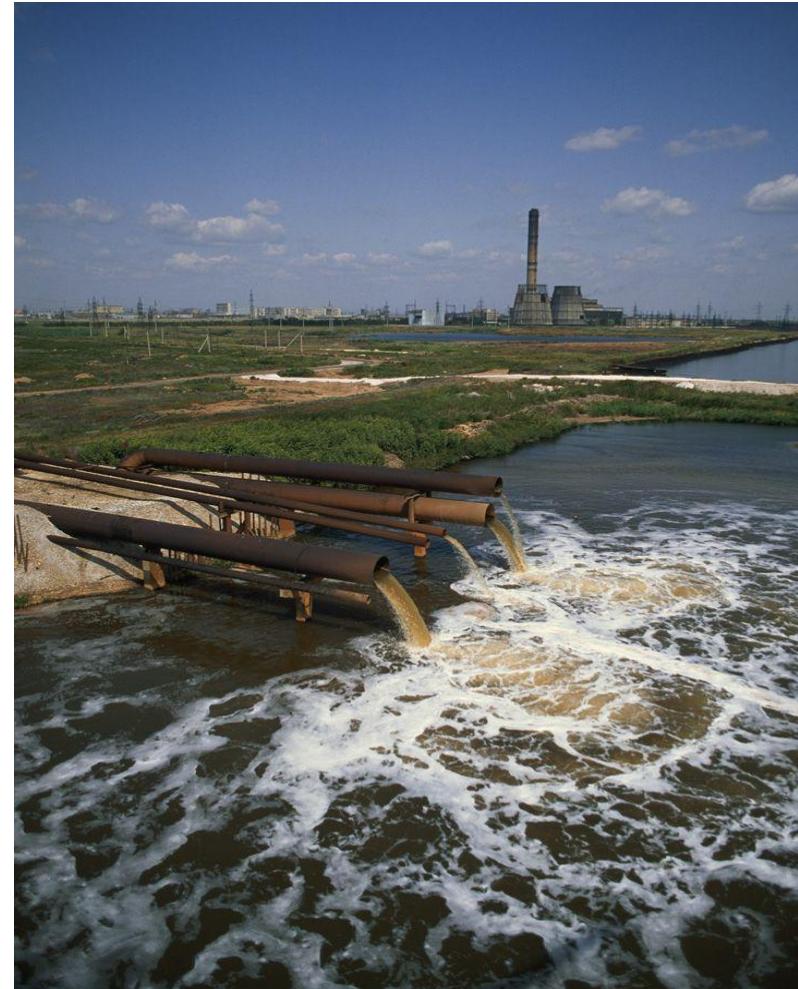
- Not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking.



<https://indianexpress.com/article/cities/>

Industrial Runoff

- Stormwater and **industrial runoff** is a leading cause for water pollution.
- Industrial runoff typically contains high concentrations of pollutants such as heavy metals and petroleum hydrocarbons.



<https://www.nationalgeographic.org/encyclopedia/pollution>

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Water pollution and its Environmental effect

Oil Spill

- An oil spill refers to any uncontrolled release of crude oil, gasoline, fuels, or other oil by-products into the environment.



<https://www.orfonline.org/expert-speak/mauritius-oil-spill>

Oil Spill

- The Deepwater Horizon oil spill was an industrial disaster that began on April 20, 2010, in the Gulf of Mexico on the BP-operated Macondo Prospect, considered to be the largest marine oil spill in the history of the petroleum industry



<https://www.orfonline.org/expert-speak/mauritius-oil-spill>

Types of pollution – Water Pollution

Sources of Water Pollution

- Water pollution comes from point sources or non-point sources.
- **Point sources** include factories, sewage pipes and specific spills from pipelines or containers.
- **Non-point sources**, however, do not have a specific point of origin. Runoff from storms and melting snow carry fertilizers, pesticides, oil and gasoline, litter such as plastic bags and animal faeces into storm drains, creeks, rivers, lakes and, ultimately, the ocean.

Major water pollutants

- Runoff from agricultural fields, industrial sites, or urban areas
 - . Agricultural runoff typically includes fertilizer or toxic chemicals. Fertilizer can cause algal blooms .
- Raw sewage
- Trash such as plastic bags, fishing line, and other material
- oil spills



Types of pollution – Water Pollution

Major pollutant types

Major types of water pollution around the world is caused by

- microbial pathogens (mostly disease-causing bacteria and viruses)
- nutrients from fertilizers and faeces
- heavy metals such as arsenic and mercury
- chemicals from roads and industry and
- litte
- Heat pollution, especially near power plants, can severely impact local ecosystems.

Types of pollution – Water Pollution

Effects of Water Contamination

- Diarrhea, skin diseases and other infections
- Bioaccumulation occurs as heavy metals like mercury move up through the food chain contaminate shellfish and fish like mackerel, tuna and sharks, exposing consumers to these toxic chemicals.
- Mercury poses higher health risks to children under 6 and to child-bearing women because it interferes with brain development.
- Oil floats on water, cutting off oxygen for plankton. Oil causes tissue damage in coral and coral larvae, causes heart defects in bluefin tuna larvae and other fish and even small amounts of oil impairs the ability of seabirds to fly, swim and dive for food.

Types of Pollution-Land Pollution

Land Pollution refers to the deterioration of the earth's land surfaces.

It is a result of indirect and direct effects of human activities.

It is a global issue that needs to be fixed immediately.

Soil pollution as part of land degradation is caused by the presence of Xenobiotics (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste

EPA (Environmental Protection Agency) estimates the pollution

Soil Pollution

The presence of substances in soil that are not naturally produced by biological species is of great public concern.

Xenobiotic

- Xenobiotics are defined as chemicals to which an organism is exposed that are extrinsic to the normal metabolism of that organism.
 - Ex: poly aromatic hydrocarbons (PAHs), persistent organic pollutants (POPs)

Recalcitrants:

- **Recalcitrants** are pollutants that persist in the environment, they are capable of **long range transportation, bioaccumulation**, in human and animals, and biomagnifications in food chain.
- The **term “long-range transport”** refers to the **transport** by the wind of air pollutants or their precursors from the areas where they were emitted to other locations at **downwind distances of 100 km or more.**
 - Ex: **most phenols** (especially chloro- and nitro-derivatives) and fungicides.

Landfills

- Landfills are well-engineered facilities designed to receive specific kinds of waste, including municipal solid waste, construction and demolition debris and hazardous waste.



<https://www.nationalgeographic.org/encyclopedia/pollution>

Causes of Land Pollution

various substances that spill on the land cause land pollution.

Similarly, these substances have different sources of origin.

The most common ones are:

Garbage

Factories

Farming

Mining

Garbage: wet and dry waste , e waste generated at household gets dumped onto land which is referred to as a landfill. landfills release toxic gases that harm living beings as well as the ozone layer.

Factories

Factories produce toxic waste products and chemical which prove very damaging to land.

Farming : fulfil our food demands but may be harmful sometimes. Clearing of forests for land area in order to farm and use of insecticides and fertilizers sprayed on crops also damage the land.

Mining

Is done in order to obtain coal and minerals, we dig holes into the land. This results in land erosion and aswell produces harmful gases and toxins which results in contaminated land as well as the air.

Effects of Land Pollution

- Cancer and skin infections.
- landfills also release methane gas which increases the effect of Global warming; Leachate contaminating ground water

Prevention of Land Pollution

- Reducing the usage of chemicals and pesticides
- Reforestation
- Recovering and Recycling Material
- Limit use of disposable products

Types of pollution : Noise pollution-

Unpleasant sound is noise

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.

According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is.



Effects of Noise pollution :

- **Noise pollution** is an invisible danger.
- It causes is **Noise Induced Hearing Loss (NIHL)**.
- Exposure to loud **noise** can also cause high blood pressure, heart disease, sleep disturbances, and stress.
- These health problems can **affect** all age groups, especially children.

Prevention of Noise Pollution:

- Upgrade Insulation.
- Noise Cancelling Headphones and Earplugs.
- Turn Off Electrical Appliances.
- Place Furniture Strategically in Your Property.

Types of Pollution - **Thermal pollution**

Thermal pollution is sudden increase or decrease in temperature of a natural body of water, that may be ocean, lake, river or pond by human influence.

Causes:

This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature.

It is from hot water or cold water being dumped into a body of water



Effects of thermal pollution

- It decrease the amount of dissolved oxygen in the water
- aquatic life like fishes, their larvae and eggs gets damaged .
- Kills some species of fish and macroinvertebrates that have a limited tolerance for temperature change, and migration of living entities
- Contributes to global warming

t
Types of Pollution- Radioactive pollution

The radioactive pollution is the physical pollution resulting due to of release of radioactive substances into the environment during nuclear explosions and testing of nuclear weapons, nuclear weapon production and decommissioning, mining of radioactive ores



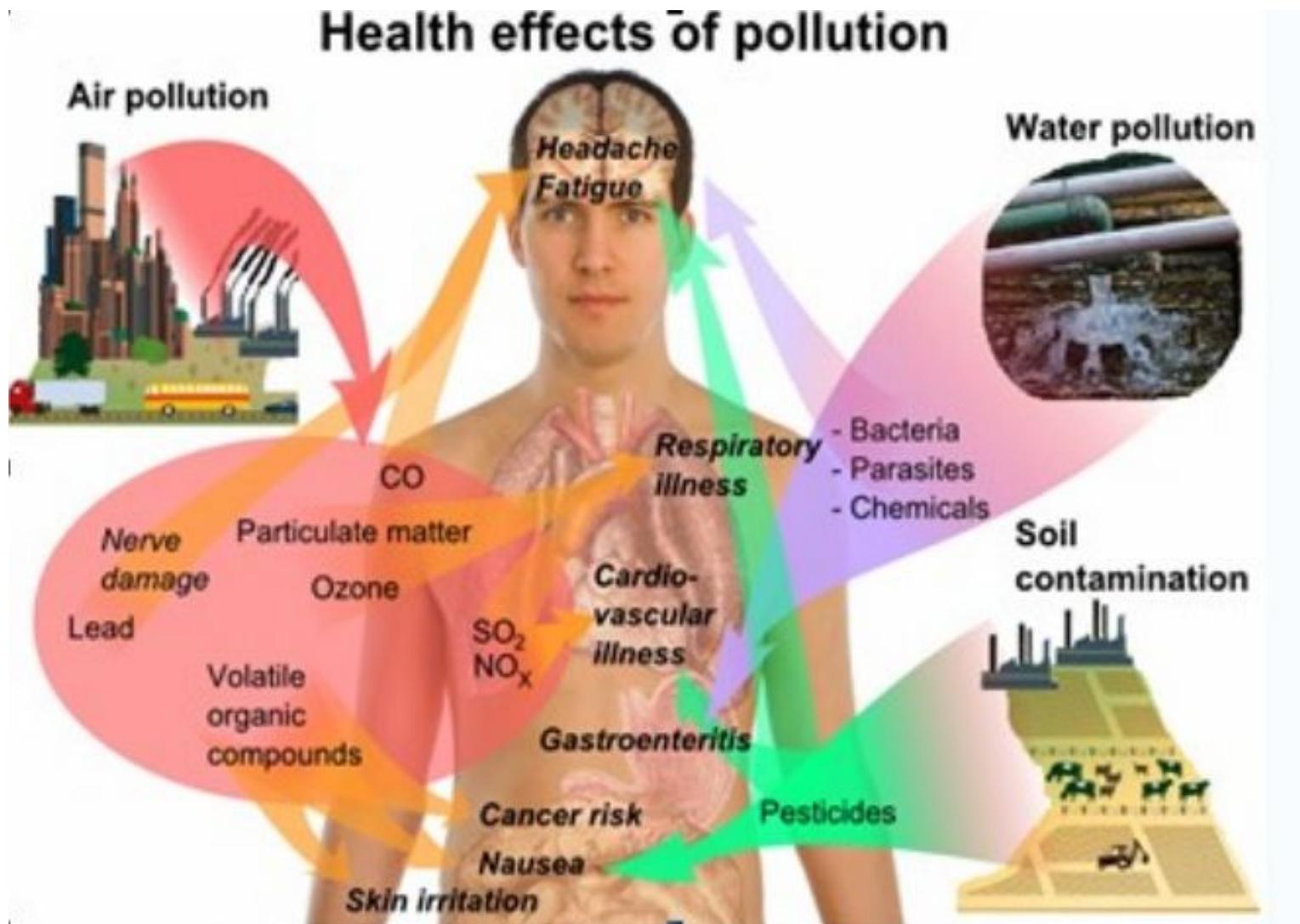
Effects of Radiation :

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as

- skin burns
- acute radiation syndrome ("radiation sickness").
- Skin cancer
- cardiovascular disease.
- chronic respiratory disease,
- lung cancer

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Effects of Environmental Pollution on human





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Pollution – Introduction

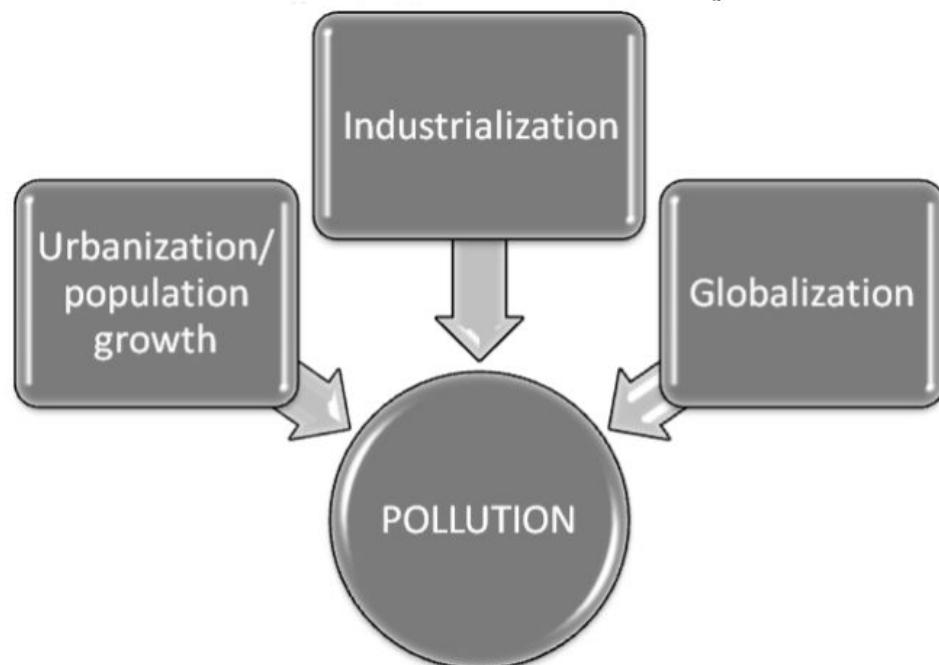
The term *pollution* can refer to both artificial and natural materials that are created, consumed, and discarded in an unsustainable manner.

Pollutant

Pollutant is defined as harmful material released into the environment that causes undesirable effects in the environment.

Pollutants are the elements, molecules and particles involved in pollution - life can be harmed when exposed to these materials, and the effects of them on humans and plants are well known.

Environmental pollution may destabilize development process and competitiveness of developing nations whose economies depends on natural resources.



The Fundamental Drivers of Pollution

<https://www.pide.org.pk/pdf/PDR/2016/Volume4/589-604.pdf>

- **Industrialisation** is the first fundamental cause of pollution.
- Among other things, industrialization set in motion the widespread use of fossil fuels (oil, gas and coal) which are now the main sources of pollution.
- Industrial pollution contribute majorly in emitting waste gases like carbon monoxide, sulphur oxides, and nitrogen oxides which are the waste products of industry and end up in the air as well as dumping of industrial waste into water, endangering human life

Overview on Pollution

- Any form of pollution that can trace its immediate source to industrial practices is known as industrial pollution.
- Most of the pollution on the planet can be traced back to industries of some kind.



<https://www.conserve-energy-future.com/causes-effects-of-industrial-pollution.php>

Types of pollution

The term "pollution" refers to any substance that negatively impacts the environment or organisms that live within the affected environment.

The five major types of pollution include:

- **Air pollution,**
- **Water pollution,**
- **Soil pollution,**
- **Light pollution,**
- **Thermal Pollution**
- **Radioactive Pollution and**
- **Noise pollution.**

TYPES OF POLLUTION



Water Pollution | Air Pollution | Land Pollution | Sound Pollution | Light Pollution

Air pollution

Sources: Urbanization/ Manmade- Outdoor pollution sources and Indoor pollution sources

- **Burning of fossil fuels :** The burning of fossil fuels contributes to the formation of smog, a dense layer of particulate matter that hangs like a cloud over many major cities and industrial zones.
- **Vehicle and factory emissions :** Carbon monoxide, sulfur dioxide and lead are typically released directly into the atmosphere from industrial activity and vehicles.
Ozone, is usually created from the chemical decomposition of nitrogen oxides released from automobiles. Nitrogen dioxide is the product of the oxidation of nitrogen oxides.

Indoor include carbon monoxide, methane, particulate matter (PM), polyaromatic hydrocarbons (PAH) and volatile organic compounds (VOC).
SPM is usually caused by dust, combustion,

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Air pollution and its effects

- Air pollution is the introduction of harmful chemicals into the atmosphere.
- The exhaust from vehicles for instance, is polluting the air with toxic chemicals such as carbon monoxide and formaldehyde.



<https://www.nationalgeographic.org/encyclopedia/pollution>

Air pollution

Sources:

Natural sources: Volcanic eruption, dust storm, forest fire, Carbon dioxide from humans during respiration, Methane from cattle during digestion, Oxygen from plants during Photosynthesis



Manmade



natural



Major Pollutants of air:

- Ozone
- particulate matter
- carbon monoxide
- nitrogen dioxide
- sulfur dioxide and
- lead
- Volatile organic compounds (VOCs)
- Chlorofluorocarbons (CFCs)
- Mercury (Hg)
- Peroxyacetyl nitrates (PANs)

Types of air pollutants:

It can be further divided into **Primarily and Secondary air pollutants** if we go deep.

Primarily air pollutants can be caused by primary sources or secondary sources. The pollutants that are a direct result of the process can be called Primary pollutants. Eg. sulfur-dioxide emitted from factories.

Secondary pollutants are the ones that are caused by the intermingling and reactions of primary pollutants. Smog created by the interactions of several primary pollutants is known as a secondary pollutant.

Classification of Air Pollution

Air pollution can be classified into two sections –

Visible air pollution, like smog over a city is an example of visible pollution.

Invisible air pollutants are less noticeable, but they can be more deadly. Good examples of invisible air pollutants are sulfur dioxide, carbon monoxide and nitrogen oxides

Effects of Air pollution

1. Respiratory and Heart Problems- Asthma, chronic bronchitis, emphysema, heart attacks and strokes along with cancer



2. Child Health Problems- Exposure to high air pollution levels during pregnancy causes miscarriages as well as premature birth, autism, asthma and spectrum disorder in young children. Brain development and pneumonia

3. Global Warming - With increased temperatures worldwide, an increase in sea levels and melting of ice from colder regions and icebergs, displacement, and loss of habitat have already signaled an impending disaster if actions for preservation and normalization aren't undertaken soon.

Environmental effects of air pollution

4. Acid Rain

Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combine with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to humans, animals, and crops.



5. Depletion of the Ozone Layer

Ozone exists in the Earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays. Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydrochlorofluorocarbons in the atmosphere.

Smog

- **Smog** is air pollution that reduces visibility.
- Ex: New Delhi 2019.
- Shanghai smog, The great smog of London (1952)
- Higher levels of smog are associated with a wide range of diseases such as chronic obstructive pulmonary disorder, heart disease, stroke and lung cancer.



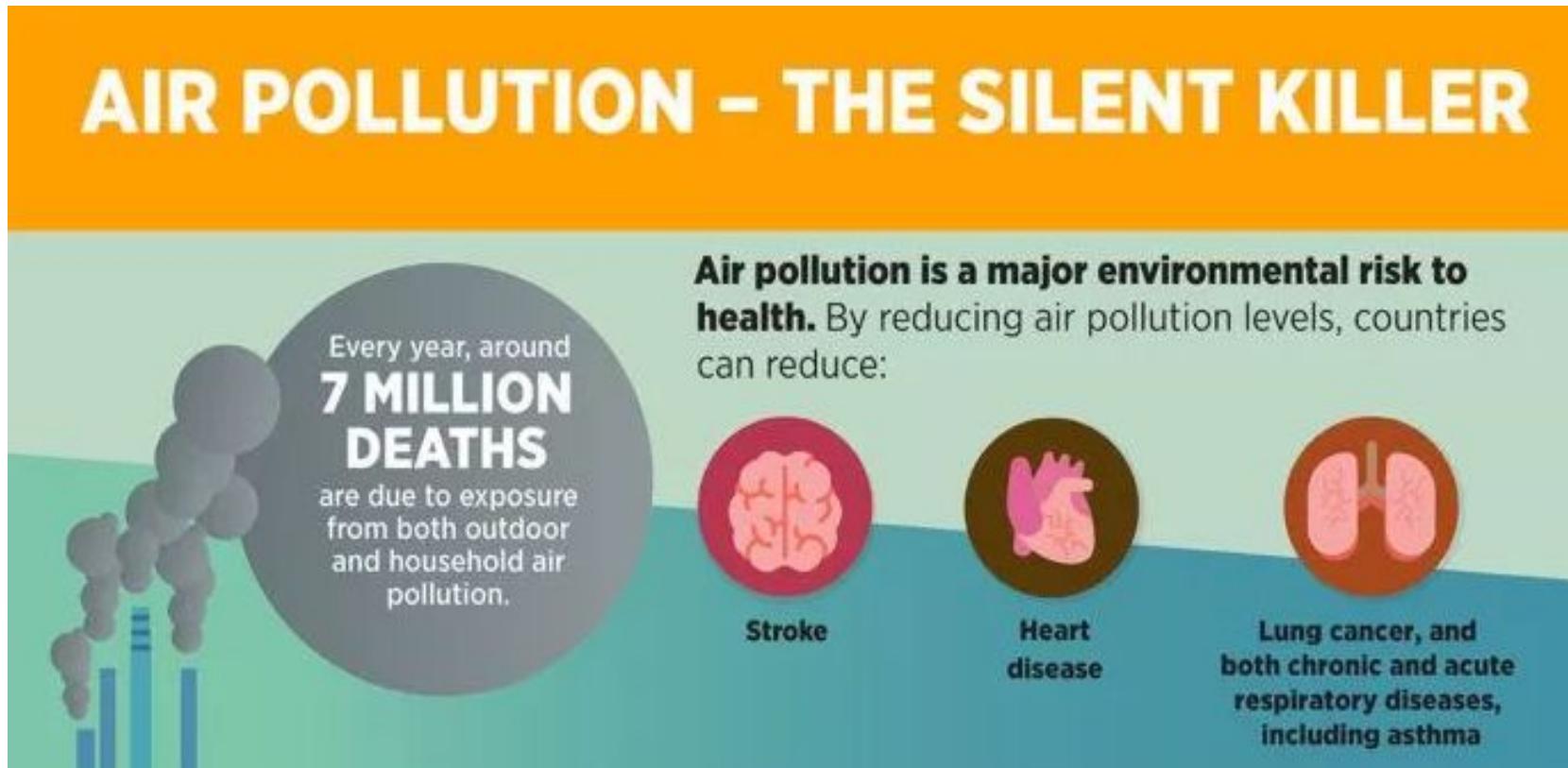
<https://www.insider.com/new-delhi-smog-air-pollution-photos-2019-11>

Solutions To Air Pollution

1. Use the Public Mode of Transportation
2. Better Household Practices
3. Conserve Energy
4. Understand the Concept of Reduce, Reuse and Recycle
5. Use Energy-Efficient Devices

Health effect of air pollution

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

<https://www.conserve-energy-future.com/causes-effects-solutions-of-air-pollution>

Water pollution

- Water pollution happens when toxic substances enter water bodies such as lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed.
- This degrades the quality of water.



<https://www.britannica.com/explore/savingearth/water-pollution>

Pollutants or contaminants which enter a body of water can be further divided into:

Degradable (non-conservative) pollutants: impurities which eventually decompose into harmless substances or which may be removed by treatment methods; that is, certain organic materials and chemicals, domestic sewage, heat, plant nutrients, most bacteria and viruses, certain sediments

Non-degradable (conservative) pollutants: impurities which persist in the water environment and do not reduce in concentration unless diluted or removed through treatment; that is, certain organic and inorganic chemicals, salts, colloidal suspensions

Hazardous waterborne pollutants: complex forms of deleterious wastes including toxic trace metals, certain inorganic and organic compounds

Radionuclide pollutants: materials which have been subjected to a radioactive source.

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Water pollution and its Environmental effect

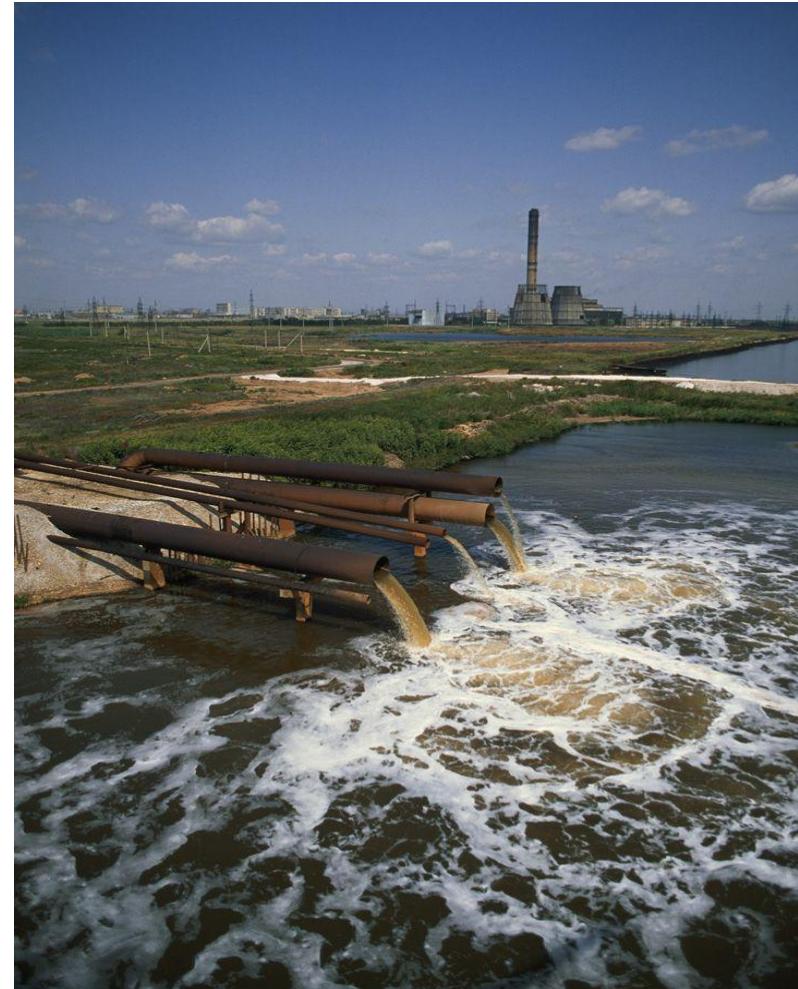
- Not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking.



<https://indianexpress.com/article/cities/>

Industrial Runoff

- Stormwater and **industrial runoff** is a leading cause for water pollution.
- Industrial runoff typically contains high concentrations of pollutants such as heavy metals and petroleum hydrocarbons.



<https://www.nationalgeographic.org/encyclopedia/pollution>

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Water pollution and its Environmental effect

Oil Spill

- An **oil spill** refers to any uncontrolled release of crude oil, gasoline, fuels, or other oil by-products into the environment.



<https://www.orfonline.org/expert-speak/mauritius-oil-spill>

Oil Spill

- The Deepwater Horizon oil spill was an industrial disaster that began on April 20, 2010, in the Gulf of Mexico on the BP-operated Macondo Prospect, considered to be the largest marine oil spill in the history of the petroleum industry



<https://www.orfonline.org/expert-speak/mauritius-oil-spill>

Types of pollution – Water Pollution

Sources of Water Pollution

- Water pollution comes from point sources or non-point sources.
- **Point sources** include factories, sewage pipes and specific spills from pipelines or containers.
- **Non-point sources**, however, do not have a specific point of origin. Runoff from storms and melting snow carry fertilizers, pesticides, oil and gasoline, litter such as plastic bags and animal faeces into storm drains, creeks, rivers, lakes and, ultimately, the ocean.

Major water pollutants

- Runoff from agricultural fields, industrial sites, or urban areas
 - . Agricultural runoff typically includes fertilizer or toxic chemicals. Fertilizer can cause algal blooms .
- Raw sewage
- Trash such as plastic bags, fishing line, and other material
- oil spills



Types of pollution – Water Pollution

Major pollutant types

Major types of water pollution around the world is caused by

- microbial pathogens (mostly disease-causing bacteria and viruses)
- nutrients from fertilizers and faeces
- heavy metals such as arsenic and mercury
- chemicals from roads and industry and
- litter
- Heat pollution, especially near power plants, can severely impact local ecosystems.

Types of pollution – Water Pollution

Effects of Water Contamination

- Diarrhea, skin diseases and other infections
- Bioaccumulation occurs as heavy metals like mercury move up through the food chain contaminate shellfish and fish like mackerel, tuna and sharks, exposing consumers to these toxic chemicals.
- Mercury poses higher health risks to children under 6 and to child-bearing women because it interferes with brain development.
- Oil floats on water, cutting off oxygen for plankton. Oil causes tissue damage in coral and coral larvae, causes heart defects in bluefin tuna larvae and other fish and even small amounts of oil impairs the ability of seabirds to fly, swim and dive for food.

Types of Pollution-Land Pollution

Land Pollution refers to the deterioration of the earth's land surfaces.

It is a result of indirect and direct effects of human activities.

It is a global issue that needs to be fixed immediately.

Soil pollution as part of land degradation is caused by the presence of Xenobiotics (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste

EPA (Environmental Protection Agency) estimates the pollution

Soil Pollution

The presence of substances in soil that are not naturally produced by biological species is of great public concern.

Xenobiotic

- Xenobiotics are defined as chemicals to which an organism is exposed that are extrinsic to the normal metabolism of that organism.
 - Ex: poly aromatic hydrocarbons (PAHs), persistent organic pollutants (POPs)

Recalcitrants:

- **Recalcitrants** are pollutants that persist in the environment, they are capable of long range transportation, bioaccumulation, in human and animals, and biomagnifications in food chain.
- The term “**long-range transport**” refers to the **transport** by the wind of air pollutants or their precursors from the areas where they were emitted to other locations at downwind distances of 100 km or more.
 - Ex: most phenols (especially chloro- and nitro-derivatives) and fungicides.

Landfills

- Landfills are well-engineered facilities designed to receive specific kinds of waste, including municipal solid waste, construction and demolition debris and hazardous waste.



<https://www.nationalgeographic.org/encyclopedia/pollution>

Causes of Land Pollution

various substances that spill on the land cause land pollution.

Similarly, these substances have different sources of origin.

The most common ones are:

Garbage

Factories

Farming

Mining

Garbage: wet and dry waste , e waste generated at household gets dumped onto land which is referred to as a landfill. landfills release toxic gases that harm living beings as well as the ozone layer.

Factories

Factories produce toxic waste products and chemical which prove very damaging to land.

Farming : fulfil our food demands but may be harmful sometimes. Clearing of forests for land area in order to farm and use of insecticides and fertilizers sprayed on crops also damage the land.

Mining

Is done in order to obtain coal and minerals, we dig holes into the land. This results in land erosion and aswell produces harmful gases and toxins which results in contaminated land as well as the air.

Effects of Land Pollution

- Cancer and skin infections.
- landfills also release methane gas which increases the effect of Global warming; Leachate contaminating ground water

Prevention of Land Pollution

- Reducing the usage of chemicals and pesticides
- Reforestation
- Recovering and Recycling Material
- Limit use of disposable products

Types of pollution : Noise pollution-

Unpleasant sound is noise

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.

According to the World Health Organization, sound levels less than 70 dB are not damaging to living organisms, regardless of how long or consistent the exposure is.



Effects of Noise pollution :

- **Noise pollution** is an invisible danger.
- It causes is **Noise Induced Hearing Loss (NIHL)**.
- Exposure to loud **noise** can also cause high blood pressure, heart disease, sleep disturbances, and stress.
- These health problems can **affect** all age groups, especially children.

Prevention of Noise Pollution:

- Upgrade Insulation.
- Noise Cancelling Headphones and Earplugs.
- Turn Off Electrical Appliances.
- Place Furniture Strategically in Your Property.

Types of Pollution - **Thermal pollution**

Thermal pollution is sudden increase or decrease in temperature of a natural body of water, that may be ocean, lake, river or pond by human influence.

Causes:

This normally occurs when a plant or facility takes in water from a natural resource and puts it back with an altered temperature.

It is from hot water or cold water being dumped into a body of water



Effects of thermal pollution

- It decrease the amount of dissolved oxygen in the water
- aquatic life like fishes, their larvae and eggs gets damaged .
- Kills some species of fish and macroinvertebrates that have a limited tolerance for temperature change, and migration of living entities
- Contributes to global warming

t

Types of Pollution- **Radioactive pollution**

The radioactive pollution is the physical pollution resulting due to release of radioactive substances into the environment during nuclear explosions and testing of nuclear weapons, nuclear weapon production and decommissioning, mining of radioactive ores



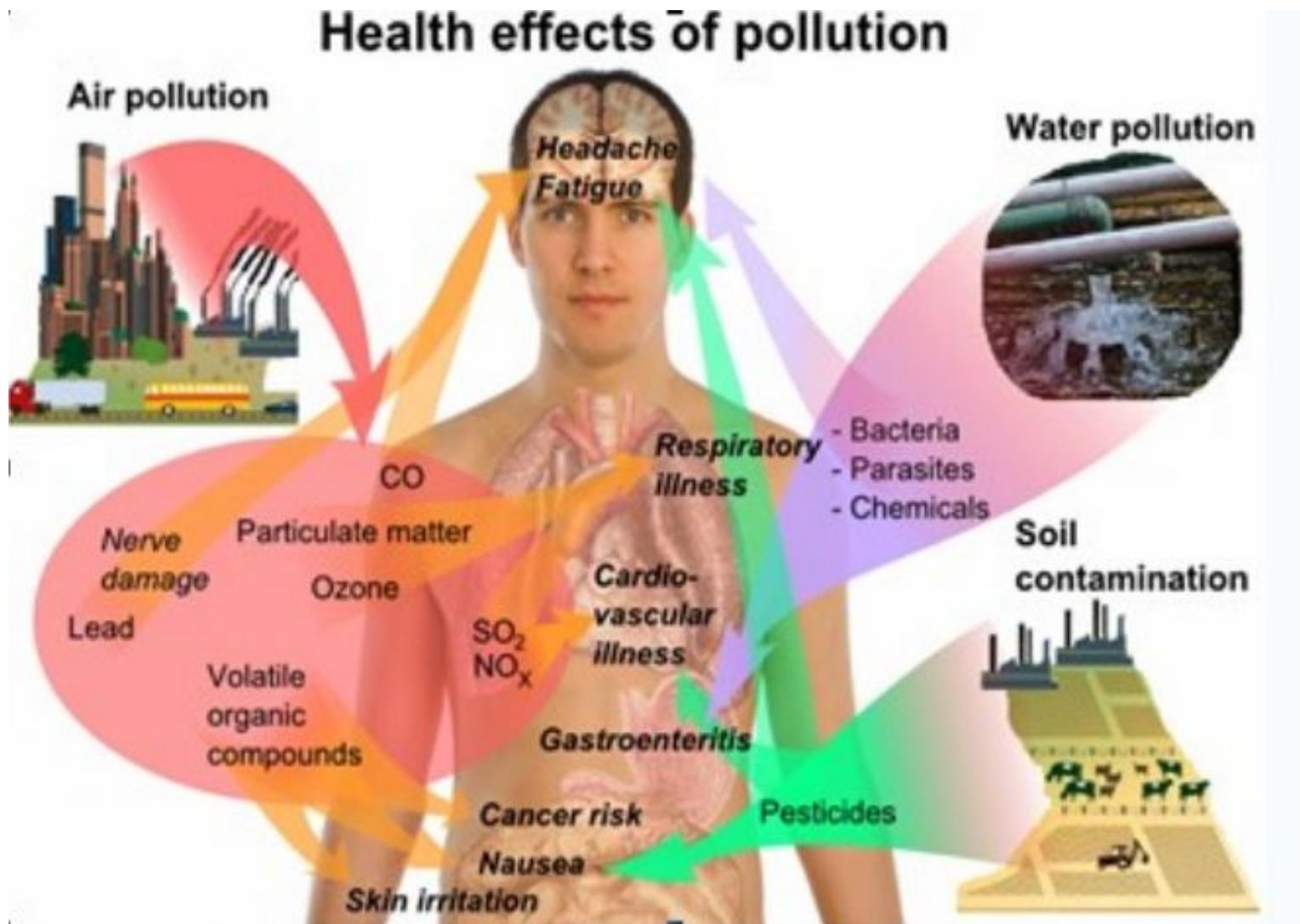
Effects of Radiation :

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as

- skin burns
- acute radiation syndrome ("radiation sickness").
- Skin cancer
- cardiovascular disease.
- chronic respiratory disease,
- lung cancer

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Effects of Environmental Pollution on human





THANK YOU

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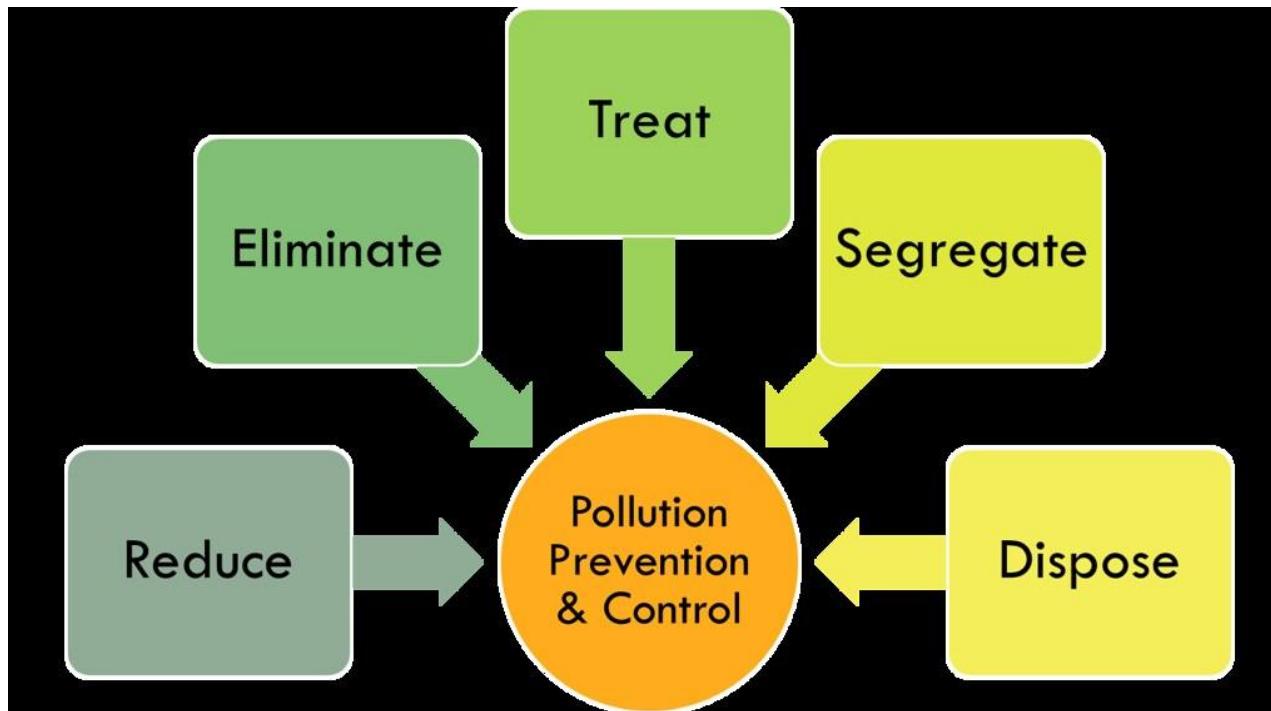
Environmental Pollution and management

Dr. Sasmitta Sabat
Department of Biotechnology

INTRODUCTION

- Around the world, people and governments are making efforts to combat pollution.
- **Pollution control** is the process of reducing or eliminating the release of pollutants into the **environment**.
- It is regulated by various environmental agencies which establish pollutant **discharge** limits for air, water, and land.
- Recycling, for instance, is becoming more common.
- In recycling, trash is processed so its useful materials can be used again.
- Glass, aluminum cans, and many types of plastic can be melted and reused.
- Paper can be broken down and turned into new paper.

Pollution control



<https://www.lanl.gov/environment/sustainability/pollution-prevention.php>

International agencies

World Health Organization (WHO),

World Meteorological Organization (WMO) and

United Nations Environment Programme (UNEP) have instituted monitoring and research projects in order to clarify the issues involved in air pollution and to promote measures to prevent further deterioration of public health and environmental and climatic conditions.

The Global Environmental Monitoring System GEMS/Air (WHO/ UNEP 1993) is organized and sponsored by WHO and UNEP and has developed a comprehensive programme for providing the instruments of rational air pollution management

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Growing recognition of the environmental and public health impacts associated with anthropogenic activities has prompted the development and application of methods and technologies to reduce the effects of pollution.

Governments have adopted regulatory and other policy measures to minimize negative effects and ensure that environmental quality standards are achieved.

Best Ways to Reduce Air Pollution

1. Using public transports.
2. Turn off the lights when not in use.
3. Recycle and Reuse.
4. No to plastic bags.
5. Reduction of forest fires and smoking.
6. Use of fans instead of Air Conditioner.
7. Use filters for chimneys.
8. Avoid usage of crackers.
9. Avoid using of products with chemicals
10. Implement Afforestation

Under the pollution control approach, attempts to protect the environment have especially relied on isolating contaminants from the environment and using end-of-pipe filters and scrubbers.

These solutions have tended to focus on media-specific environmental quality objectives or emission limits, and have been primarily directed at point source discharges into specific environmental media (air, water, soil).

Factor Coordination :

Industrial development, city planning, water resources development and transportation policies

Environmental pollution Management:

- Environmental pollution controls often include the management of land development and the design of transportation systems so as to reduce pollution.
- Environmental planning, the management of land development, and the design of transportation systems are key components of environmental pollution control.

Stages of the pollution management model:

Strategies for reducing these impacts can be directed at three different levels in the process:

1. Altering the human activity,
2. Regulating and reducing quantities of pollutant released at the point of emission, and
3. Cleaning up the pollutant and restoring ecosystems after pollution has occurred.

Control Measures

Controls can be divided into two basic types of controls - technological and administrative.

Technological:

Gaseous- Condensation, adsorption, absorption, incinerator

Particulate- wet scrubbers, electrostatic precipitators, Filters

WATER POLLUTION

CONTROL

water pollution problems

- Surface Water Pollution Control
- Groundwater Pollution Control

Water pollution refers to the qualitative state of impurity or uncleanliness in hydrologic waters of a certain region, such as a watershed.

It results from an occurrence or process which causes a reduction in the utility of the earth's waters, especially as related to human health and environmental effects.

Pollution occurring within these drainage systems originates from the following sources:

Point sources: waste discharges into a receiving water body at a specific location, at a point such as a sewer pipe

Non-point (dispersed) sources: pollution entering a receiving water body from dispersed sources in the watershed; uncollected rainfall runoff water drainage into a stream is typical. Non-point sources are also sometimes referred to as “diffuse” waters.

Intermittent sources: from a point or source which discharges under certain circumstances, such as with overloaded conditions; combined sewer overflows during heavy rainfall runoff periods are typical.

Water pollution control

regulations

National and state (or province) levels,

- Environmental protection agencies (EPAs) and
- Ministries of health are usually charged with this responsibility

Water supplies include:

- **Public water supply**: waters which with conventional treatment will be suitable for human consumption
- **Agricultural supply**: waters suitable for irrigation and livestock watering without treatment
- **Industrial/commercial supply**: waters suitable for industrial and commercial uses with or without treatment.

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Soil Pollution control

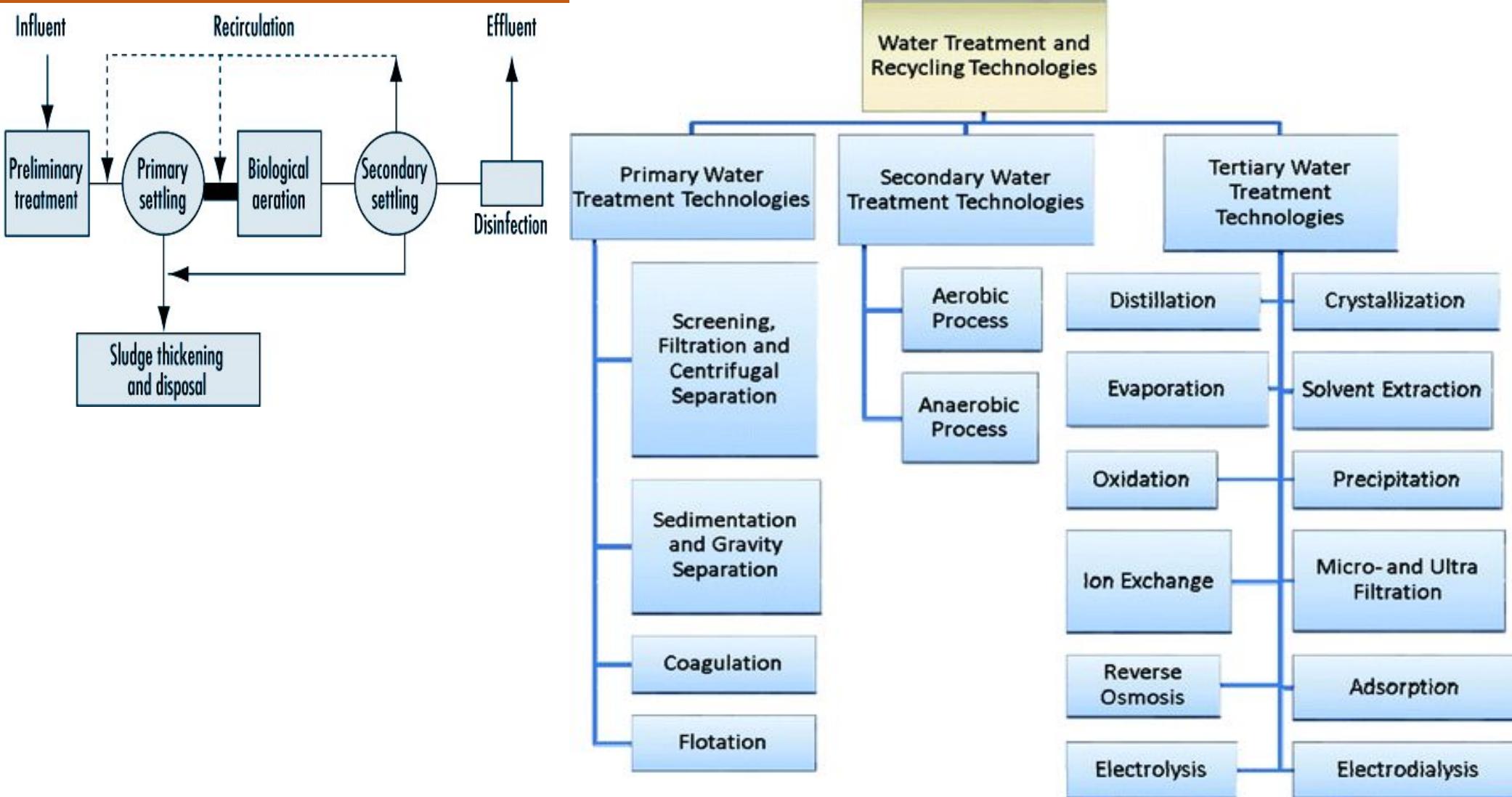
- Solid pollution control methods which are typically used include landfilling, composting , and incineration.

BIS GUIDELINES OF PARAMETERS

Parameters	UNITS	GUIDELINE VALUE
pH	-	4-12
Suspended solids	mg/l	24-5700
BOD5	mg/l	450-4,790
COD	mg/l	80 - 95000
Total nitrogen	mg/l	15-180
Total phosphorus	mg/l	11-160
Oil and grease	mg/l	10
Total coliform bacteria	Mpn/100ml	400
Magnesium	mg/l	25-49
Potassium	mg/l	11-160
Chloride	mg/l	48-469
Calcium	mg/l	57-112

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Environmental Pollution and management- WATER



SOLID WASTE MANAGEMENT:

Environmental awareness is leading to a rapid transformation of waste management practices.

Interpretation of this change is necessary before examining in more detail the methods that are applied to waste management and to the handling of residues.

Modern principles of waste management are based on the paradigm of a geared connection between the biosphere and the anthroposphere.

Waste Management Practices

Waste may be grouped into three major categories, depending on its production:

1. from the primary sector of production (mining, forestry, agriculture, animal breeding, fishery)
2. from the production and transformation industry (foods, equipment, products of all types)
3. from the consumption sector (households, enterprises, transportation, trade, construction, services, etc.).

Waste can be also classified by legislative point of view:

Municipal waste and mixed waste from enterprises which may be **aggregated as municipal waste**, since both consist of the same categories of waste and are of small size (vegetables, paper, metals, glass, plastics and so on), although in differing proportions.

Bulky urban waste (furniture, equipment, vehicles, construction and demolition waste other than inert material)

Waste subject to special legislation (e.g., hazardous, infectious, radioactive).

Management of municipal and ordinary commercial waste:

Collected by trucks, these wastes can be transported (directly or by road-to-road, road-to-rail or road-to-waterway transfer stations and long-distance transportation means) to a landfill, or to a treatment plant for material recovery (mechanical sorting, composting, biomethanization), or for energy recovery (grid or kiln incinerator, pyrolysis).

SOLID WASTE MANAGEMENT AND RECYCLING

Solid wastes are traditionally described as residual products, which represent a cost when one has to resort to disposal.

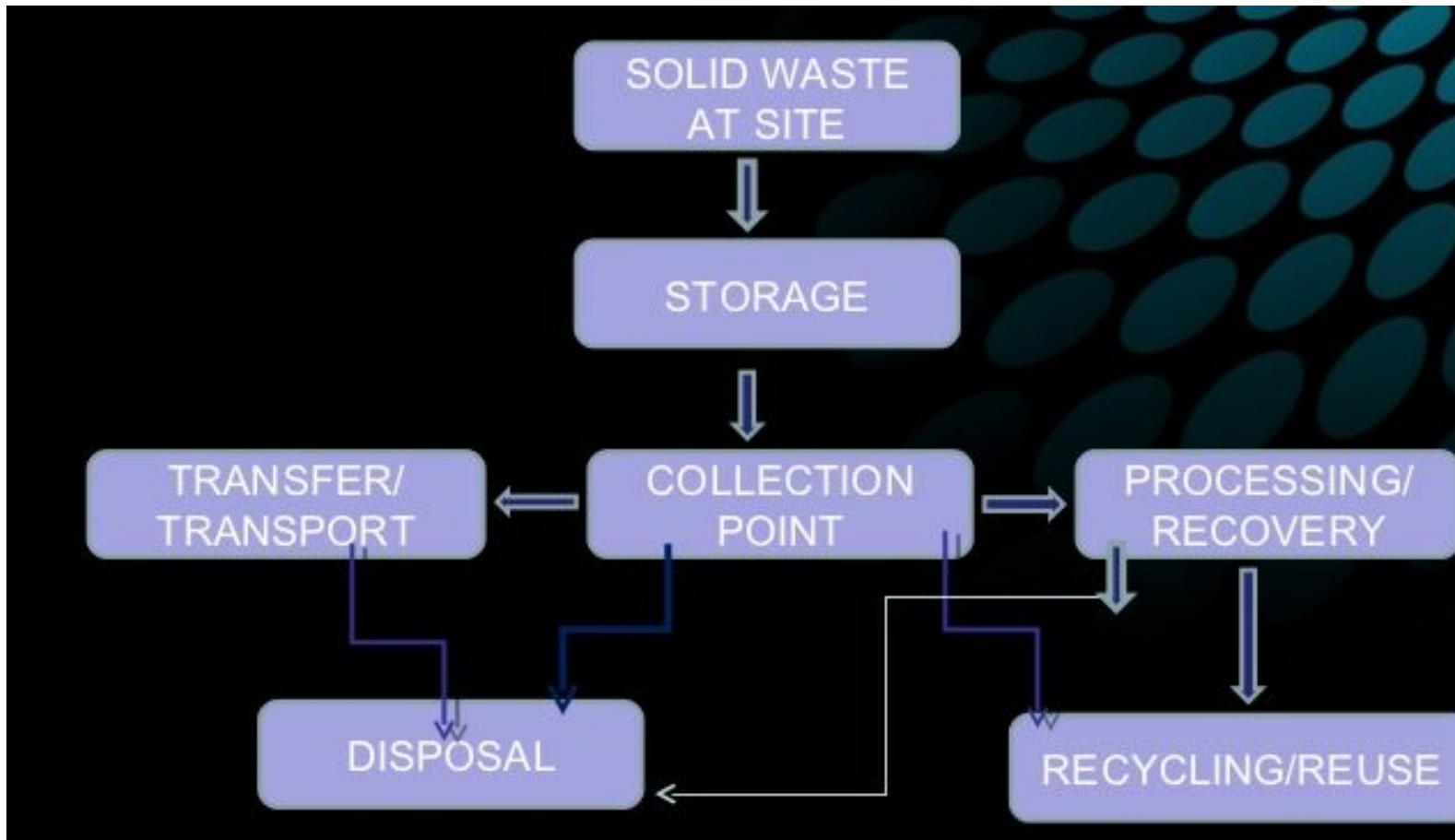
Management of waste encompasses a complex set of potential impacts on human health and safety, and the environment.

The impacts, although the type of hazards may be similar, should be distinguished for three distinct types of operation:

- handling and storage at the waste producer
- collection and transportation
- sorting, processing and disposal.

ENVIRONMENTAL STUDIES & LIFE SCIENCES

Environmental Pollution and management-SOLID



Occupational health and safety authorities in the industrialized countries are focusing on working conditions which, a few years ago, passed off unnoticed with unspoken acceptance, such as:
improper heavy lifting and excessive amount of materials handled per working day

- inappropriate exposure to dust of unknown composition
- unnoticed impact by micro-organisms (bacteria, fungi) and endotoxins
- unnoticed exposure to toxic chemicals.

Recycling

Recycling or salvaging is the word covering both reuse (use for the same purpose) and reclamation/recovery of materials or energy.

The reasons for implementing recycling may change depending on national and local conditions, and the key ideas in the arguments for recycling may be:

- detoxification of hazardous waste when high environmental standards are set by the authorities
- resource recovery in low income areas
- reduction of volume in areas where landfilling is predominant
- energy recovery in areas where conversion of waste to energy can replace fossil fuel (coal, natural gas, crude oil and so on) for energy production.

Noise is an unwanted sound in wrong place at wrong time

Sources: Equipment usage in anthropogenic activities in industry.

Effects: Human- Rise in BP, stress levels and violent behavior.

Hearing Damage- depends on intensity and duration of sound

Physiological and psychological changes in various parts of body

Noise level tolerance: Unit is decibels- Silence zone- 40-50 dB

Residential zone-45-50 dB

Commercial Zone-55-65 dB

Industrial Zone-70-75 dB

Solution: Sound proofing using fibreglass core, enclosures, acoustic lining

Presence of waste heat in water which can cause undesirable changes in the natural environment.

Sources: processes like evaporation, convection, radiation, use of dryers and evaporators.



Effects: decreases oxygen level in the atmosphere, leading to health effects of human beings.

Control: cooling ponds, spray ponds, cooling towers-dry/ wet

Sources: Natural: cosmic rays,

Anthropogenic: Nuclear power plants, X rays, nuclear accidents.

Effects: Genetic damage affecting genes and chromosomes.

Somatic damage- Burns, miscarriages, eye cataract, thyroid and cancer of bone, breast , lung, skin

Control: Proper siting, disposal of waste and maintenance

Prevention of Radiation :

- Select reagents and procedures that minimize the volume and toxicity of all wastes.
- Avoid ordering excess radioactive materials than requirement
- Non radioactive wastes must never be mixed with radioactive wastes.
- Promotion of Non-radioactive tracers and methods for many common assays, and procedures used in biomedical
- Substitute with Short-lived Radionuclides where feasible
- Reduce the activity and volumes of materials used in the experiment to achieve minimal waste generation
- Replace hazardous chemical solvents with formulations not regulated as hazardous or mixed wastes
- Limit the number of users of radioactive materials
- Limit the number of areas where radioactive materials are used



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