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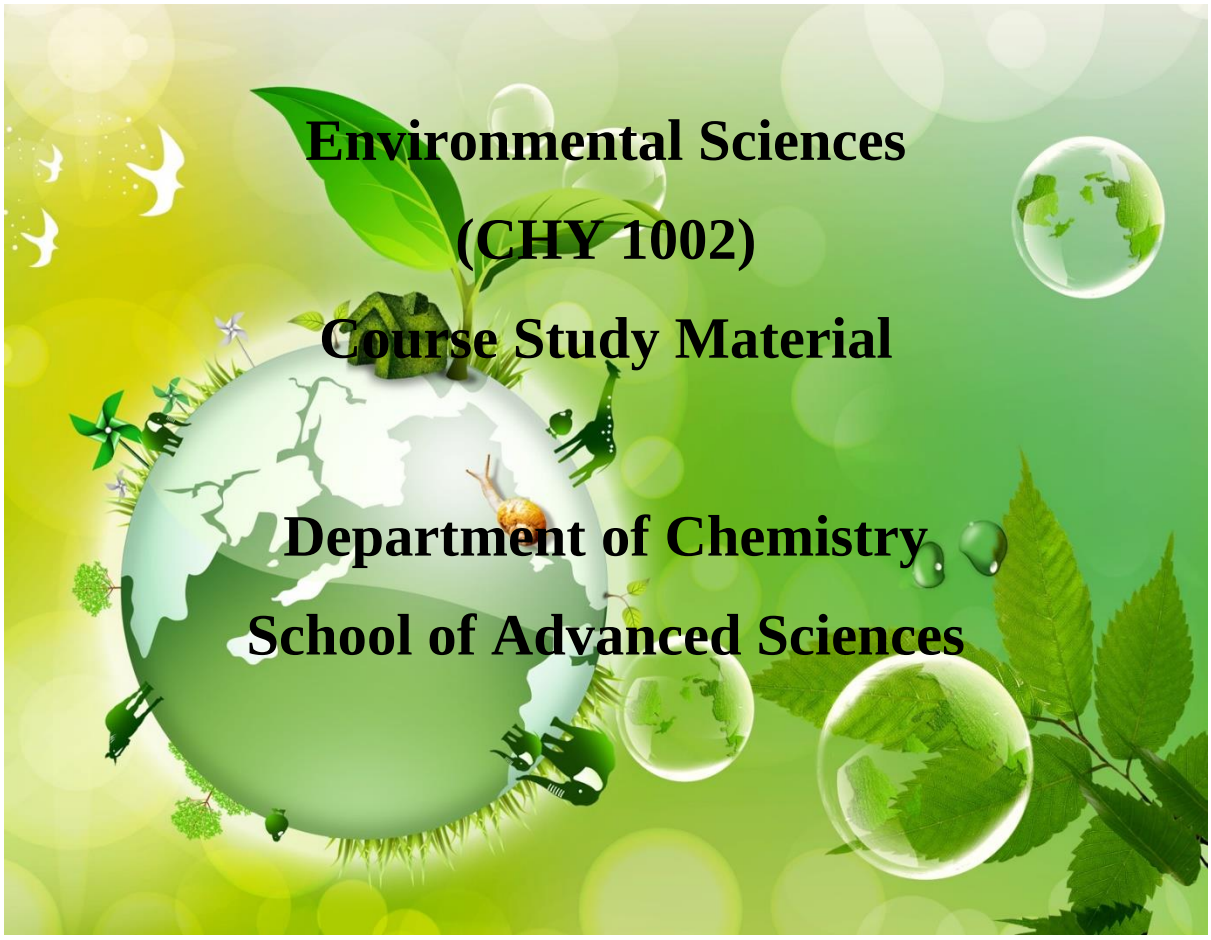

Environmental Sciences

(CHY 1002)

Course Study Material

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Module 1

Environment and Ecosystem

- Key environmental problems, their basic causes and sustainable solutions.
- IPAT equation.
- Ecosystem, earth – life support system and ecosystem components
- Food chain, food web, Energy flow in ecosystem
- Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch
- Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

ENVIRONMENT

The environment is everything around us. It includes the living and the non-living things (air, water, and energy)

Environmental science, an *interdisciplinary* study of how humans interact with the living and non-living parts of their environment.

What are the components of our environment?

One way of classification of our surroundings is into Chemical, Physical and Biological components.

Chemical – all material things

Physical – mainly concerned with energy processes

Biological – both flora and fauna, as well as their interactions.

EARTH'S LIFE-SUPPORT SYSTEM HAS FOUR MAJOR COMPONENTS

- The four major components of the earth's life-support system are the
- atmosphere (air)
- hydrosphere (water)
- geosphere (rock, soil, and sediment),
- biosphere (living things).

➢ Life is sustained by the flow of energy from the sun through the biosphere, the cycling of nutrients within the biosphere and gravity.

MAJOR ENVIRONMENTAL PROBLEMS

- Air, water and land pollution
- Green house effect
- Global warming
- Destruction of ozone layer
- Problem of waste disposal
- Decline in biological diversity
- World food crisis.

MAJOR CAUSES OF ENVIRONMENTAL PROBLEMS

SUSTAINABLE SOLUTIONS

THREE PRINCIPLES OF SUSTAINABILITY

Lessons from nature that we use throughout to guide us in living more sustainably.

• **Reliance on solar energy**: The sun warms the planet and supports *photosynthesis*—a complex chemical process used by plants to provide the *nutrients*, or chemicals that most organisms need in order to stay alive and reproduce. Without the sun, there would be no plants, no animals, and no food. The sun also powers indirect forms of solar energy such as wind and flowing water, which we can use to produce electricity.

• **Biodiversity** (short for *biological diversity*): This refers to the astounding variety of organisms, the natural systems in which they exist and interact (such as deserts, grasslands, forests, and oceans), and the natural services that these organisms and living systems provide free of charge (such as renewal of topsoil, pest control, and air and water purification). Biodiversity also provides countless ways for life to adapt to changing environmental conditions. Without it, most life would have been wiped out long ago.

• **Chemical cycling**: Also referred to as nutrient cycling, this circulation of chemicals from the environment (mostly from soil and water) through organisms and back to the environment is necessary for life. Natural processes keep this cycle going, and the earth receives no new supplies of these chemicals.

Thus, for life to sustain itself, these nutrients must be cycled in this way, indefinitely. Without chemical cycling, there would be no air, no water, no soil, no food, and no life.

IPAT -Environmental Impact Model

In the early 1970s, scientists Paul Ehrlich and John Holdren developed a simple model showing how population size (P), affluence, or resource consumption per person (A), and the beneficial and harmful environmental effects of technologies (T) help to determine the environmental impact (I) of human activities. We can summarize this model by the simple equation

$$I = P \times A \times T.$$

Impact (I) = Population (P) × Affluence (A) × Technology (T)

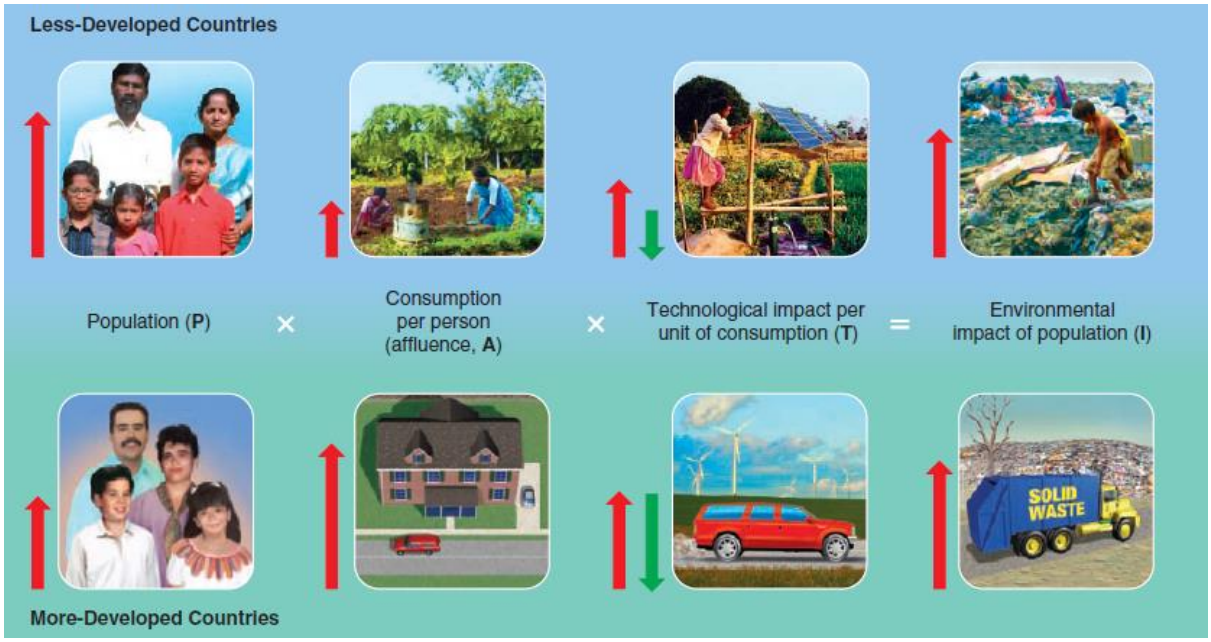


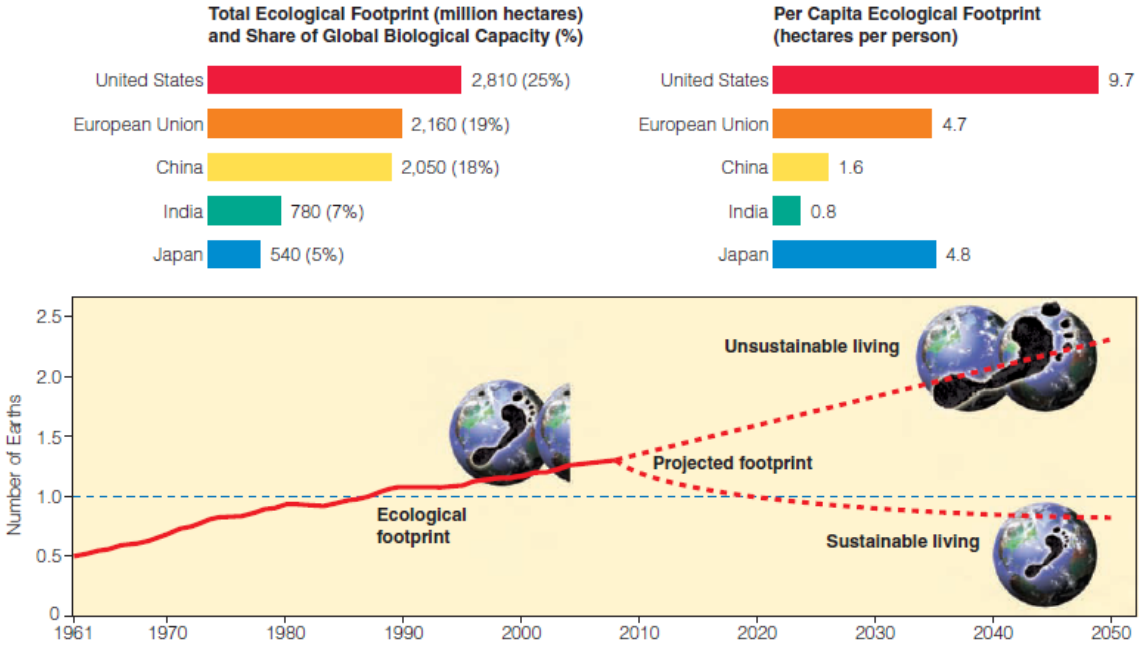
Figure shows the relative importance of these three factors in less-developed and more-developed countries. While the ecological footprint model emphasizes the use of renewable resources, this model includes the per capita use of both renewable and non-renewable resources. The environmental impact (I) is a rough estimate of how much humanity is degrading the natural capital it depends upon.

In most less-developed countries, the key factors in total environmental impact are population size and the degradation of renewable resources as a large number of poor people struggle to stay alive. In such countries, where per capita resource use is low, about 1.4 billion poor people struggle to survive on the equivalent of $1.25 a day and about half of the world's people must live on the equivalent of less than $2.25 a day.

In more-developed countries, high rates of per capita resource use and the resulting high per capita levels of pollution and resource depletion and degradation usually are the key factors determining overall environmental impact. In other words, *overconsumption* by about 1 billion people is putting tremendous pressure on our life-support systems. To some analysts this factor is more important than the population growth factor.

ECOLOGICAL FOOTPRINT

As our ecological footprints grow, we are depleting and degrading more of the earth's natural capital.



ECOLOGY

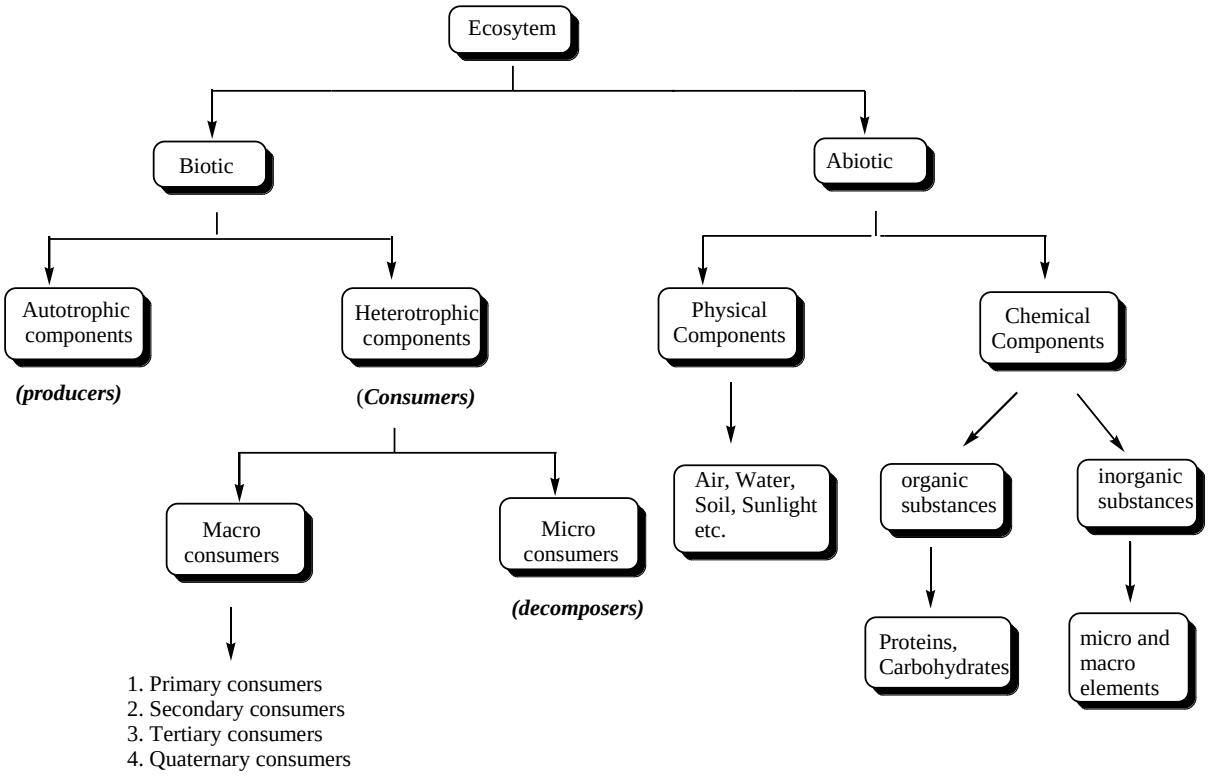
- Ecology is the study of **interactions among organisms or group of organisms** with their environment.

- The environment consists of both **biotic components** (living organisms) and **abiotic components** (non-living organisms).

- ***Habitat*** refers to the physical and chemical factors of the place where the organisms live.

STRUCTURE OF ECOSYSTEM

Ecosystem consists of both biotic and abiotic components:



BIOTIC COMPONENTS:

- **Producers** – Green plants which can synthesize their food themselves (Plants)
- **Consumers** – All organisms which get their organic food by feeding upon other organisms (Rabbit, man)
- **Decomposer** – They derive their nutrition by breaking down the complex organic molecule to simpler organic compound (Bacteria, fungi)

- **Consumers**

- Herbivores – Plant eaters, They feed directly on producers known as primary consumers (e.g. Rabbit, human)
- Carnivores – Meat eaters, They feed on other consumers
- If they feed on herbivores they are called secondary consumers (Frog)
- If they feed on other carnivores they known as tertiary consumers (snake, big fish)
- Omnivores – They feed on both plants and animals. (humans, rat)
- Detritivores - They feed on the parts of dead organisms (ants, earthworm)

- **Decomposer**

- They derive their nutrition by breaking down the complex organic molecules to simpler organic compounds and finally into inorganic nutrients. (bacteria and fungi)

ABIOTIC COMPONENTS:

- **Physical factors:**

- The sunlight, average temp, annual rainfall, wind,
soil type, water availability etc. are some of the important physical features which have strong influence on the ecosystem

- **Chemical factors:**

- Availability of major essential nutrients like carbon, nitrogen, phosphorous, potassium, hydrogen, oxygen and sulphur largely influence the functioning of the ecosystem

FUNCTIONS OF AN ECOSYSTEM

➢ In the ecosystem, biotic components and other materials like N, C, H_2O circulated within and outside of the system.

➢ The energy is transferred from one trophic level to the other in the form of a chain called as food chain.

The major functional attributes of an ecosystems are as follows

❖ Food chain, Food webs and tropic structure

❖ Energy flow

❖ Cycling of nutrients (Biogeochemical cycles)

❖ Primary and secondary production

❖ Ecosystem development and regulation

Food Chain: The **transfer of food energy** from the source in plants through series of organisms that consume and are consumed is called the *'food chain'*.

Sunlight ⟶ Plants ⟶ Herbivores ⟶ Carnivores

(Producers) (Primary consumers) (Secondary consumers)

Food Web: The **interlocking pattern of various food chains** in an ecosystem is known as food web.

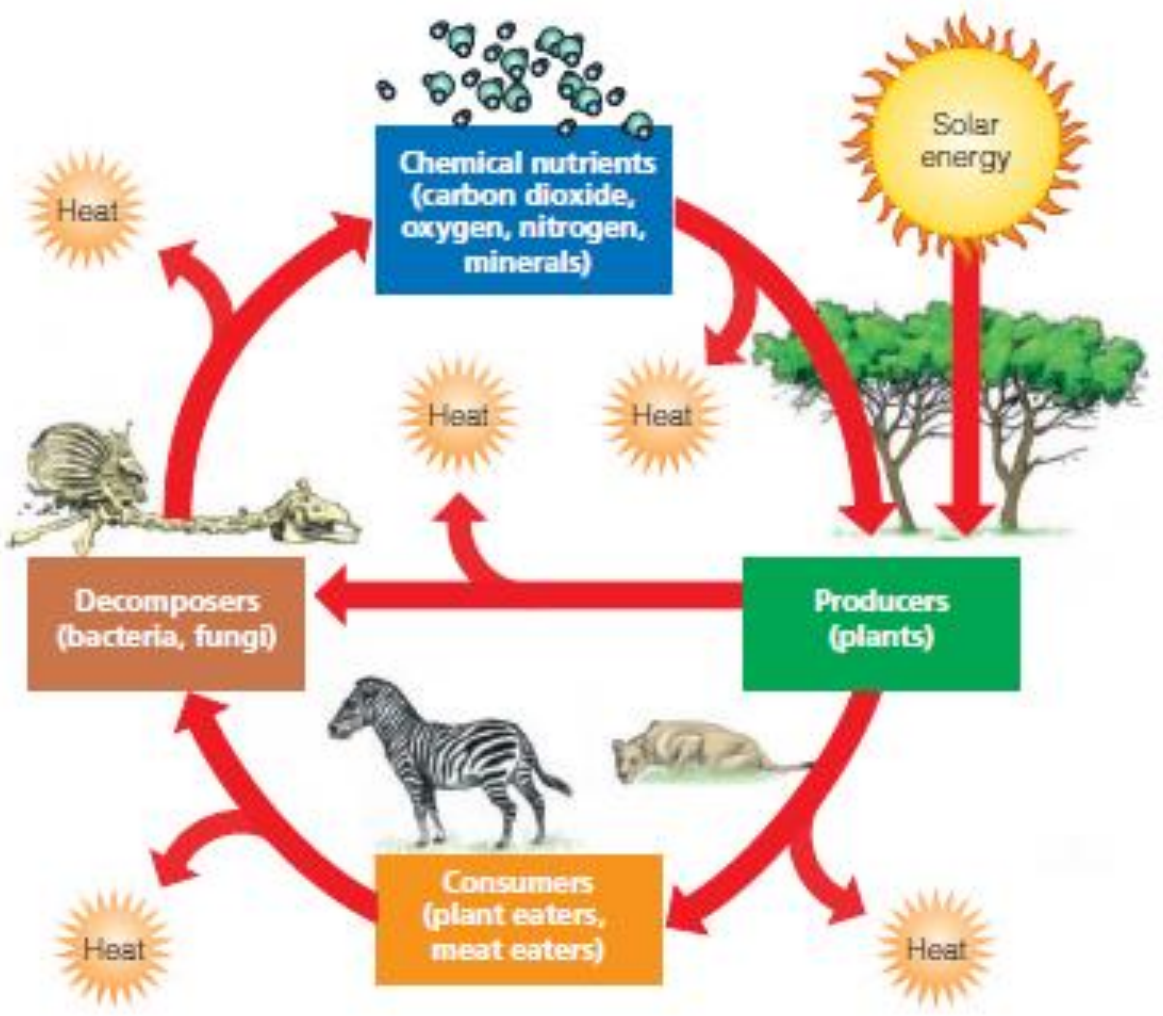
In a food web, many **food chains are interconnected**, where different types of organisms are connected at different tropic levels, so that there are a number of opportunities of eating and being eaten at each tropic level.

Example: Insects, rates, deer's, etc. may eat Grass; these may be eaten by carnivores (Snake, tiger). Thus, there is an interlocking of various food chains called food webs.

Inorder to give **stability for the ecosystem** nature established food web. If a species at lower trophic level is extinct then the higher trophic level species can feed on others to continue their survival without going to extinction due to greater opportunity of eating in food web.

NATURAL CAPITAL

- The main structural components of an ecosystem (energy, chemicals, and organisms).
- Nutrient cycling and the flow of energy—first from the sun, then through organisms, and finally into the environment as low-quality heat.



ENERGY FLOW IN THE ECOSYSTEM

- Energy is needed for every biological activity.

- Solar energy is transformed into chemical energy by a process of photosynthesis. This energy is stored in plant tissue, and then transformed in to mechanical and heat form during metabolic activities.

- In the biological world, the energy flows from sun to plants and then to all heterotrophic organisms like micro-organisms, animals, and man i.e. from producers to consumers. 1% of the total sunlight falling on the green plants is utilized in photosynthesis.

- This is sufficient to maintain all life on this earth. There is no 100% flow of energy from producers to consumers. Some is always lost to environment. Because of this, energy cannot be recycled in an ecosystem '*it can only flow one way*'.

The flow of energy follows the two laws of thermodynamics:

Ist law of thermodynamics: The law states that energy can neither be created nor be destroyed but it can be transformed from one form to another. Similarly, solar energy utilized by green plants (producers) in photosynthesis converted into biochemical energy of plants and later into that of consumers

IInd law of thermodynamics: The law states that energy transformation involves degradation or dissipation of energy from a concentrated to a dispersed form. We have seen dissipation of energy occurs at every trophic level. There is loss of 90% energy, only 10% is transferred from one trophic level to the other.

NUTRIENT CYCLING IN ECOSYSTEM

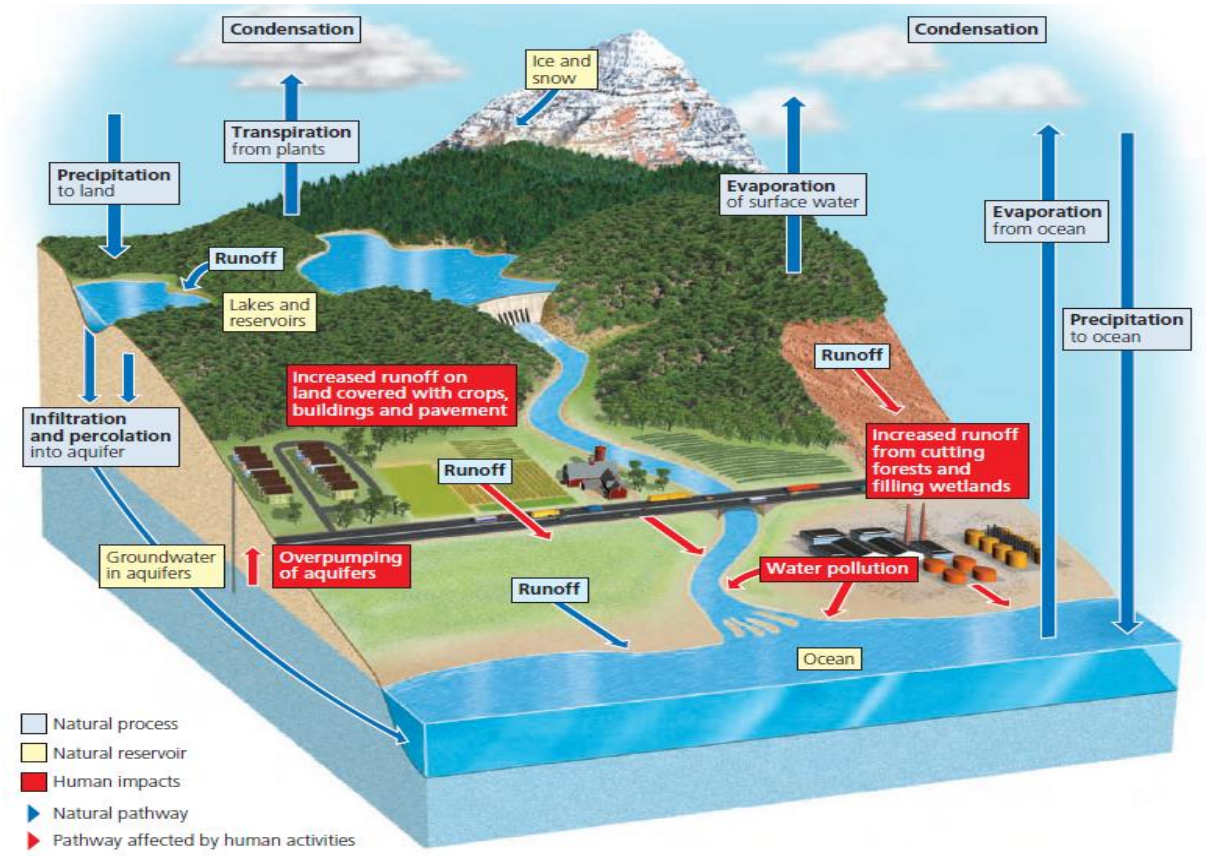
- Matter, in the form of nutrients, cycles within and among ecosystems and the biosphere

- Human activities are altering these chemical cycles.

The elements and compounds that make up nutrients move continually through air, water, soil, rock, and living organisms within ecosystems, as well as in the biosphere in cycles called biogeochemical cycles (life-earth-chemical cycles), or nutrient cycles.

WATER CYCLE

Biogeochemical cycle that collects, purifies, and distributes the earth's fixed supply of water from the environment to living organisms and then back to the environment.



The water cycle is powered by energy from the sun and involves three major processes-evaporation, precipitation, and transpiration. Incoming solar energy causes *evaporation* of water from the earth's oceans, lakes, rivers, and soil. Evaporation changes liquid water into water vapor in the atmosphere, and gravity draws the water back to the earth's surface as *precipitation* (rain, snow, sleet, and dew). Over land, about 90% of the water that reaches the atmosphere evaporates from the surfaces of plants, through a process called *transpiration*, and from the soil.

Water returning to the earth's surface as precipitation takes various paths. Most precipitation falling on terrestrial ecosystems becomes *surface runoff*. This water flows into streams, which eventually carry water back to lakes and oceans, from which it can evaporate to repeat the cycle. Some surface water also seeps into the upper layers of soils where it is used by plants, and some evaporates from the soils back into the atmosphere.

Some precipitation is converted to ice that is stored in *glaciers*, usually for long periods of time. Some precipitation sinks through soil and permeable rock formations to underground layers of rock, sand, and gravel called *aquifers*, where it is stored as *groundwater*.

A small amount of the earth's water ends up in the living components of ecosystems. As producers, plants absorb some of this water through their roots, most of which evaporates from plant leaves back into the atmosphere during transpiration; some of the water combines with carbon dioxide during photosynthesis to produce high-energy organic compounds such as carbohydrates. Eventually these compounds are broken down in plant cells, which release the water back into the environment. Consumers get their water from their food and by drinking it.

Human influence on water cycle

❖ We withdraw large quantities of freshwater from streams, lakes, and aquifers sometimes at rates faster than nature can replace it.

❖ We clear vegetation from land for agriculture, mining, road building, and other activities, and cover much of the land with buildings, concrete, and asphalt. This increases runoff, reduces infiltration that would normally recharge groundwater supplies, accelerates topsoil erosion, and increases the risk of flooding.

❖ We increase flooding when we drain and fill wetlands for farming and urban development. Wetlands provide the natural service of flood control, acting like sponges to absorb and hold overflows of water from drenching rains or rapidly melting snow.

NITROGEN CYCLE

Bacteria in Action

Cyclic movement of nitrogen in different chemical forms from the environment to organisms and then back to the environment.

The major reservoir for nitrogen is the atmosphere. Chemically unreactive nitrogen gas (N2) makes up 78% of the volume of the atmosphere. Nitrogen is a crucial component of proteins, many vitamins, and nucleic However, N_2 cannot be absorbed and used directly as a nutrient by multicellular plants or animals.

Two natural processes convert, or *fix*, N_2 into compounds that plants and animals can use as nutrients. One is electrical discharges, or lightning, taking place in the atmosphere. The other takes place in aquatic systems, in soil, and in the roots of some plants, where specialized bacteria, called *nitrogen-fixing bacteria*, complete this conversion as part of the **nitrogen cycle**.

The nitrogen cycle consists of several major steps. In *nitrogen fixation*, specialized bacteria in soil as well as bluegreen algae (cyanobacteria) in aquatic environments combine gaseous N_2 with hydrogen to make ammonia (NH_3). The bacteria use some of the ammonia they produce as a nutrient and excrete the rest into the soil or water. Some of the ammonia is converted to ammonium ions (NH_4^+) that plants can use as a nutrient.

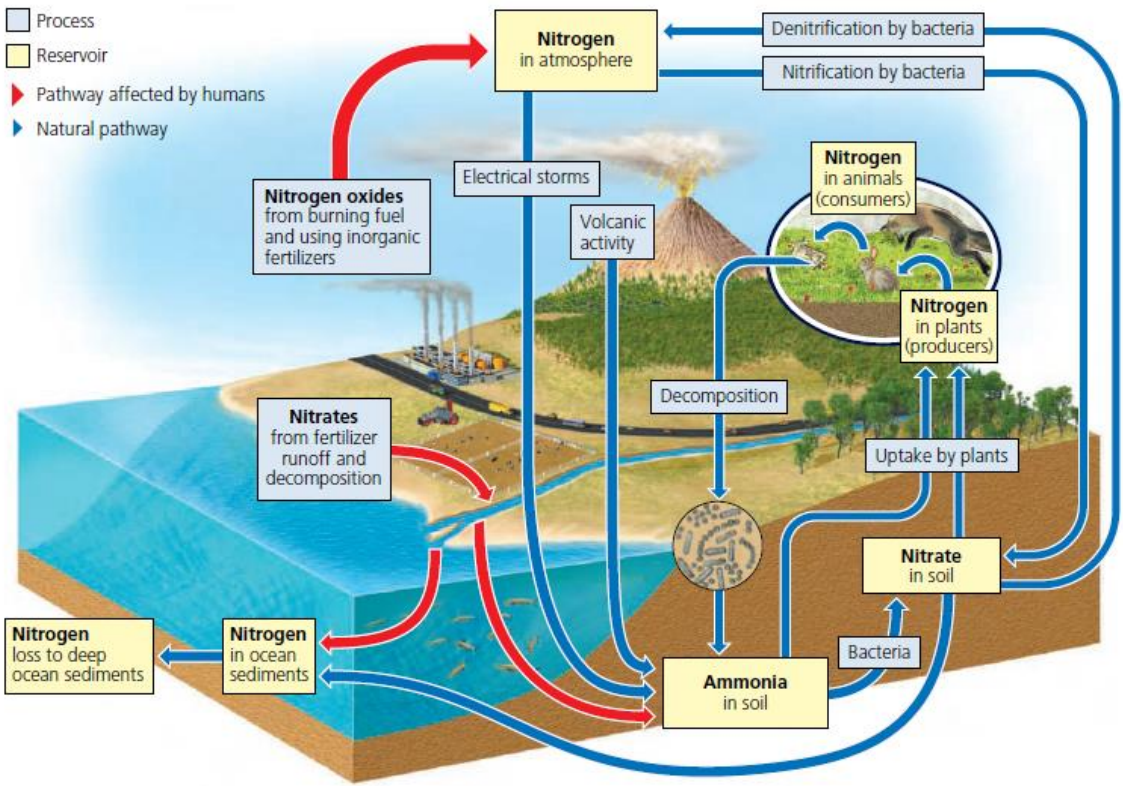
Ammonia not taken up by plants may undergo *nitrification*. In this process, specialized soil bacteria convert most of the NH_3 and NH_4^+ in soil to *nitrate ions* (NO_3^-), which are easily taken up by the roots of plants. The plants then use these forms of nitrogen to produce acids such as DNA (various amino acids, proteins, nucleic acids, and vitamins).

Animals that eat plants eventually consume these nitrogen-containing compounds, as do detritus feeders and decomposers. Plants and animals return nitrogen-rich organic compounds to the environment as both wastes and cast-off particles of tissues such as leaves, skin, or hair, and through their bodies when they die and are decomposed or eaten by detritus feeders.

In *ammonification*, vast armies of specialized decomposer bacteria convert this detritus into simpler nitrogen-containing inorganic compounds such as ammonia (NH_3) and water-soluble salts containing ammonium ions (NH_4^+). In *denitrification*, specialized bacteria in waterlogged soil and in the bottom sediments of lakes, oceans, swamps, and bogs convert NH_3 and NH_4^+ back into nitrate ions, and then into nitrogen gas (N_2) and nitrous oxide gas (N_2O). These gases are released to the atmosphere to begin the nitrogen cycle again.

Human interference in Nitrogen cycle:

1. We add large amounts of nitric oxide (NO) into the atmosphere when N_2 and O_2 combine as we burn any fuel at high temperatures,
such as in car, truck, and jet engines. In the atmosphere, this gas can be converted to nitrogen dioxide gas (NO_2) and nitric acid vapor (HNO_3), which can return to the earth's surface as damaging *acid deposition,*commonly called *acid rain*.
2. We add nitrous oxide (N_2O) to the atmosphere through the action of anaerobic bacteria on commercial inorganic fertilizer or organic animal manure applied to the soil. This greenhouse gas can warm the atmosphere and deplete stratospheric ozone, which keeps most of the sun's harmful ultraviolet radiation from reaching the earth's surface.
3. We release large quantities of nitrogen stored in soils and plants as gaseous compounds into the atmosphere through destruction of forests, grasslands, and wetlands.
4. We upset the nitrogen cycle in aquatic ecosystems by adding excess nitrates (NO_3^-) to bodies of water through agricultural runoff of fertilizers and animal manure and through discharges from municipal sewage systems. This can cause excess growth of algae.
5. We remove nitrogen from topsoil when we harvest nitrogen-rich crops, irrigate crops (washing nitrates out of the soil), and burn or clear grasslands and forests before planting crops.



CARBON CYCLE

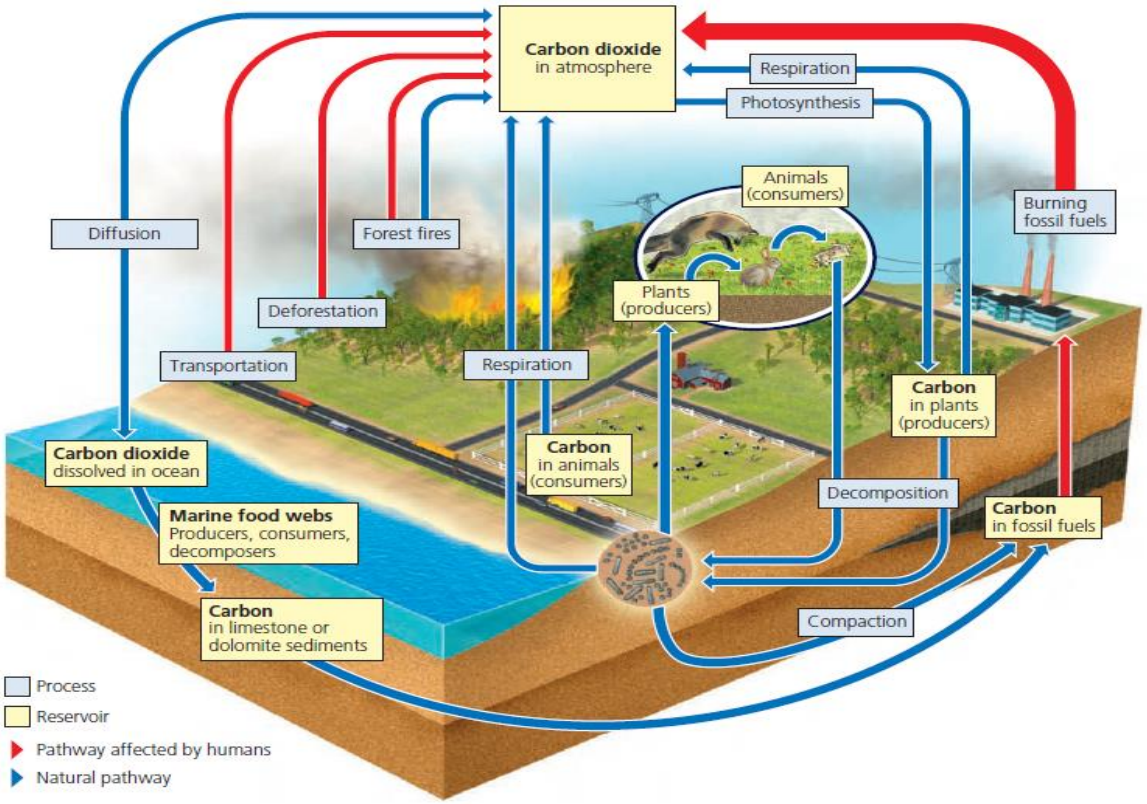
Cyclic movement of carbon in different chemical forms from the environment to organisms and then back to the environment.

Carbon is the basic building block of the **carbohydrates, fats, proteins, DNA**, and other organic compounds necessary for life. Various compounds of carbon circulate through the biosphere, the atmosphere, and parts of the hydrosphere.

The carbon cycle is based on carbon dioxide (CO_2) gas, which makes up **0.039%** of the volume of the earth's atmosphere and is also dissolved in water. Carbon dioxide is a key component of the **atmosphere's thermostat**. If the carbon cycle removes too much CO_2 from the atmosphere, the atmosphere will cool, and if it generates too much CO_2, the atmosphere will get warmer. Thus, even slight changes in this cycle caused by natural or human factors can affect the earth's climate and ultimately help to determine the types of life that can exist in various places.

Terrestrial producers remove CO_2 from the atmosphere and aquatic producers remove it from the water. These producers then use photosynthesis to convert CO_2 into complex **carbohydrates such as glucose** ($C_6H_{12}O_6$). The cells in oxygen-consuming producers, consumers, and decomposers then carry out aerobic respiration. This process breaks down glucose and other complex organic compounds to produce CO_2 in the atmosphere and water for reuse by producers. This linkage between ***photosynthesis*** **in producers and** ***aerobic respiration*** **in producers, consumers, and decomposers circulates carbon in the biosphere.** Oxygen and hydrogen—the other elements in carbohydrates—cycle almost in step with carbon.

Some carbon atoms take a long time to recycle. Decomposers release the carbon stored in the bodies of dead organisms on land back into the air as CO_2. However, in water, decomposers release carbon that can be stored as insoluble carbonates in bottom sediment. Indeed, **marine sediments are the earth's largest store of carbon**. Over millions of years, buried deposits of dead plant matter and bacteria are compressed between layers of sediment, where high pressure and heat convert them to carbon-containing ***fossil fuels*** **such as coal, oil, and natural gas.**



Human influence on carbon cycle:

- We are altering the carbon cycle mostly by adding large amounts of carbon dioxide to the atmosphere
- When we burn carbon-containing fossil fuels (especially coal to produce electricity).
- We also alter the cycle by clearing carbon-absorbing vegetation from forests especially tropical forests, faster than it can grow back.

ECOLOGICAL SUCCESSION

Ecological succession is the gradual process by which ecosystems change and develop over time. Nothing remains the same and habitats are constantly changing.

Types:

- **Primary Succession**: The process of creating life in an area where no life previously existed
- **Secondary Succession**: The process of restabilization that follows a disturbance in an area where life has formed an ecosystem.

STAGES OF ECOLOGICAL SUCCESSION

- **Nudation** : It is the development of a bare area without any life form.
- **Invasion**: It is the successful establishment of one or more species on a bare area through dispersal or migration.
- **Competition and coactions** : As the number of individuals grows there is competition, both inter-specific and intra-specific for space, water and nutrition.
- **Reaction** : The living organism grow use water and nutrients from the substratum and modify the environment in such a way that it become unsuitable for the existing species and favor some new species and leads to several seral communities.
- **Stabilization**: The succession ultimately stabilize in a more or less stable community called climax which is in equilibrium with the environment

Ecological successions starting on different types of areas are named differently

- **Hydrarch or Hydrosere**: Starting in watery area like pond, Swamp, bog
- **Mesarch**: Starting in an area of adequate moisture
- **Xerarch or xerosere**: Starting in a dry area with little moisture such as bare rock, sand and saline soil

Module 1 -Important Questions:

1. What are the major environmental problems? Give the basic causes and sustainable solutions for the same.
2. Explain IPAT equation with respect to less developed countries and more developed countries.
3. What are the structural components of Ecosystem?
4. What are life support system and explain the function of ecosystem?
5. Explain food chain and food web.
6. How energy flows in ecosystem following the laws of thermodynamics?
7. What are the different stages of ecological succession?
8. Starting from Hydrarch/ mesarch/ xerarch how does ecological succession proceed to stable community?
9. What is biogeochemical or nutrient cycle? Explain the human interference on water, carbon and nitrogen cycles.
10. In detail explain water/carbon/nitrogen cycle with suitable illustration.

MODULE 2

BIODIVERSITY

- Importance of Biodiversity
- Types, mega-biodiversity;
- Species interaction
- Extinct, endemic, endangered and rare species
- Hot-spots
- GM crops
- Terrestrial biodiversity
- Aquatic biodiversity
- Significance of biodiversity
- Threats to biodiversity -Natural and anthropogenic activities
- Conservation of biodiversity

Biological diversity, or **biodiversity**, is the variety of the earth's *species*, or varying life-forms, the genes they contain, the ecosystems in which they live, and the ecosystem processes of energy flow and nutrient cycling that sustain all life.

- Scientists have identified more than 2 million species. Tens of millions - remain unknown.
- The tremendous variety of life on Earth is made possible by complex interactions among all living things including microscopic species like algae and mites.
- The biodiversity found in genes, species, ecosystems, and ecosystem processes is vital to sustaining life on earth.
- Each species plays a specific ecological role called its **ecological niche**.
- Any given species may play one or more of five important roles - native, nonnative, indicator, keystone, or foundation—in a particular ecosystem.

- Species Diversity Includes the Variety and Abundance of Species in a Particular Place.
- **Species richness**- the number of different species present.
- **Species evenness**- the comparative numbers of individuals of each species present.

LEVELS OF BIODIVERSITY

- The three levels at which biological variety has been identified as the following

- **Genetic diversity**
- **Species diversity**
- **Ecosystem diversity**

- **<u>Genetic Diversity</u>:** Genetic diversity is a level of biodiversity that refers to the total number of genetic characteristics in the genetic makeup of a species.
- Genes are the basic unit of hereditary information transmitted from one to the other.
- Eg. *Oryza sativa* – differ in size, shape, aroma and nutrient content.
- Worldwide there are more than 40,000 different varieties of rice, species name *Oryza sativa*.

<u>Species diversity:</u>

- **Species diversity** refers to the number and distribution of species in one location.
- Humans have a huge effect on species diversity; the main reasons are:

- Destruction, Modification, and/or Fragmentation of Habitat

-Introduction of Exotic Species

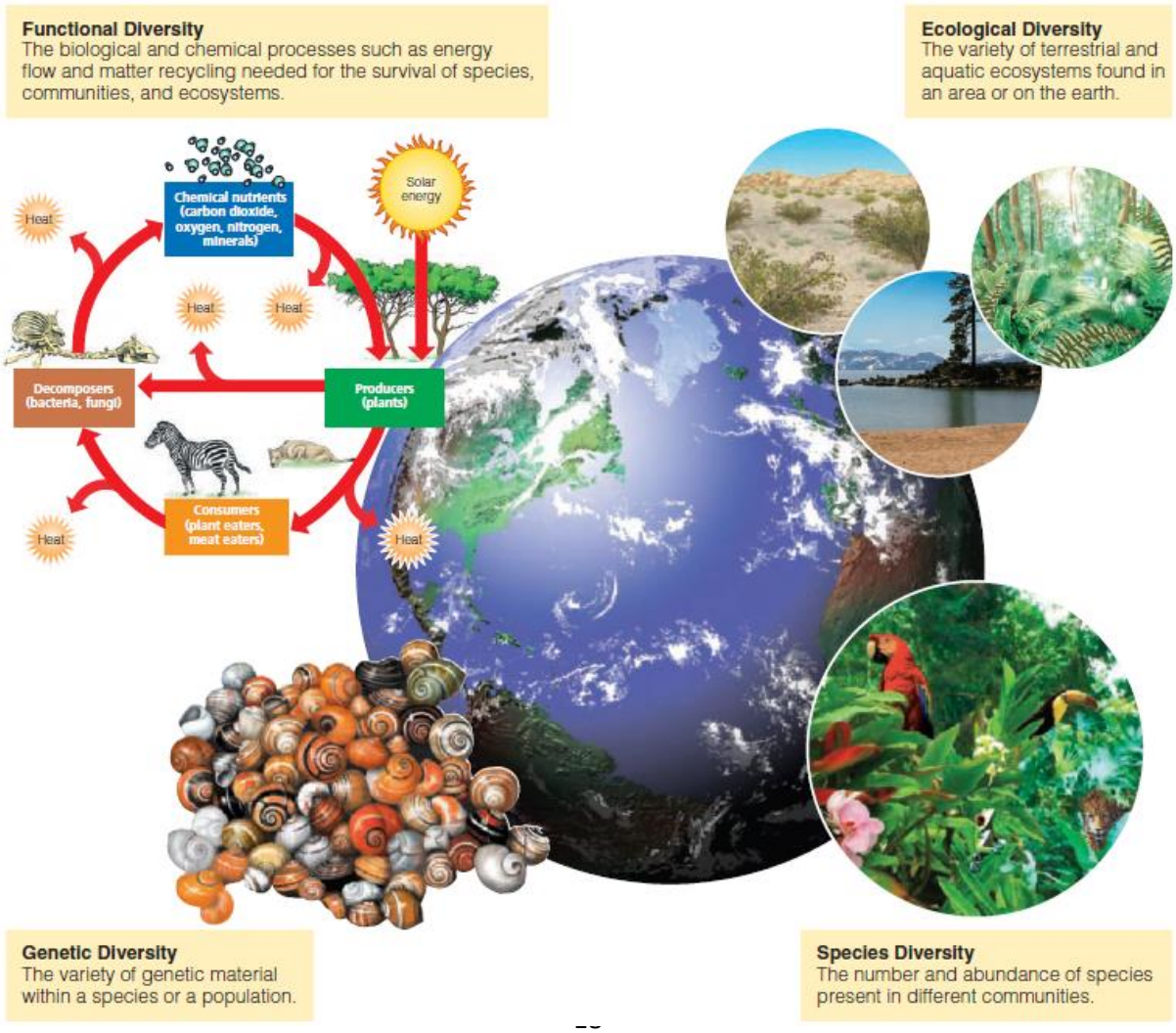
-Over harvest

- Global Climate Change

<u>Ecosystem Diversity:</u>

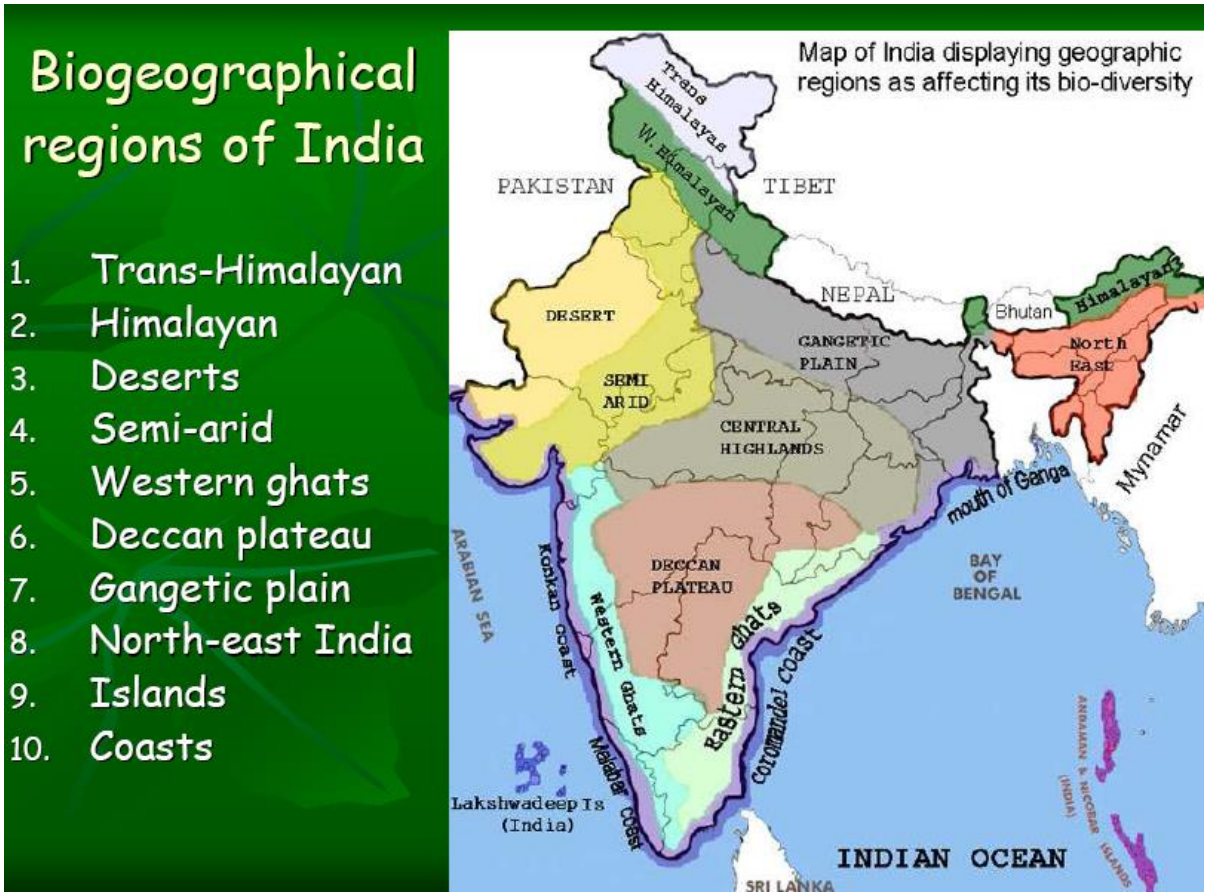
- **Ecosystem diversity** refers to the diversity of a place at the level of ecosystems.
- The ecosystems also show variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc.
- This diversity has developed over millions of years of evolution
- We cannot even replace the diversity of one ecosystem by that of another.

Eg: Rain forest, Pond Ecosystem, Desert Ecosystem



INDIA- A MEGA BIODIVERSITY NATION

- 6% of the world's species exist in India
- 10th among plant richness, 11th in terms of endemic species
- 6th place in origin of agricultural crops
- Total number of living species identified 150,000
- 2 hotspots of the world are found in india
- One of the 12 mega-biodiversity countries exists in India
- Different types of climate, topography and flora and fauna induced by these.
- The annual rainfall varies from less than 37 cm in Rajasthan to 1200cm in Meghalaya
- Three different seasons – winter, summer and monsoons.
- The seasonal severity varies considerabley.
- The vegetation rages from:- Xerophytes in Rajasthan
- Evergreen in the North-East and Western Ghat areas
- Mangroves of coastal areas
- Dry deciduous forests of central India
- Conifers of the hills Alpine pastures in the high reaches of the Himalaya



HOT SPOTS OF BIODIVERSITY

Definition - Areas which exhibit high species richness as well as high endemism are termed as hot spots of biodiversity

Criteria for recognizing hot spots

-Richness of the endemic species

At least 0.5 % of plant species should be endemic.

Endemic Species: Species which are restricted to a particular area

Two hotspots present in India

- **Eastern Himalayas**
- **Western Ghats**

Eastern Himalayas:

- Northern Himalayan states of India, some part in Nepal and Bhutan
- 35,000 plant species of which 30% are endemic species, 63 % mammals, 60 % of the Indian birds are from North East
- Eg: Orchid species, citrus, jute, Indian tiger

Western ghats

- 40% plants, 62% amphibians, 50 % lizards are endemic
- Forests occur upto 500 m elevation – 20% forest evergreen
- Only 6.8% of the original forests are existing now in this region
- Eg: Different species of Lizards, reticulated python, Indian salamander, lizard hawk

IMPORTANT TERMINOLOGY

Endangered species: Species in danger of extinction and whose survival is unlikely if the casual factors continue operating. Eg: Peacock, Indian tiger

Extinct: If not seen for 50 years. Used for species which are no longer known to exist in the world. Eg: Dinasour, Dodo, Himalayan Quail, Indian Cheetah

Vulnerable: Species believed likely to join the endangered category in the near future if the casual features continue operating. Eg: Indian Rhinoceros, Nilgiri Langur.

Rare: Species with small world populations that are not at present endangered or vulnerable but are at risk. Eg: Sparrows, black buck.

Endemic Species: Native to a particular place. Eg: Asiatic Lion, Red Panda

Native species: Those species that normally live and thrive in a particular ecosystem. African elphants in Africa.

Exotic: *invasive*, *alien*, and *exotic species.* Non- native species which have been moved by human being from their native place to non-native environment. Eg: Orchids, Cacti

VALUES OF BIODIVERSITY

Intrinsic value: Something that has value in and of itself

Utilitarian value: It is useful to others

UTILITARIAN VALUES

- ❖ Consumptive use value
- ❖ Productive use value
- ❖ Social value
- ❖ Ethical value
- ❖ Aesthetic value
- ❖ Option value
- ❖ Ecosystem service value

Consumptive use Value:

- Biodiversity products are consumed directly
- Food from animals: Cattle, pigs, chickens, buffaloes, ducks – all are originally beloged to forests we tamed them now.
- Plants: greens and vegetables – all our food crops are originally existed in forests
- Fish – belongs to water bodies
- Herbal Medicines- medicines extracted from tropical plants and organisms. Eg: Tetracycline, quinine, cancer drugs from periwinkle
- Fuel

Productive use value:

- Commercially usable – marketed
- Lumber
- Wild gene resources
- Tusks of elephants
- Musk from musk deer
- Silk from silkworms
- Wool from sheep

Cultural and social value:

- Customs, religion and psycho-spiritual related values
- Certain plants are worshipped or used to worship
- Holy basil (Tulsi), Mango leaves, Palm pree in Egypt
- Dances of tribal people are often related to wildlife
- -snake, fish, cow, peacock etc
- Cows and snakes are worshiped

Ethical value:

- Ethical value is also known as existence value
- Having affection for other living beings and feeling that all life should be preserved
- We do not use several of plant and animal species directly. But we still feel that they shoud not go to extinction

Aesthetic value:

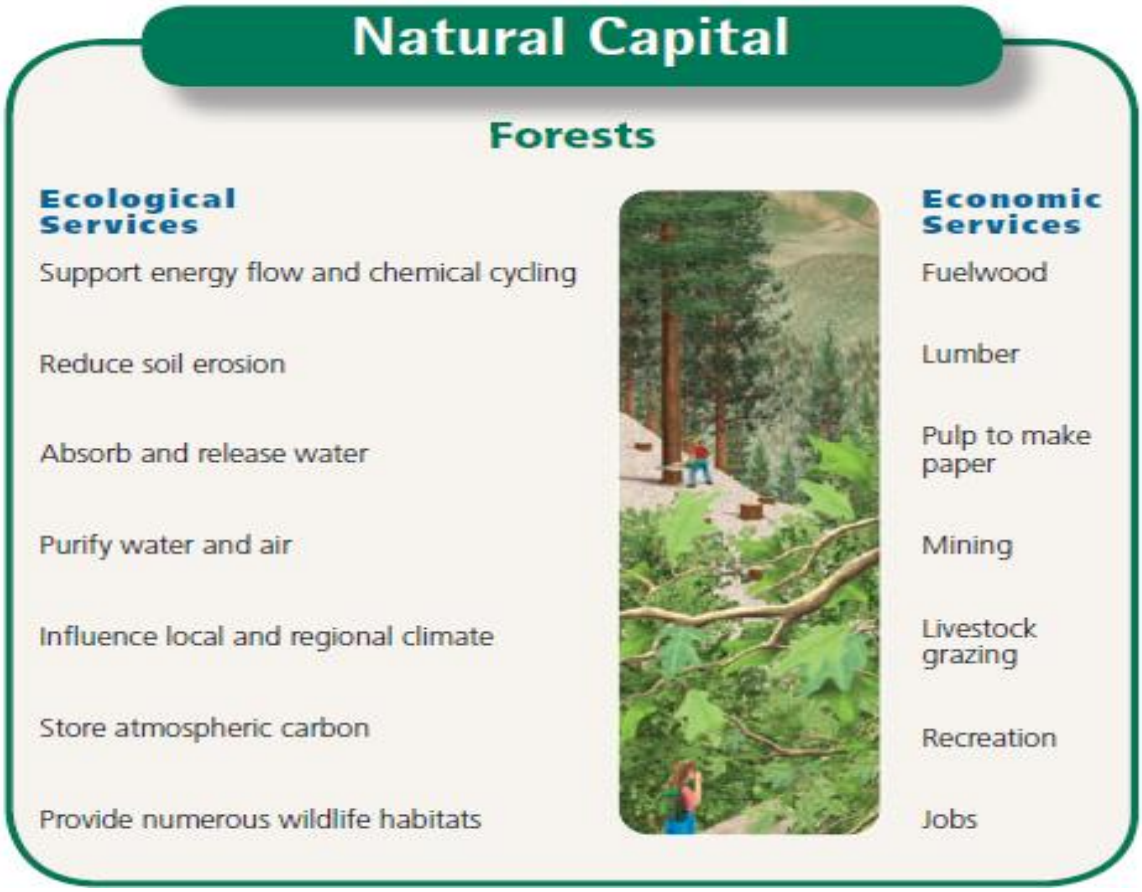
- No one wish to visit vast stretches of barren land with no sign of visible life.
- People spend money to visit- eco-tourism.
- The willingness to pay – to visit
- Eco-tourism estimated for aesthetic value – about 12 billions dollars annually

Option value:

- The potential of biodiversity – presently unknown and needed to be explored.
- Potential, cure for AIDS or cancer.
- Exploration within the depth of marine eco-system

Ecosystem service value:

- Prevention of Soil erosion,
- prevention of floods and disaster
- Maintaining soil fertility,
- Cycling of nutrients C,N,P,S.
- Contribution to watercycle.
- Pollution breakdown and absorption (CO_2 is absorbed by forest)
- Reduction of the threat of global warming.



THREATS TO BIODIVERSITY

- Habitat destruction
- Poaching
- Man-wildlife conflicts
- Pollution
- Species Introductions
- Global Climatic Change
- Exploitation

HABITAT DESTRUCTION

❖ **Loss of Habitat:**

Is the largest cause. Forests and grasslands have been cleared for

- agriculture
- pasturing
- human settlement and
- for development projects
- In India forests are lost at a rate of 0.6%/year

❖ **Habitat fragmentation:**

- Small regions of forest are removed for
  - roads,
  - urbanisation,
  - agriculture
- It results in division of forests into smaller fragments
- Some animals need large territories (eg: Bear, tiger)
- When forests are divided these animals cannot survive

❖ **Deforestation:**

Cutting trees for timber, removal of medicinal plants, construction of dam

❖ **Raw materials:**

Production of hybrid seeds – wild plants used as raw materials. As a result plant species become endangered

❖ **Production of drugs:**

- Wild plants – used for production of drugs; therefore several medicinal plant become extinct
- Wetlands are often destroyed due to draining, filling and Pollution

POACHING

- Killing/hunting of animals
- **Illegal trade of wild life**
  - Despite ban, animals are killed for Furs, horns, tusks, skins (crocodile)
  - Live specimens are smuggled
  - Subsistence poaching: Killing animals for food
  - Commercial poaching : Hunting & killing animals to sell their products

MAN-WILDLIFE CONFLICTS

- **Man-wildlife conflicts arise**
    - when wildlife starts causing immense damage and danger to the man
    - Such condition, very difficult for the forest department to compromise the affected villagers & gain village support for wild life conservations.

- **Examples:**

1. In Sambalpur, Orissa

– 200 humans killed by elephants.

- In retaliation the villagers killed 100 elephants

2. Man eating tiger - In Royal Chitwan National park, Kathmandu

In 2004 - 20 Nepalese people were killed,1 four year old child

Remedy:

- Tiger conservation projects: Making available tranquilizers guns, binoculars and radiosets etc to deal with danger
- Solar powered fencing instead of electric
- Croping near forests should be prevented
- Adequate food should be made available for animals within the forest
- Wild animal hunting rituals should be stopped.

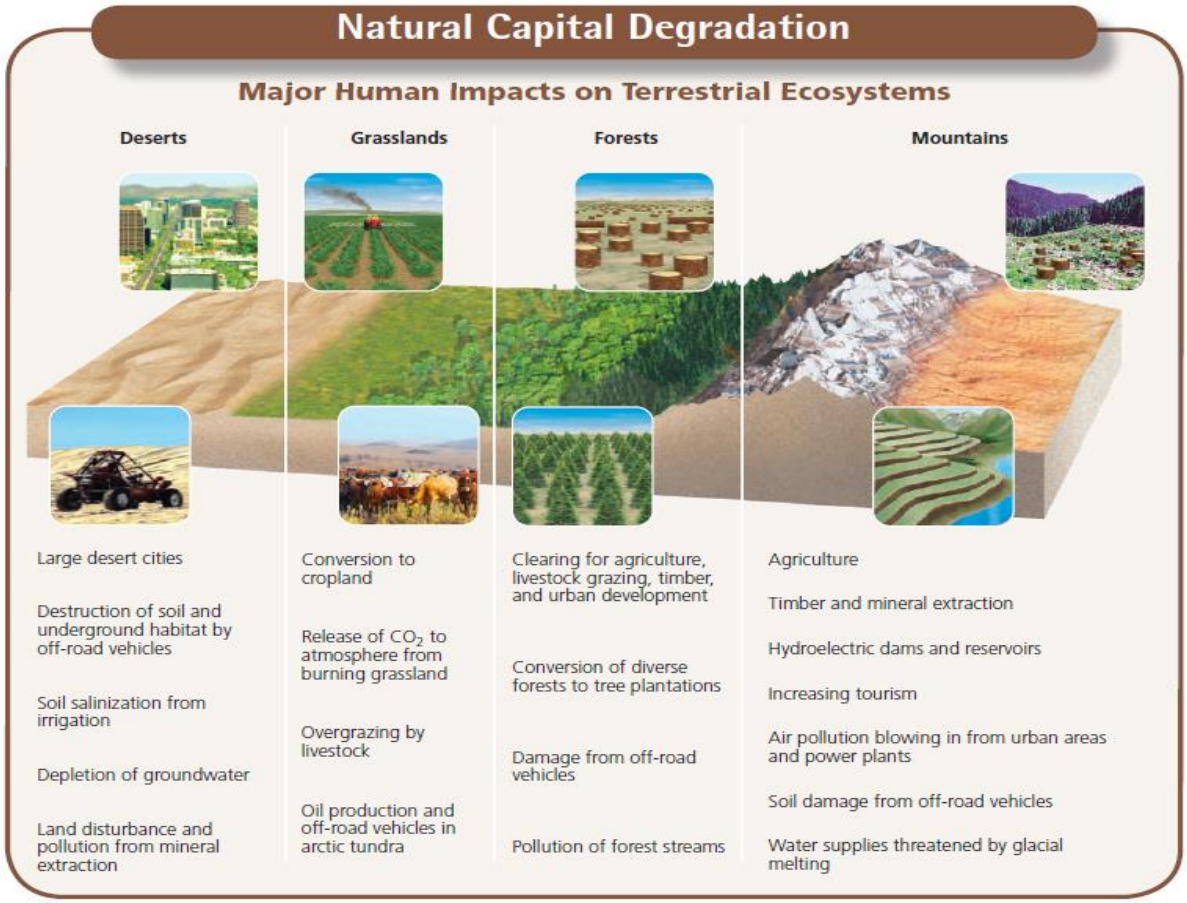
How to sustain Terrestrial Ecosystem?

❖ We can sustain forests by **emphasizing the economic value** of their ecological services, removing government subsidies that hasten their destruction, protecting old-growth forests, harvesting trees no faster than they are replenished, and **planting trees**.

❖ We can sustain the productivity of grasslands by **controlling the numbers and distribution of grazing livestock, and by restoring degraded grasslands**.

❖ Sustaining biodiversity will require more effective **protection of existing parks and nature reserves**, as well as the protection of much more of the earth's remaining undisturbed land area.

❖ We can help to sustain terrestrial biodiversity by identifying and protecting severely threatened areas (**biodiversity hotspots**), restoring damaged ecosystems **(using restoration ecology**), and sharing with other species much of the land we dominate **(using reconciliation ecology).**



CONSERVATION OF BIODIVERSITY

Two approaches of Biodiversity Conservation

❖ **In Situ conservation (within habitat): This is achieved by protection of wild flora and fauna in nature itself**

- Biosphere Reserves
- National Parks
- Wildlife Sancturies
- Conservation reserves
- Tiger reserves
- Seed Stands and seed production areas
- Plus trees

❖ **Ex situ conservation -Conservation of flora and fauna outside their habitat**

- Botanical gardens
- Arboreta
- Herbal gardens
- Clonal repositories
- Plant herbarium
- Provenance trials

- Gene banks / Seed banks
- Culture collections

In-Situ Conservation

1. Biosphere reserves:

It conserve some representative ecosystems as a whole for long-term in situ conservation.

Following the "Man and biosphere" approach advocated by the UNESCO, 14 sites have been identified as biosphere reserves covering area of 49012.62 sq.km

Name of the place	State
Nanda Devi	U.P.
Nilgiri	Karnataka, Kerala, Tamil Nadu
Gulf of Mannar	Tamil Nadu
Sunderbans	West Bengal
Manas	Assam
Similipal	Orrisa
Nokrek	Meghalaya
Great Nicobars	-

2. National Parks:

➢ A National Park is an area dedicated for the conservation of wildlife along with its environment. It is also meant for enjoyment through tourism but without impairing the environment. Each National Park usually aims at conservation specifically of some particular species of wildlife along with others.

➢ There are 97 existing national parks in India covering an area of 38,199.47 km^2, which is 1.16% of the geographical area of the country.

➢ In addition, 74 national parks are proposed in the protected area network report.

Name of National Park	State	Important Wildlife
Kaziranga	Assam	One horned Rhino
Gir National Park	Gujarat	Indian Lion
Dachigam	J & K	Hangul
Bandipur	Karnataka	Elephant
Periyar	Kerala	Elephant, Tiger
Kanha	M.P.	Tiger
Corbett	U.P.	Tiger
Dudwa	U.P.	Tiger
Ranthambore	Rajasthan	Tiger
Sariska	Rajasthan	Tiger

3. Wildlife sanctuaries:

➢ They are also protected areas where killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. There are 508 wildlife sanctuaries covering an area of 3.6 % of the geographical area. Another 217 sanctuaries are proposed in the Protected Area Network Report.

➢ For plants, there is one gene sanctuary for Citrus (Lemon family) and one for pitcher plant (an insect eating plant) in Northeast India.

➢ For the protection and conservation of certain animals, there have been specific projects in our country e.g. Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Snow Leopard Project etc.

4. Tiger Reserves:

➢ Project Tiger was launched in the year 1973 to save the tiger. Starting from nine (9) reserves in 1973-74. In number it has grown upto 29 in 2006. Geographical area covered by these project tiger areas is 1.17%.

➢ Eg: Periyar, Kanha, Corbett

Name of Sanctuary	State	Major Wild Life
Ghana Bird Sanctuary	Rajasthan	300 species of birds (including migratory)
Hazaribagh Sanctuary	Bihar	Tiger, Leopard
Sultanpur Bird Sanctuary	Haryana	Migratory birds
Nal Sarovar Bird Sanctuary	Gujarat	Water birds
Abohar Wildlife Sanctuary	Punjab	Black buck
Mudamalai Wildlife Sanctuary	Tamil Nadu	Tiger, elephant, Leopard
Vedanthangal Bird Sanctuary	Tamil Nadu	Water birds
Jaldapara Wild Life Sanctuary	W. Bengal	Rhinoceros, elephant, Tiger
Wild Ass Sanctuary	Gujarat	Wild ass, wolf, nilgai, chinkara

5. Seed Stands and Seed production areas:

- The best natural stands or plantations that are near full stocking are used for the development of seed production areas.
- One of the important component is the improvement of seed quality.

6. Plus trees:

- Tree Plus selection is one of the methods to conserve diversity at species level.
- Plus tree is a phenotypically superior tree. It is the utilization part of gene conservation.

Ex-Situ Conservation

1. Botanical gardens:

- India has more than 100 botanical gardens under different management systems located in different bio-geographical regions.
- Central and state governments manage 33 botanical gardens that maintain the diversity in the form of plants or plant populations.

2. Arboreta:

- An arboretum generally refers to a place established for conservation of tree species.
- FRI (Forest Research Institute) Dehradun,
  - an arboretum with 130 tree species
  - a bamboosetum of 53 species
- NBPGR (National Bureau of Plant Genetic Resources), Bhubaneswar

- ❖ an arboretum of 1,430 species of trees
- ❖ a palmeretum of 100 different types of palms
- ❖ a bamboosetum with 61 collection of bamboo
- ❖ an orchidarium housing 220 species of orchids

3. Herbal gardens:

- Refers to the gardens that conserve herbs, shrubs that are of medicinal value and aromatic value.
- The concept of herbal gardens has been picked up by the NGOs in India.
- Several institutions, State Forest Departments and NGOs in different parts of the country, have established herbal gardens.

4. Plant herbarium:

- Plant diversity preserved in the form of herbarium
- The Botanical Survey of India has the largest holding of 1,500,000 specimens.
- There are many more herbaria
- Presidency College Madras (1,00,000)
- The Blater Herbarium at St. Xavier's College, Bombay (1,00,000)
- St. Joseph's College, Tiruchirapally (60,000)

5. Provenance trials:

- Provenance trials help in exploration of gene resources called genecological exploration
- More than ninety species provenance trials have been established in different parts of India to screen out best provenance for raising new plantations with increased productivity
- Provenance are collected from different geographical, ecological and environmental conditions and play important role in gene conservation.

6. Seed Orchards:

- Seed orchards contribute greatly to the production of quality planting stock of the desired species
- These are plantations established primarily for the production of seed of proven genetic quality.
- Establishment of seed orchards is part of long-term conservation management programme and also a long-term breeding programme.

7. Zoos and aquariums:

- Captive breeding programmes of endangered animals
- Semen banks
- Zoo Authority of India
- 164 recognized zoos
- Laboratory for Conservation of Endangered Species, Hyderabad.
- Captive breeding of Red Panda and its restocking into the wild

AQUATIC BIODIVERSITY

- **The general nature of aquatic systems:**

Saltwater and freshwater aquatic life zones cover almost three-fourths of the earth's surface, with oceans dominating the planet.

The key factors determining biodiversity in aquatic systems are temperature, dissolved oxygen content, availability of food, and availability of light and nutrients necessary for photosynthesis.

- **Importance of marine aquatic systems:**

Saltwater ecosystems are irreplaceable reservoirs of biodiversity and provide major ecological and economic services.

- **Human activities affect marine ecosystems:**

Human activities threaten aquatic biodiversity and disrupt ecological and economic services provided by saltwater systems.

- **Importance of freshwater ecosystems:**

Freshwater ecosystems provide major ecological and economic services, and are irreplaceable reservoirs of biodiversity.

- **Human activities affect freshwater ecosystems:**

Human activities threaten biodiversity and disrupt ecological and economic services provided by freshwater lakes, rivers, and wetlands.

Aquatic systems include

(a) Saltwater oceans
(b) Bays, such as Trunk Bay at St. John in the U.S. Virgin Islands
(c) Freshwater lakes such as Peyto Lake in Canada's Banff National Park
(d) Wild freshwater mountain streams.

We can divide aquatic life forms into several major types:

Plankton, which include

(a) **Phytoplankton**, tiny drifting plants and
(b) **Zooplankton**, drifting animals that feed on each other and on phytoplankton; Eg: Jellyfish, which uses long tentacles with stinging cells to stun or kill its prey.

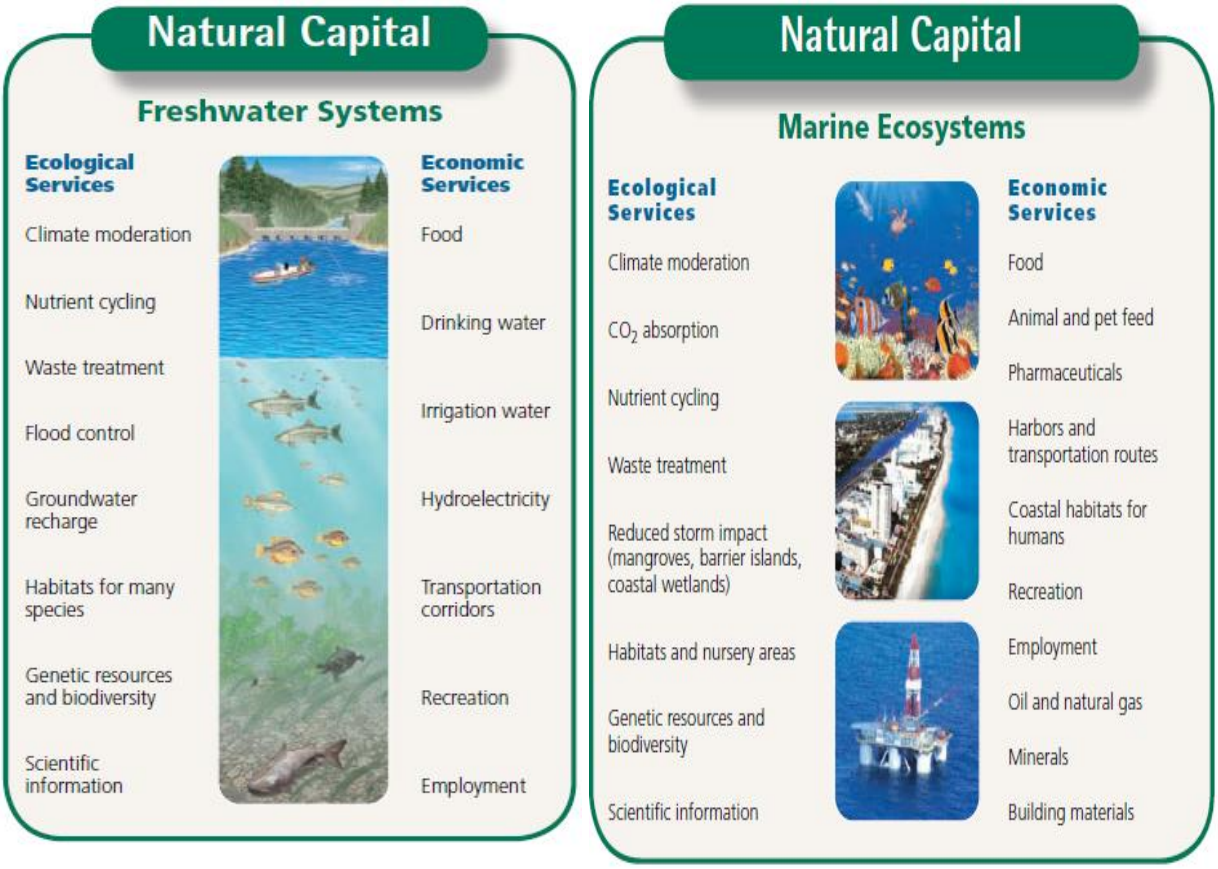
Other major types of aquatic life are

(c) **Nekton**, or strongly swimming aquatic animals such as whale, and
(d) **Benthos**, or bottom dwellers such as sea star attached to coral in the Red Sea.

Human Activities Are Disrupting and Degrading Freshwater Systems

- **Dams and canals fragment about 40% of the world's 237 largest rivers.** They alter and destroy terrestrial and aquatic wildlife habitats along these rivers and in their coastal deltas and estuaries by reducing water flow and increasing damage from coastal storms.
- **Flood control levees and dikes built along rivers disconnect the rivers** from their floodplains, destroy aquatic habitats, and alter or reduce the functions of nearby wetlands.
- **Cities and farms, which add pollutants** and excess plant nutrients to nearby streams, rivers, and lakes.

➢ **Inland wetlands have been drained or filled to grow crops** or have been covered with concrete, asphalt, and buildings. The rest were lost to mining, logging, oil and gas extraction, highway construction, and urban development.



GENETICALLY MODIFIED CROPS

History of crop improvement

- By trial and error for almost 9900 years
- By scientific principles of breeding for last 100 years
- **By chemical induced mutation for last 75 years**
- By rDNA technology last 25 years

CHALLENGES AHEAD

- Population in 2050 AD: 1.5 B
- Shrinking area of cultivated land
- Diminishing water resources
- Malnutrition and undernourishment
- Deterioration in soil quality
- Climate change (global warming)

Genetically Modified (GM) Crops

➢ GM crops are genetically improved and contain a gene or genes from the same or a different species artificially inserted in its genome.

➢ Tissue Culture & Transformation – gives the maximum flexibility for moving genes within or between species.

➢ **Bt-cotton -** First GM crop – 2002

- Second in global cotton production
- Area – 8.0 million hectares – 2008
- Yield gain - 31%
- Reduction in pesticide sprays – 39%

➢ **Golden Rice**

- For Nutritional quality
- Expression of enzymes of β-carotene pathway in rice endosperm
- Amelioration of Vitamin A deficiency

Advantages of GMO's:

❖ Enhance desired traits
❖ Pest resistance
❖ Improve nutritional content
❖ Less time than controlled breeding
❖ Improve accuracy
❖ Herbicide tolerance
❖ Cold tolerance
❖ Medical advantage eg. Edible vaccines
❖ Virtual end of world hunger. Eg. No malnutrition
❖ Cheaper or faster to grow and don't have to be rich in plant
❖ Endless possibilities and anything alive can be genetically modified
❖ Reduce production cost to reduced chemical and mechanical need in planting, maintenance and harvest.

Disadvantages of GMO's

❖ Harm to organisms
❖ Doesnot taste natural
❖ Spread of superweeds
❖ Spread of superbugs
❖ New trade, tariff and quota issues
❖ May cause health problems
❖ Larger companies have more power
❖ Possible greed to GMO manufacturers
❖ Unforeseen allergen risks
❖ Allergies may become more intense
❖ New allergies may arise
❖ Widening corporate size gaps between food producing giants and smaller ones.

Species Interaction - Five Major Ways

Ecologists identify five basic types of interactions between species as they share limited resources such as food, shelter, and space:

• **Interspecific competition:**
When members of two or more species interact to gain access to the same limited resources such as food, water, light, and space.
• **Predation:** When a member of one species (the *predator) feeds directly on all or part of a member* of another species (the *prey).*
• **Parasitism:** When one organism (the *parasite)* feeds on another organism (the *host), usually by* living on or in the host.
• **Mutualism:** Interaction that benefits both species by providing each with food, shelter, or some other resource.
• **Commensalism:** Interaction that benefits one species but has little or no effect on the other.
These interactions have significant effects on the resource use and population sizes of the species in an ecosystem

INTERSPECIFIC COMPETITION

Resource partitioning:

Species competing for similar scarce resources evolve specialized traits that allow them to share resources by using parts of them, using them at different times, or using them in different ways.

Figure 5-2 *Sharing the wealth:* This diagram illustrates *resource partitioning* among five species of insect-eating warblers in the spruce forests of the U.S. state of Maine. Each species minimizes competition with the others for food by spending at least half its feeding time in a distinct portion (yellow highlighted areas) of the spruce trees, and by consuming somewhat different insect species. (After R. H. MacArthur, "Population Ecology of Some Warblers in Northeastern Coniferous Forests," *Ecology* 36 (1958): 533–536.)

THE PREDATOR–PREY RELATIONSHIP

[One species benefits other species dies]

- Herbivores can simply walk, swim or fly up to the plants they feed on.
- Carnivores feeding on mobile prey have two main options: *pursuit and ambush.*

➢ Cheetah catch prey by running fast

➢ The American bald eagle can fly and have keen eyesight.

➢ Interactions between Predator and Prey Species Can Drive Each Other's Evolution

➢ Prey species have developed specialized ways to avoid their predators:

➢ Camouflage, chemical warfare, warning coloration, mimicry, deceptive looks, deceptive behavior.

➢ **Coevolution**

Long-term interactions between bats and their prey such as moths and butterflies can lead to coevolution, as the bats evolve traits to increase their chance of getting a meal and the moths evolve traits to help them avoid being eaten.

PARASITISM

[Species Feed off Other Species by Living on or inside Them].

➢ Parasitism occurs when one species (the *parasite) feeds* on another organism (the *host), usually by living on or* inside the host. In this relationship, the parasite benefits and the host is often harmed but not immediately killed.

➢ **Example: Blood-sucking parasitic sea lamprey** attached itself to an adult lake trout from the Great Lakes (USA).

MUTUALISM

[Both Species Benefit]

➢ In mutualism, two species behave in ways that benefit both by providing each with food, shelter, or some other resource.

➢ **Hummingbird benefits by feeding on nectar** in this flower, and it benefits the flower by pollinating it.

Example:

(a) Oxpeckers and black rhinoceros: Oxpeckers (or tickbirds) feed on parasitic ticks that infest large, thick-skinned animals such as the endangered black rhinoceros.

(b) Clownfish and sea anemone: A clownfish gains protection and food by living among deadly, stinging sea anemones and helps to protect the anemones from some of their predators.

COMMENSALISM

[One Species Benefits and the Other Is Not Harmed]

- Commensalism is an interaction that benefits one species but has little, if any, beneficial or harmful effect on the other.
- Bromeliad—an epiphyte, or air plant—in Brazil's Atlantic tropical rain forest roots on the trunk of a tree, rather than in soil, without penetrating or harming the tree.
- In this interaction, the epiphyte gains access to sunlight, water, and nutrients from the tree's debris; the tree apparently remains unharmed and gains no benefit.

Module 2- Important Questions:

1. Justify India as a megabiodiversity nation.
2. How do species interact among themselves?
3. Give the merits and demerits of GM Crops.
4. In detail explain the importance of terrestrial biodiversity.
5. Elaborate on the threats to biodiversity particularly man-wild life conflict, habitat destruction and poaching.
6. Explain the Ex-Situ and In-situ methodologies for conservation of biodiversity.
7. What are hot spots? Give the salient features of Indian hot spots.
8. Explain extinct, endangered, vulnerable, rare, endemic and exotic species with suitable example.
9. Describe the ecological and economical benefits rendered by aquatic biodiversity.
10. With suitable examples explain the Mutualism, commensalism, parasitism, prey-predator relationship and interspecific competition.

Module – 3

Sustaining Natural Resources and Environmental Quality

- Environmental hazards – causes and solutions.
- Biological hazards – AIDS, Malaria,
- Chemical hazards- BPA, PCB, Phthalates, Mercury.
- Nuclear hazards
- Risk and evaluation of hazards.
- Water footprint; virtual water, blue revolution.
- Water quality management and its conservation.
- Solid and hazardous waste – types and waste management methods.

Environmental hazards:

- ❖ **Biological Hazard**
- ❖ **Chemical Hazard**
- ❖ **Nuclear Hazard**
- ❖ **Risk and evaluation of hazards.**

Major Health Hazards:

Biological - Pathogens like bacteria, viruses, parasites, protozoa, and fungi.

Chemical - harmful chemicals in air, water, soil, food, and human-made products

Physical - fire, earthquakes, volcanic eruptions, floods, and storms

Cultural factors - unsafe working conditions, unsafe highways, criminal assault, and poverty

Lifestyle choices - smoking, making poor food choices, drinking too much alcohol, and having unsafe sex

****

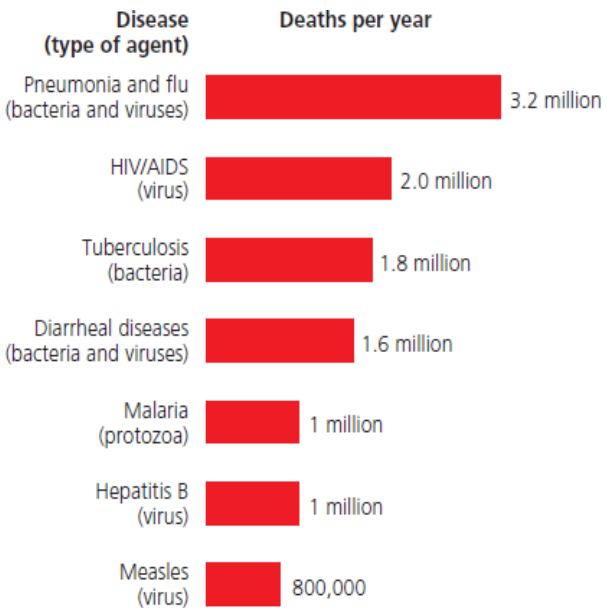
Biological Hazards:

Flu, AIDS, tuberculosis, diarrheal diseases and malaria.

A **non-transmissible disease is** a not caused by any living organism.

Eg. Cardiovascular (heart and blood vessel) diseases, most cancers, asthma, and diabetes.

A **transmissible disease (also called a *contagious or communicable*** *disease) is an infectious disease that can be transmitted* from one person to another by living organism - By pathogen such as a bacterium, virus, or parasite. Eg. tuberculosis (TB) , flu, and measles.

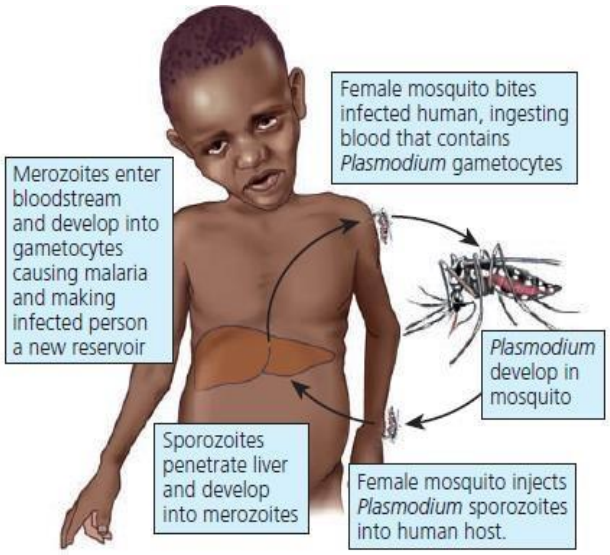


Infectious disease:

The life cycle of malaria Plasmodium parasites circulate from mosquito to human and back to mosquito.

Malaria:

About one of every five people in the world—most of them living in poor African countries—is at risk from malaria. There is no vaccine for preventing this disease. It infects and destroys red blood cells, causing intense fever, chills, drenching sweats, severe abdominal pain, vomiting, headaches, and increased susceptibility to other diseases. Four species of protozoan parasites in the genus *Plasmodium* cause malaria.



HIV/AIDS:

HIV - Human Immunodeficiency Virus. AIDS - Acquired Immunodeficiency Syndrome. Discovered in 1983. Worldwide 40 million affected - mostly in Africa, India, China, Russia. 3 million died in 2003 due to HIV/AIDS.

Where did it come from?

The origin is from monkeys, and other apes in Africa. It spread through HIV contaminated polio vaccine programs. Hepatitis B viral vaccine in New York, Los Angeles and San Francisco

Through small pox vaccine programs of Africa. Some believe that it is man made – by Genetic Engineering.

Activities spreading HIV:

Blood contact; Blood transfusion; Use of infected injection syringes, surgery tools ; Through unprotected sex with multiple partners; Can pass from mothers to their babies; During delivery and breast feeding.

Activities which do not spread HIV:

It does not spread through sweat, tears, urine or saliva. It does not spread through mosquito or bed bug bites. It does not spread through simple touch. It does not spread through sharing utensils, towels, clothing etc. The virus dies quickly outside blood.

Effects of HIV/AIDS on Environment:

Large number of deaths can cause changes in local environment. Most of the people infected are labours - loss of labour and so production decreases. With fewer adults, children find it difficult to survive. People who are infected become weak and cannot do hard physical work like farming – crops and food production will fall. Teachers, doctors affected – education and medical treatment hampered. Without labor, less time will be spent on environmental activities like soil conservation

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Chemical Hazards:

Chemicals that can cause cancers and birth defects and disrupt the human immune, nervous, and endocrine systems.

U.S. Environmental Protection Agency (EPA) listed arsenic, lead, mercury, vinyl chloride (used to make PVC plastics), and polychlorinated biphenyls (PCBs) as the top five toxic substances

Carcinogens:

Chemicals, types of radiation, or certain viruses that can cause or promote cancer

Eg: arsenic, benzene, chloroform, formaldehyde, gamma radiation, nickel, PCBs, radon, certain chemicals in tobacco smoke, ultraviolet (UV) radiation, X-rays, and vinyl chloride.

Mutagens:

Includes chemicals or forms of radiation that cause mutations, or changes, in the DNA molecules found in cells, or that increase the frequency of such changes.

Eg: nitrous acid (HNO_2), formed by the digestion of nitrite (NO_2^-) preservatives in foods.

Teratogens:

chemicals that cause harm or birth defects to a fetus or embryo.

Eg: Ethyl alcohol, angel dust, benzene, cadmium, formaldehyde, lead, mercury, mescaline, PCBs, phthalates, thalidomide, and vinyl chloride.

Chemicals may affect our Immune, Nervous, and Endocrine Systems:

- **Arsenic, methyl mercury, and dioxins** can weaken the **human immune system**
- Natural and synthetic chemicals in the environment, called **neurotoxins**, *can harm the* **human nervous system** *(brain, spinal cord, and peripheral nerves).*
- Effects can include behavioral changes, learning disabilities, retardation, attention deficit disorder, paralysis, and death.
- Examples of neurotoxins are Poly chlorinated biphenyls, **PCBs, methyl mercury, arsenic, lead, and certain pesticides**.
- **Hormonally active agents** *(HAAs)* disrupt the endocrine system Certain pesticides and other synthetic chemicals such as **bisphenol A (BPA).**
- -HAAs include **aluminum, atrazine and several other herbicides, DDT, mercury, PCBs, phthalates, and BPA.**
- **-Estrogen mimics and hormone blockers** are sometimes called ***gender benders*** *because of their possible effects on sexual* development and reproduction
- **- thyroid disrupters** and cause growth, weight, brain, and behavioral disorders.

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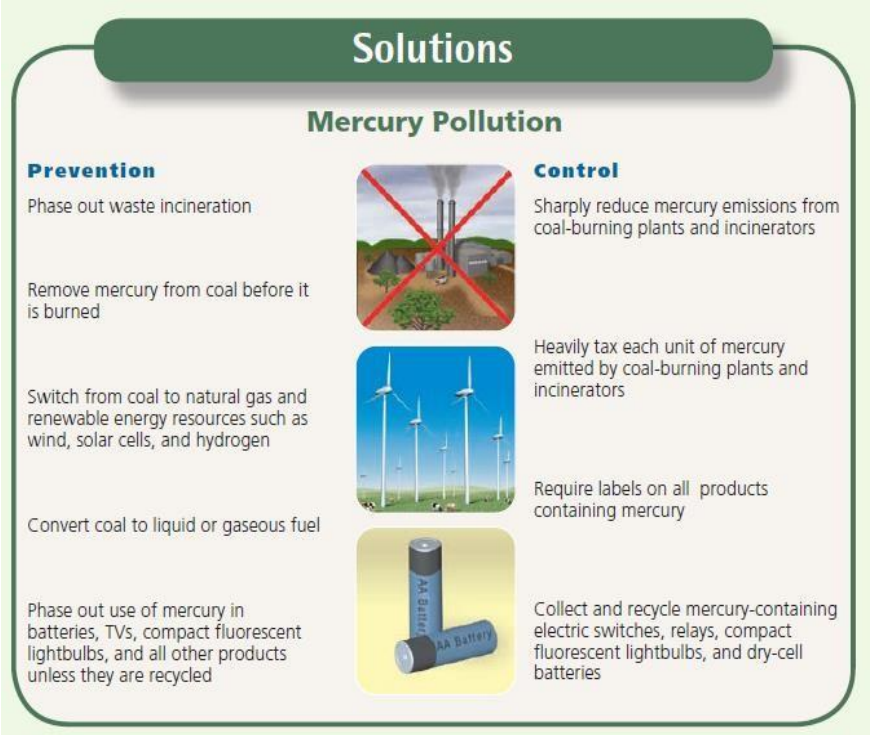
Mercury (Hg):

Hg and its compounds HgS and $HgCl_2$, methylmercury (CH_3Hg+) are all toxic. Research indicates that long- term exposure to high levels of mercury can permanently damage the human nervous system, brain function, kidneys, and lungs. fairly low levels of mercury can harm fetuses and cause birth defects.



The BPA Controversy:

Estrogen mimic is bisphenol A (BPA):

It is a chemical building block in certain hardened plastics (especially shatter-proof polycarbonate)

- Baby bottles
- Sipping cups
- Reusable water bottles
- Sports drink and juice bottles
- Microwave dishes
- Food storage containers
- Can liner in nearly all canned food
- Beverage products.

BPA adverse effects include brain damage, early puberty, prostrate disease, breast cancer, heart disease, liver damage, reduced sperm count, impaired immune function, type 2 diabetes, hyperactivity, increased aggressiveness, impaired learning, increased addiction to drugs such as amphetamines, decreased sex drive in males, and obesity in unborn test animals exposed to BPA

These ***hormone mimics are chemically similar to*** **female sex hormones called *estrogens.*** *In males, excess levels of* female hormones can cause feminization, smaller penises, lower sperm counts, and the presence of both male and female sex organs (**hermaphroditism**).

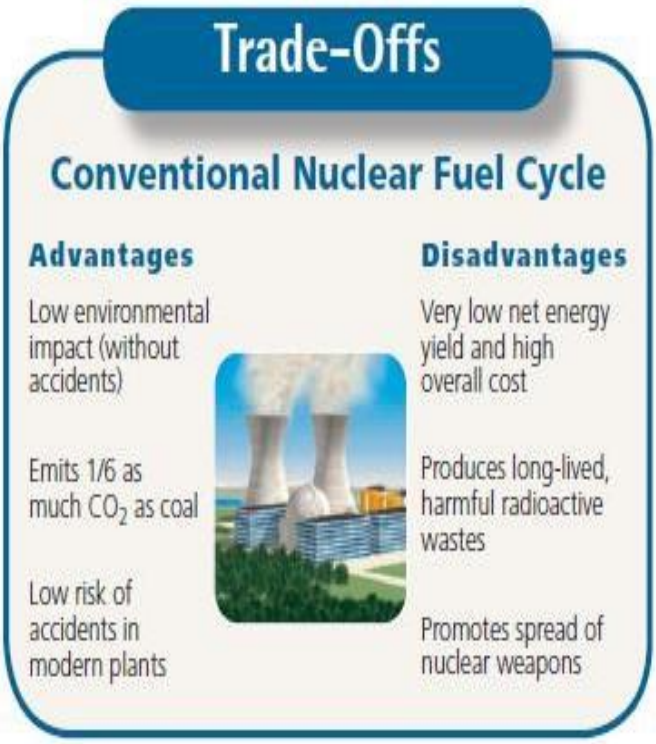
Poly Chlorinated Biphenyls (PCB):

PCB are a class of more than 200 chlorine-containing organic compounds that are very stable and non-flammable. Paints, fire retardants in fabrics, preservatives, adhesives, and pesticides. Soil, air, lakes, rivers, fish, birds, your body, and even the bodies of polar bears in the Arctic.

Phthalates:

Phthalates are used to soften **polyvinyl chloride (PVC)** plastic found in a variety of products and used as solvents in many consumer products. Phthalates are found in many perfumes, cosmetics, baby powders, body lotions, hair sprays, deodorants, nail polishes, and shampoos for adults and babies. They are also found in PVC products such as soft vinyl toys, teething rings, and blood storage bags, IV bags, and medical tubes used in hospitals. Phthalates has caused birth defects and liver cancer, kidney and liver damage, premature breast development, immune suppression, and abnormal sexual development.

Nuclear Hazard:

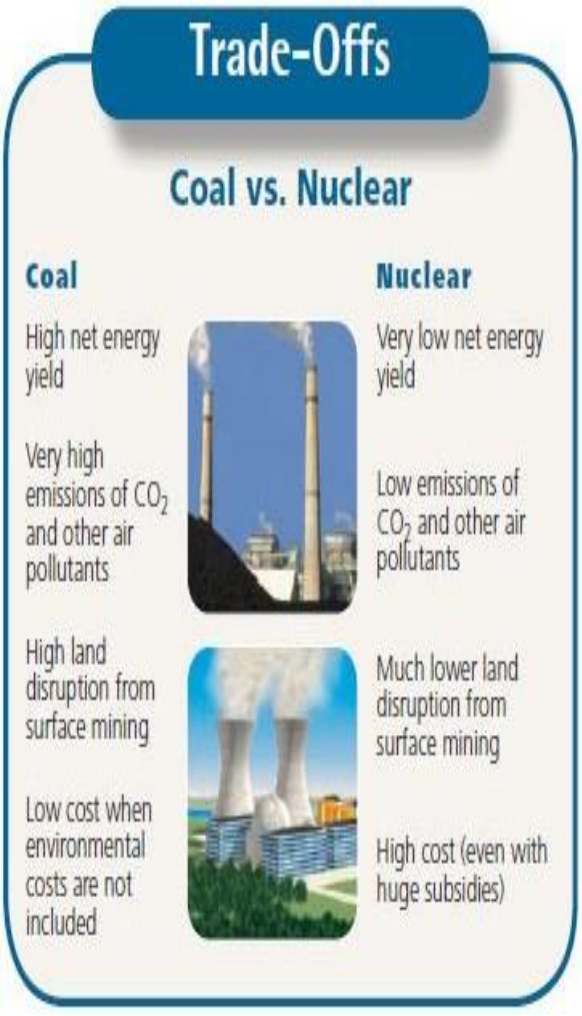


Nuclear power has a low environmental impact and a very low accident risk, but its use has been limited by a low net energy yield, high costs, fear of accidents, long-lived radioactive wastes, and the potential for spreading nuclear weapons technology.

Explosions and partial or complete meltdowns are possible, as we learned in 1986 from the serious accident at the Chernobyl nuclear plant in Ukraine.

By 2005, some 56 people had died prematurely from exposure to radiation released by the accident. The number of long-term premature deaths from the accident, primarily from exposure to radiation, range from 9,000 by World Health Organization estimates, to 212,000 as estimated by the Russian Academy of Medical Sciences, to nearly 1 million according to a 2010 study by Alexey Yablokov and two other Russian scientists, published by the New York Academy of Sciences.

High-level radioactive wastes consist mainly of spent fuel rods and assemblies from commercial nuclear power plants, the waste materials from dismantled plants, and assorted wastes from the production of nuclear weapons. They must be stored safely for at least 10,000 years and, by some estimates, up to 240,000 years if long-lived plutonium-235 is not removed from the wastes.



Risk - Assessment- Management:

Risk: -is the probability of suffering harm from a hazard that can cause injury, disease, death, economic loss, or damage.

Risk assessment: is the process of using statistical methods to estimate howmuch harm a particular hazard can cause to human health or to the environment.

Risk management: -involves deciding whether or how to reduce a particular risk to a certain level and at what cost.

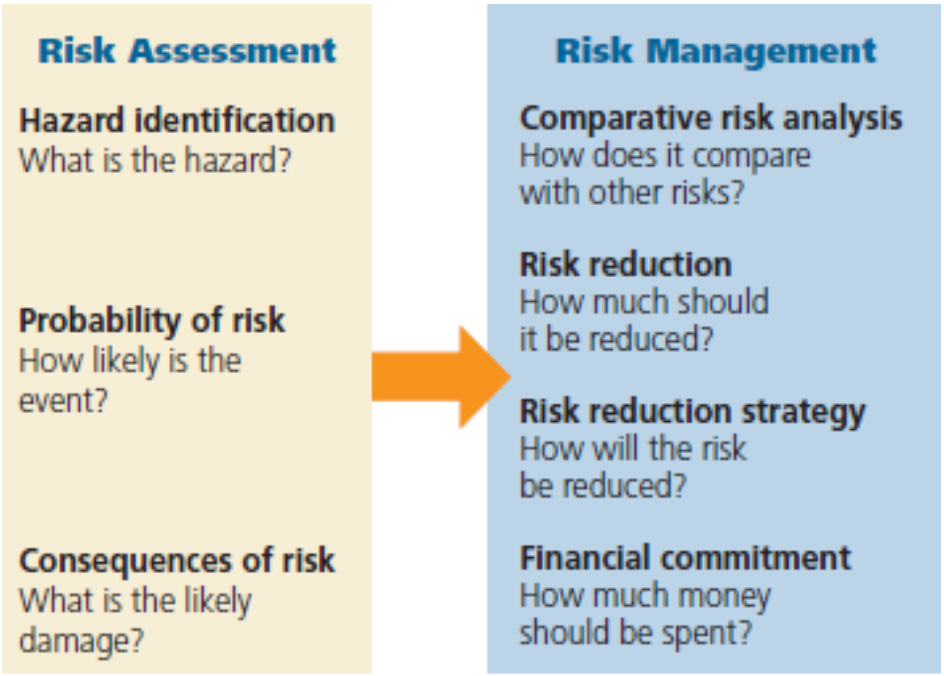


Figure 17-2 Science: Risk assessment and risk management are used to estimate the seriousness of various risks and how to reduce such risks. **Question:** What is an example of how you have applied this process in your daily living?

The overall ***reliability or the probability*** *(expressed as a* percentage) that a person, device, or complex technological system will complete a task without failing is the product of two factors:

System reliability (%) = Technology reliability (%) x Human reliability (%)

With careful design, quality control, maintenance, and monitoring, a highly complex system such as a nuclear power plant or space shuttle can achieve a high degree of technological reliability. But human reliability usually is much lower than technological reliability and is almost impossible to predict: To err is human.

Evaluating and avoiding Risks:

Scientists use live laboratory animals, case reports of poisonings, and epidemiological studies to estimate the toxicity of chemicals, but these methods have limitations. Because of the difficulty in evaluating the harm caused by exposure to chemicals, many health scientists call for much greater emphasis on pollution prevention. Becoming informed, thinking critically about risks, and making careful choices can reduce the major risks we face.

****

Water Pollutants:

Water pollution is any change in water quality that can harm living organisms or make the water unfit for human uses such as irrigation and recreation.

various infectious agents such as certain strains of coliform bacteria Escherichia coli, or E. coli

dissolved oxygen (DO), COD, BOD toxic heavy metals in the ocean.

Eutrophication is the natural nutrient enrichment of a shallow lake, estuary, or slowly moving stream. It is caused mostly by runoff of plant nutrients such as nitrates and phosphates from surrounding land.

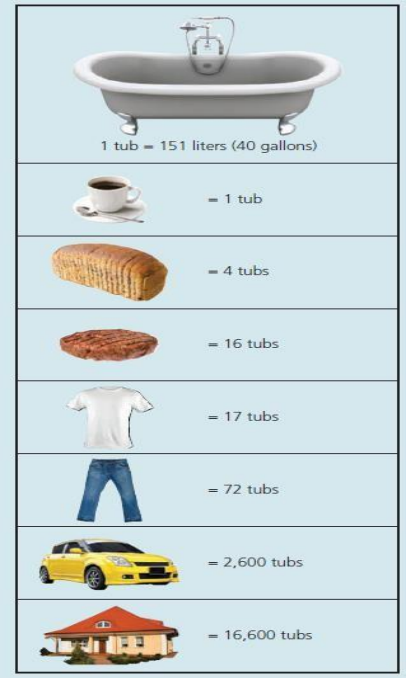
Near urban or agricultural areas, human activities can greatly accelerate the input of plant nutrients to a lake—a process called cultural eutrophication. Such inputs involve mostly nitrate- and phosphate-containing effluents from various sources.

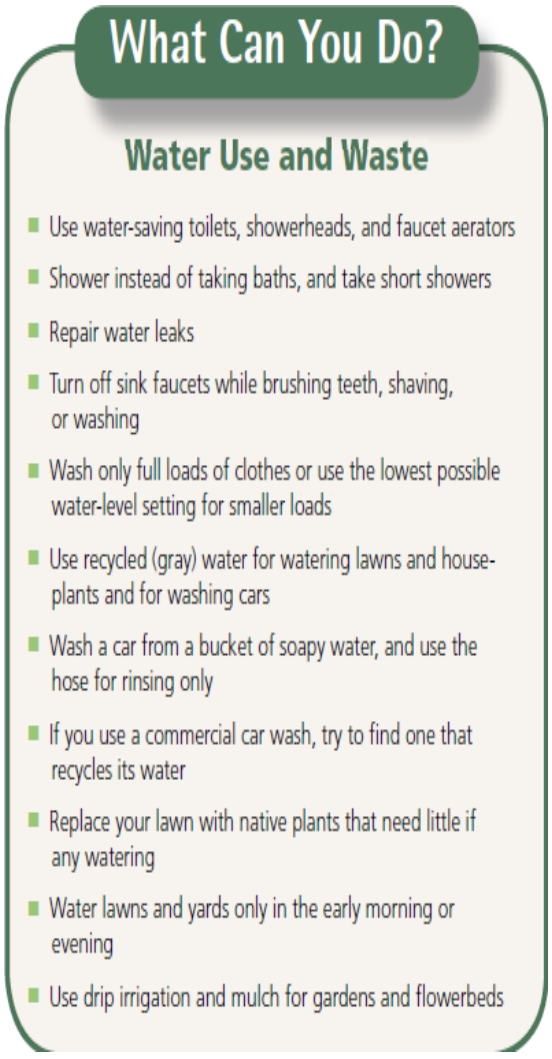
Water footprint:

- Water footprint, which is a rough measure of the volume of water that we use directly and indirectly to keep ourselves alive and to support our lifestyles.

- Water that is not directly consumed but is used to produce food and other products is called Virtual water, and it makes up a large part of our water footprints, especially in more-developed countries.

- Each of us can help to bring about a "blue revolution" and reduce our water footprints by using and wasting less water.





Solutions for Water crisis:

- Pollution Prevention to Protect Groundwater
- Protecting Watersheds Instead of Building Water Purification Plants
- Using Laws to Protect Drinking Water Quality
- Sewage Treatment to Reduce Water Pollution

Water conservation practices:

1. Decreasing run-off losses:

- Infiltration into the soil can reduce loss
- Contour cultivation
- Conservation bench terracing
- Water spreading – channeling, lagoon- leveling
- Chemical wetting agents like surfactants
- Chemical conditioners –Gypsum ($CaSO_4.2H_2O$)
- In Sodic soils – HPAN (hydrolysed
- polyacrylonitrile) improve permeability
- Water-storage structures – ponds, dug-outs

2. Reducing evaporation losses:

Some methods available

- Use of asphalt sheets below the soil
- Super slurper – copolymer of acrylonitrile and starch absorbs water upto 1400 times its weight
- Planting trees on the edges of fields

3. Storing water in soil:

- Some water is stored in soil in the root zone.
- If the land is left fallow for some time that water will become available

4. Reducing irrigation losses:

- Covered canals to reduce seepage
- Irrigation in early morning or evening
- Sprinklers
- Use of less water requiring hybrid varieties
- Drip irrigation

5. Reuse:

- Treated water can be reused
- Water from washings bath tubs etc (grey water) for watering gardens

6. Stop wastage:

- Close taps
- Repair leaks
- Use small capacity flush
-

7. Increase block pricing:

- Put a charge on water
- Introduce proper laws
- Educate people

Rainwater Harvesting:

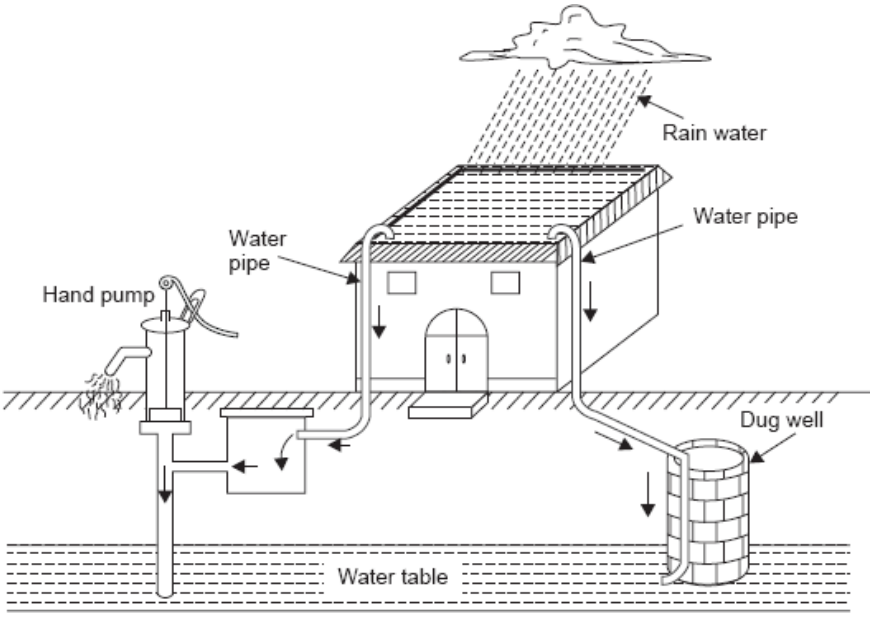
It is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by construction of special water harvesting structures like dug wells, percolation pits, lagoons, check dams etc.

- **Obectives**
  - Reduce run off loss
  - Avoid flooding of roads
  - Meet the increasing demands of water
  - Raise the water table
  - Reduce groundwater contamination
  - Supplement groundwater supplies during lean season

Methods of rainwater harvesting are

1. Storing in tanks or reservoirs above or below ground
2. Constructing pits, dug wells, lagoons trenches or check dams on rivers and streams
3. By recharging groundwater

Traditional rainwater harvesting:



In ancient India there were lakes and ponds in every village constructed by kings. In Rajasthan underground tanks and embankments were found. In Himalayan regions bamboo pipes were used to draw water from streams. Collecting rain water from roof-tops is one of the oldest techniques in India. In Villages Lake cut ponds were made. In Tamilnadu, they had separate such ponds for bathing, washing.

Solid waste:

Solid waste contributes to pollution and represents the unnecessary consumption of resources; hazardous waste contributes to pollution as well as to natural capital degradation, health problems, and premature deaths.

- **Industrial solid waste**
- **Municipal solid waste (MSW)**
- **Hazardous,** or **toxic waste**

- **A sustainable approach to solid waste is first to**
- **reduce it,**
- **then to reuse or**
- **recycle it, and**
- **finally to safely dispose of what is left.**

What Harmful Chemicals Are in Your Home?

Cleaning

- Disinfectants
- Drain, toilet, and window cleaners
- Spot removers
- Septic tank cleaners

Paint Products

- Paints, stains, varnishes, and lacquers
- Paint thinners, solvents, and strippers
- Wood preservatives
- Artist paints and inks

General

- Dry-cell batteries (mercury and cadmium)
- Glues and cements

Gardening

- Pesticides
- Weed killers
- Ant and rodent killers
- Flea powders

Automotive

- Gasoline
- Used motor oil
- Antifreeze
- Battery acid
- Brake and transmission fluid

Methods of Discarding Wastes

1. **Sanitary Land fill**
2. **Biocompost**
3. **Incineration**

Trade-Offs

Sanitary Landfills

Advantages

Low operating costs

Can handle large amounts of waste

Filled land can be used for other purposes

No shortage of landfill space in many areas

Disadvantages

Noise, traffic, and dust

Releases greenhouse gases (methane and CO_2) unless they are collected

Output approach that encourages waste production

Eventually leaks and can contaminate groundwater

Solid waste management –Priority:

First Priority

Primary Pollution and Waste Prevention

- Change industrial process to eliminate use of harmful chemicals
- Use less of a harmful product
- Reduce packaging and materials in products
- Make products that last longer and are recyclable, reusable, or easy to repair

Second Priority

Secondary Pollution and Waste Prevention

- Reuse
- Repair
- Recycle
- Compost
- Buy reusable and recyclable products

Last Priority

Waste Management

- Treat waste to reduce toxicity
- Incinerate waste
- Bury waste in landfills
- Release waste into environment for dispersal or dilution

What Can You Do?

Solid Waste

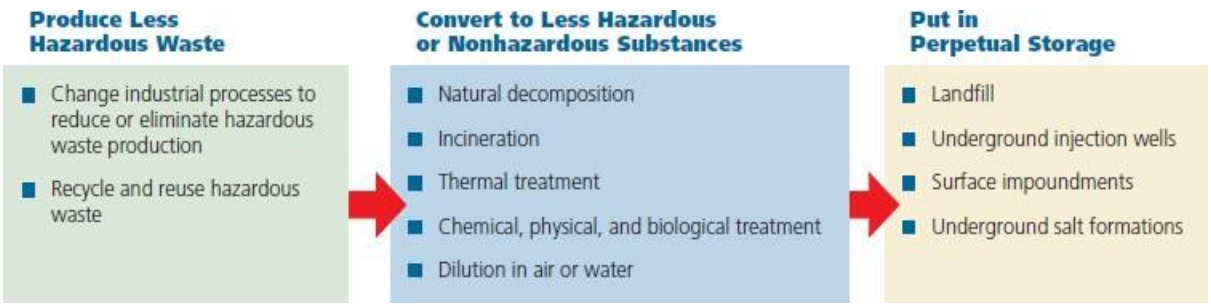
- Follow the three Rs of resource use: Reduce, Reuse, and Recycle
- Ask yourself whether you really need a particular item, and refuse packaging where possible
- Rent, borrow, or barter goods and services when you can, buy secondhand, and donate or sell unused items
- Buy things that are reusable, recyclable, or compostable, and be sure to reuse, recycle, and compost them
- Avoid disposables and do not use throwaway paper and plastic plates, cups, eating utensils, and other disposable items when reusable or refillable versions are available
- Use e-mail or text-messaging in place of conventional paper mail
- Read newspapers and magazines online and read e-books
- Buy products in bulk or concentrated form whenever possible

Trade-Offs

Recycling

Advantages	Disadvantages
Reduces energy and mineral use and air and water pollution	Can cost more than burying in areas with ample landfill space
Reduces greenhouse gas emissions	Reduces profits for landfill and incinerator owners
Reduces solid waste	Source separation inconvenient for some
Can save landfill space	

Hazardous waste:



Solutions:

Physical methods for detoxifying hazardous wastes:

Include using charcoal or resins to filter out harmful solids, distilling liquid wastes to separate out harmful chemicals, and precipitating, or allowing natural processes to separate, such chemicals from solution.

Chemical methods are used to convert hazardous:

Chemicals to harmless or less harmful chemicals through chemical reactions

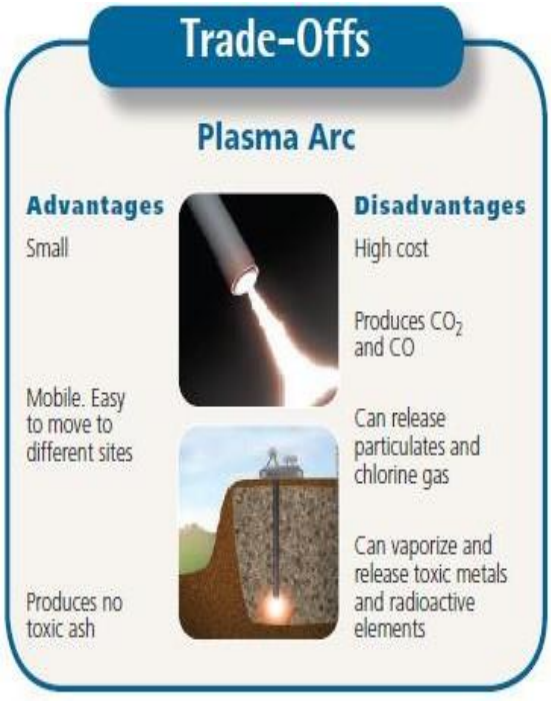
Nanomagnets:

Magnetic nanoparticles coated with certain compounds that can remove various pollutants from water.

Biological methods for treatment of hazardous waste:

- -bioremediation, in which bacteria and enzymes help to destroy toxic or hazardous substances, or convert them to harmless compounds.
- -phytoremediation, which involves using natural or genetically engineered plants to absorb, filter, and remove contaminants from polluted soil and water

Solution to solid waste:



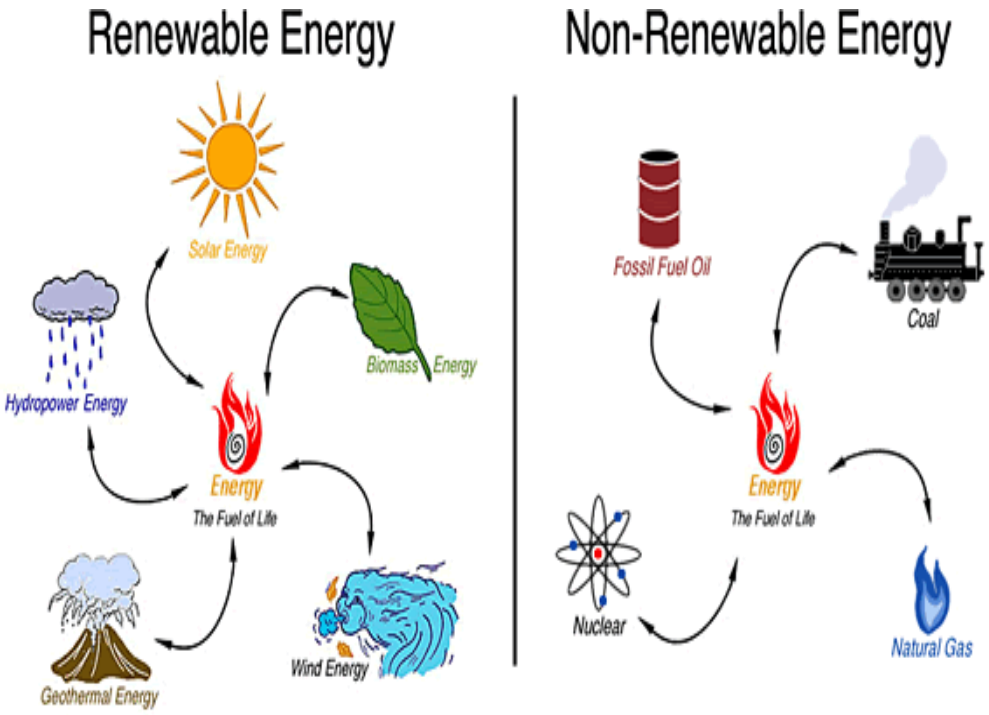
Module 3 -Important questions:

1. Infectious diseases are major health threats. There are number of ways to prevent or reduce the occurrence of infectious diseases. Do you think which four of the approaches are the most important? Why?
2. Enumerate the sources of solid waste. Discuss the various methods used to discard the solid waste with its merits and demerits.
3. List out possible domestic solid waste and Explain the available methods used for safe disposal of solid waste.
4. In future, municipal solid waste could become a source of energy in cities. Explain.
5. Describe the hazards caused by BPA, mercury and phthalates.
6. What kind of toxic substances present in soft drink canes or baby bottles that are responsible for the risk of health?
7. Distinguish the various types of water footprint, and write the challenges in conserving water at the present and comment on it.
8. Explain the available methods used for safe disposal of solid waste with neat diagrams.
9. Briefly discuss about the chemical hazard caused by the following compounds. 1.Thalidomide 2. polychlorinated biphenyl 3. Bisphenol A
10. How can we evaluate the chemical hazards? Mention the limitations associated with the methods to estimate the toxicity of chemicals?

Module – 4

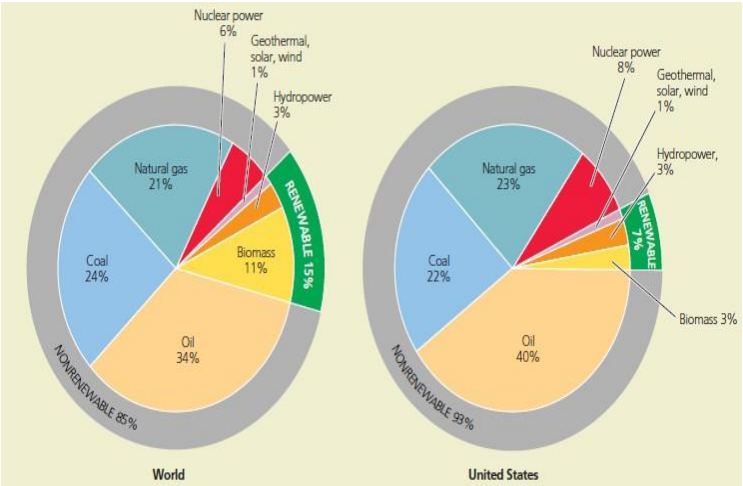
Energy Resources

- Renewable - Non-renewable energy resources-
- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy.
- Energy efficiency and renewable energy.
- Solar energy, Hydroelectric power, Ocean thermal energy,
- Wind and geothermal energy. Energy from biomass, solar-Hydrogen revolution.



Human Energy Use:

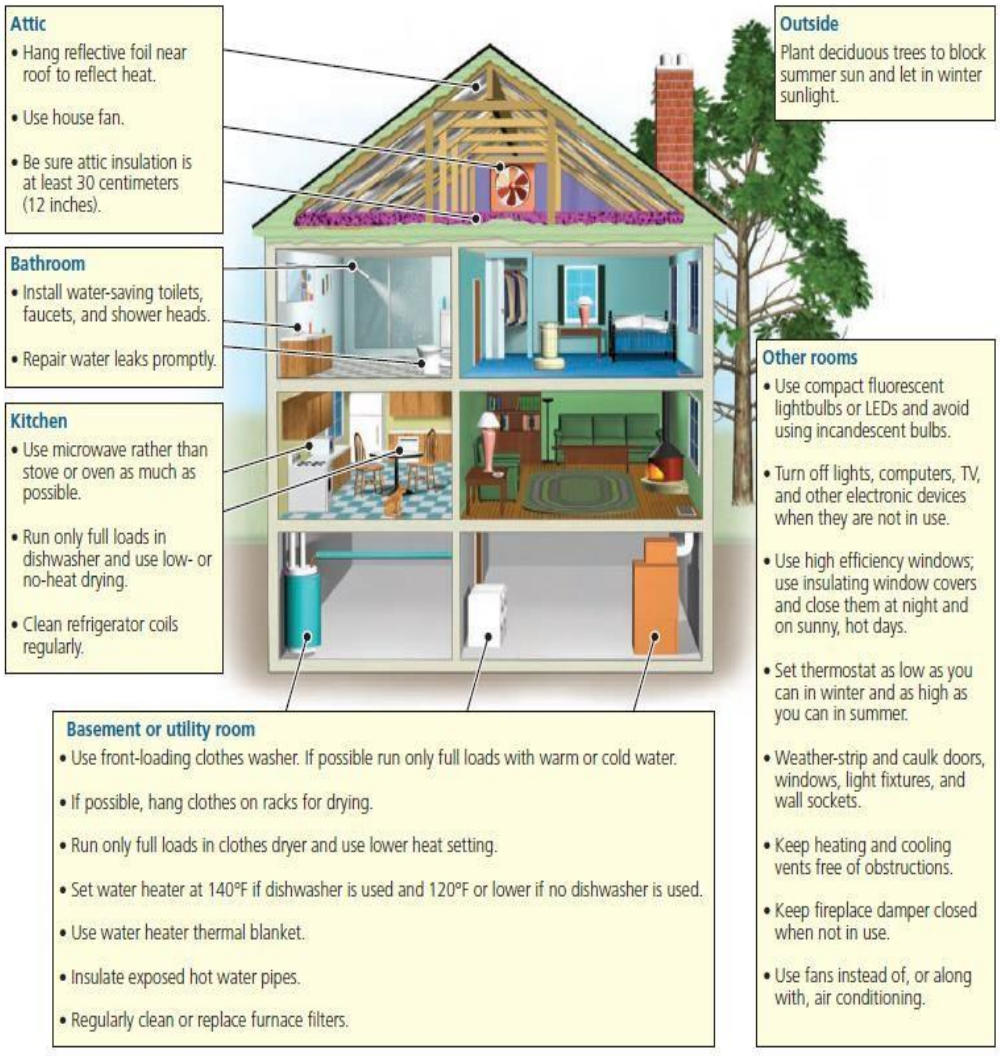
We get most of our energy by burning carbon-containing fossil fuels. Note that oil is the most widely use form of commercial energy and that about 79% of the energy used in the world. 85% of the energy used by the United States comes from burning non-renewable fossil fuels.



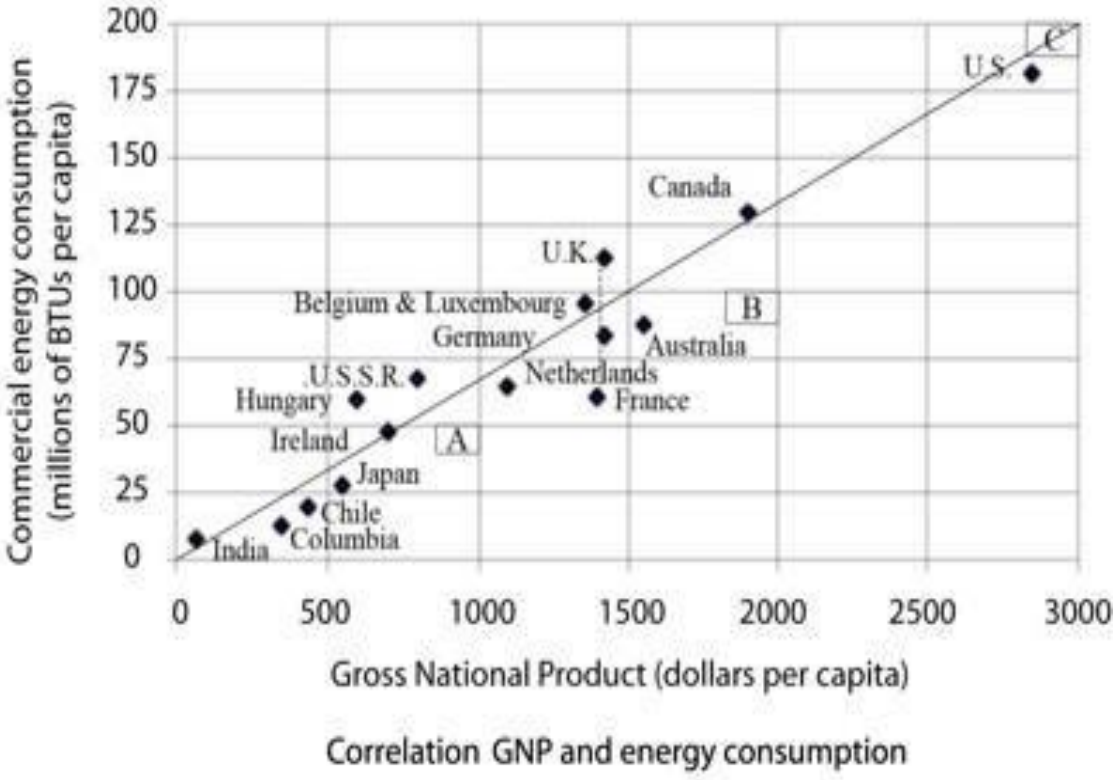
Net Energy:

Net energy is the amount of high-quality energy available from an energy resource minus the amount of energy needed to make it available. Net Energy Is the Only Energy That Really Counts. Energy Resources With Low or Negative Net Energy Yields Need Help to Compete in the Marketplace. Reducing Energy Waste Improves Net Energy Yields and Can Save Money.

What can you do for efficient energy consumption?



Per capita energy use and GNP:



Correlation GNP and energy consumption

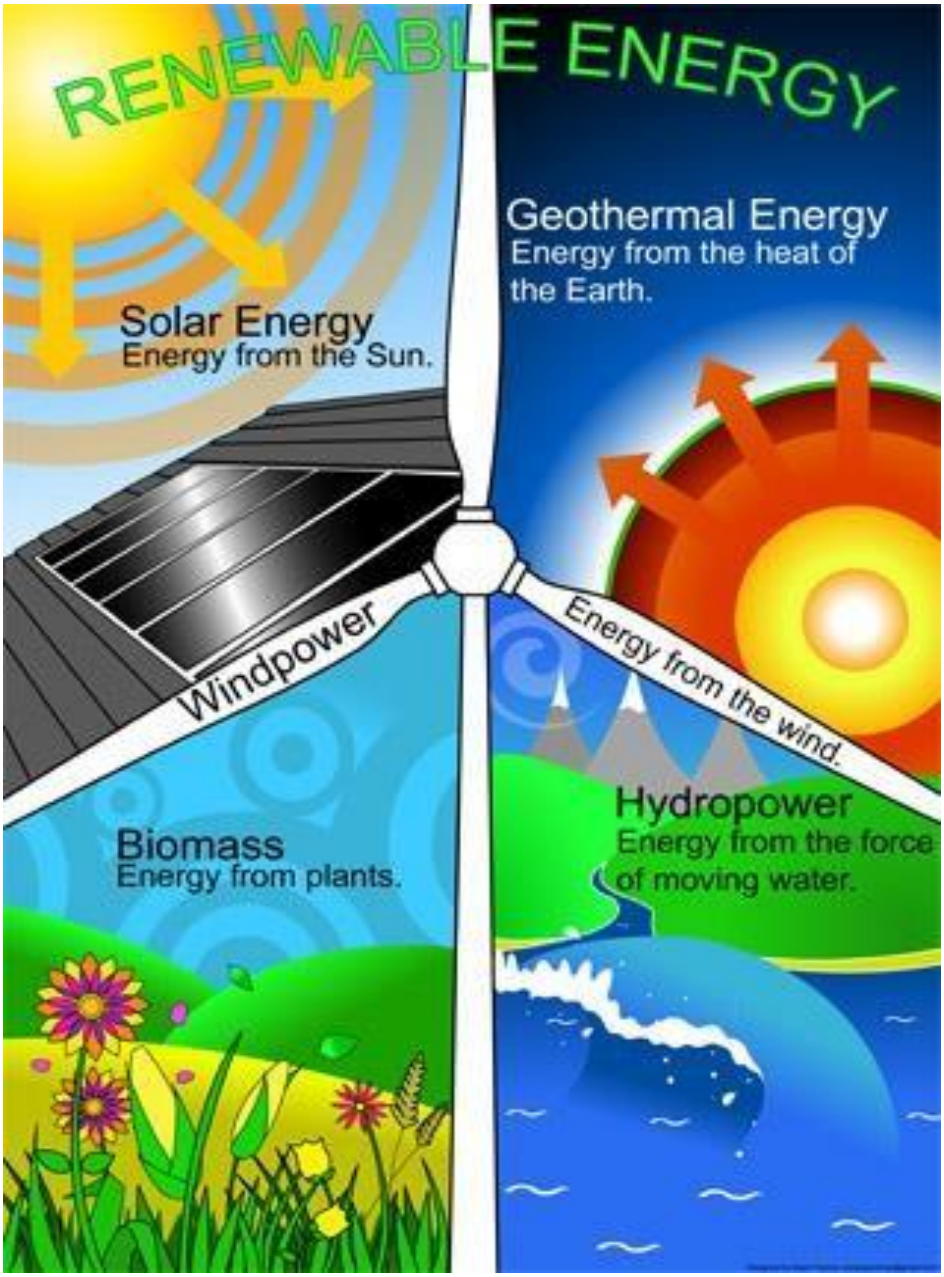
BTU = British thermal unit, (252 heat calories)
GNP = Gross National product

Renewable Energy Resources

- Solar Energy
- Wind Energy
- Hydropower
- Tidal energy
- Ocean Thermal Energy
- Geothermal Energy
- Biomass Energy
- Biogas
- Bio fuels
- Hydrogen as fuel

Non-Renewable Energy

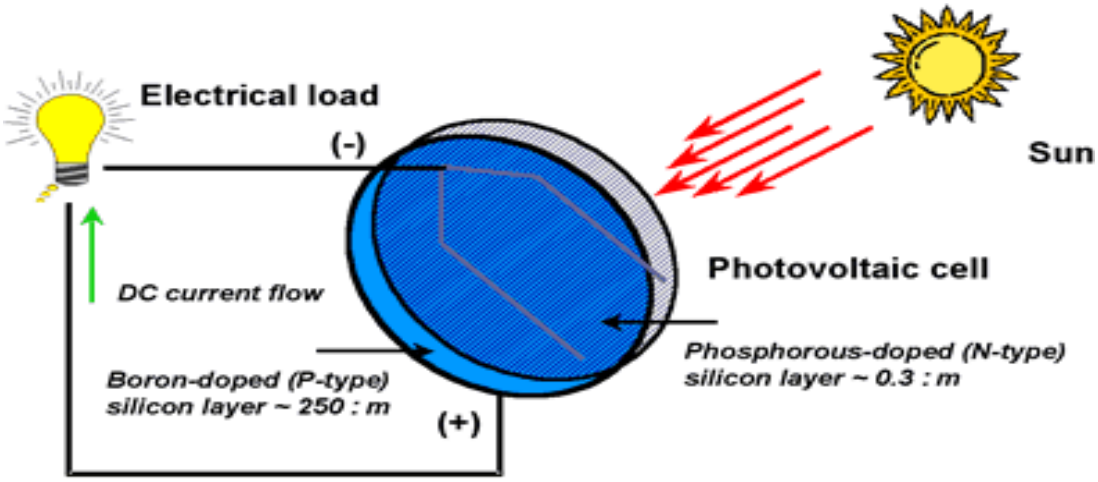
- Coal
- Petroleum
- Natural Gas
- Nuclear Energy



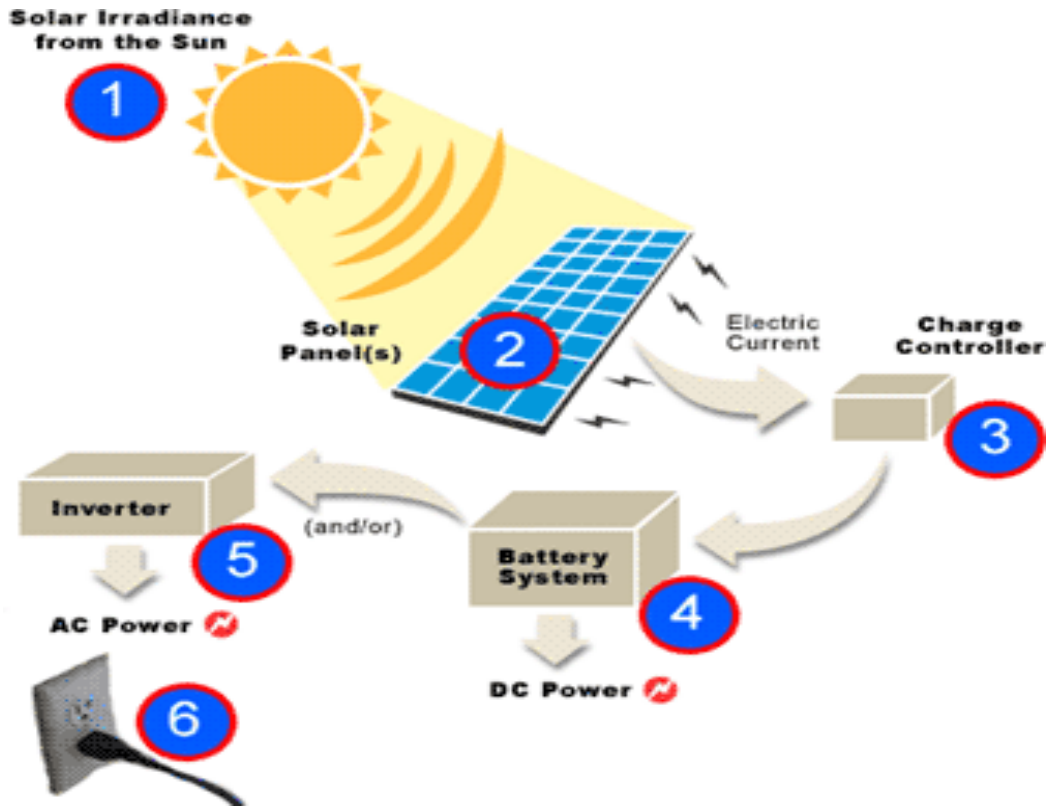
Solar Energy:

Sun is the ultimate source of energy. The nuclear fusion reaction occurring inside the sun release enormous quantities of energy in the form of heat and light. The solar energy received by the near earth space is approximately 1.4 kilojoules/Second/m^2 known as solar constant.

Solar Cells – Principle:



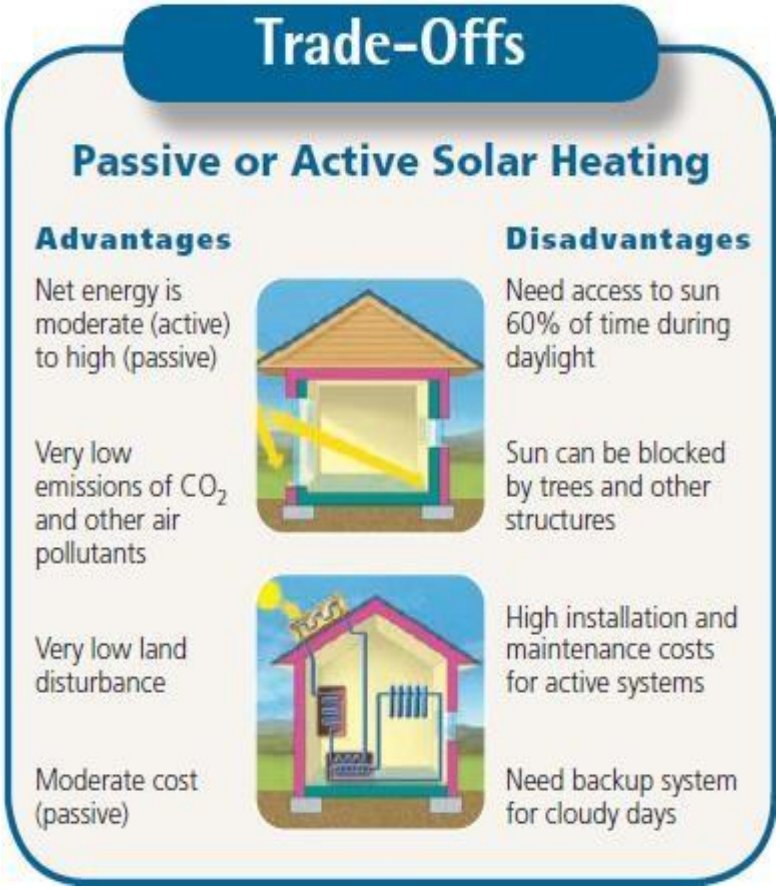
Photovoltaic cells. It is made up of thin wafers of semiconductor material like silicon or gallium. The potential difference produced by a single PV cell of 4 cm2 is about 0.4 to 0.5 volts and produce current of 60 milli amperes.



Solar Energy:

Passive and active solar heating systems can heat water and buildings effectively, and the costs of using direct sunlight to produce high temperature heat and electricity are coming down Passive solar heating systems - absorbs and stores heat from the sun directly within a well-insulated structure. Walls and floors of concrete, adobe, brick, or stone, and water tanks.

An active solar heating system - captures energy from the sun by pumping a heat absorbing fluid (such as water or an antifreeze



solution) through special collectors, usually mounted on a roof or on special racks to face the sun.

Sunlight to Produce Electricity:

-using photovoltaic (PV) cells, commonly called solar cells. Most solar cells are thin wafers of purified silicon (Si) or polycrystalline silicon with trace amounts of metals that allow them to produce electricity.

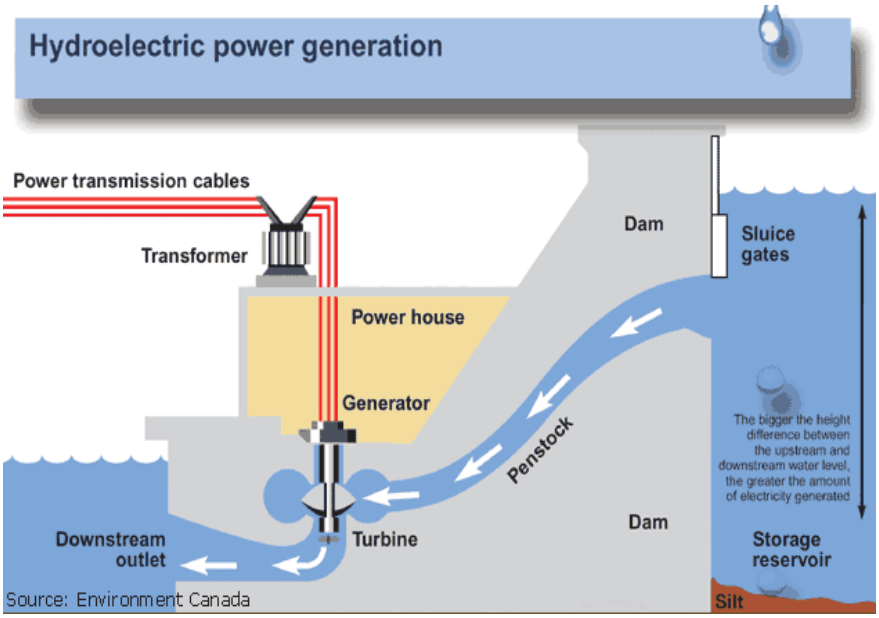
Solar thermal systems *use different methods to collect* and concentrate solar energy in order to boil water and produce steam for generating electricity

Hydropower Energy:

Electricity from Falling and Flowing Water:

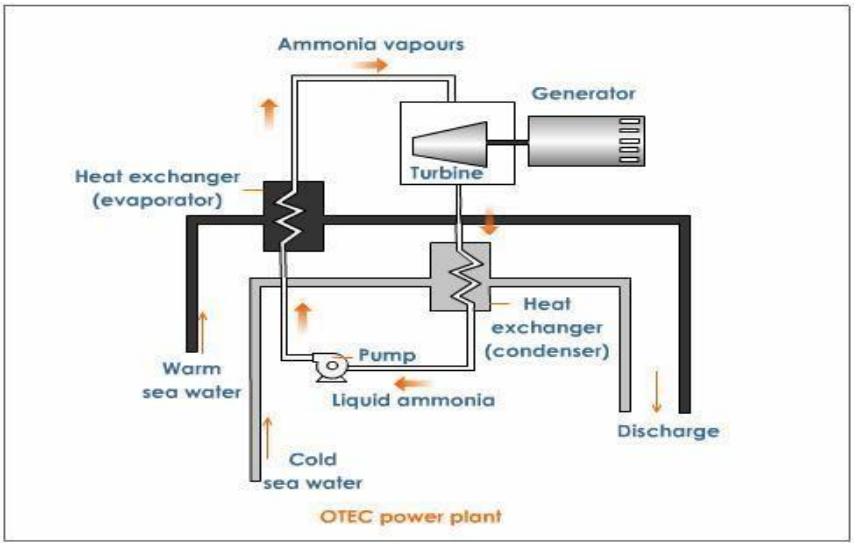
Hydropower uses the **kinetic energy of flowing and falling** water to produce electricity. A high dam across a large river to create a reservoir. Canada, China, Brazil, the United States, and Russia. Largest human-caused source of **methane**. **Microhydropower generators***:* produce electricity from flowing water by tapping into the energy from **ocean tides and waves.**

Hydropower:



Ocean Thermal Energy (OTE):

The energy available due to the difference in temperature of water at the surface of the tropical oceans and at the deeper levels is called ocean thermal energy. A difference of 20 °C or more is required. The warm surface water is used to boil liquid like ammonia. The colder water from the deep oceans is pumped to cool and condense the vapours of ammonia into liquid.



Wind Energy:

When we include the environmental costs of using energy resources in the market prices of energy, wind power is the least expensive and least polluting way to produce electricity.

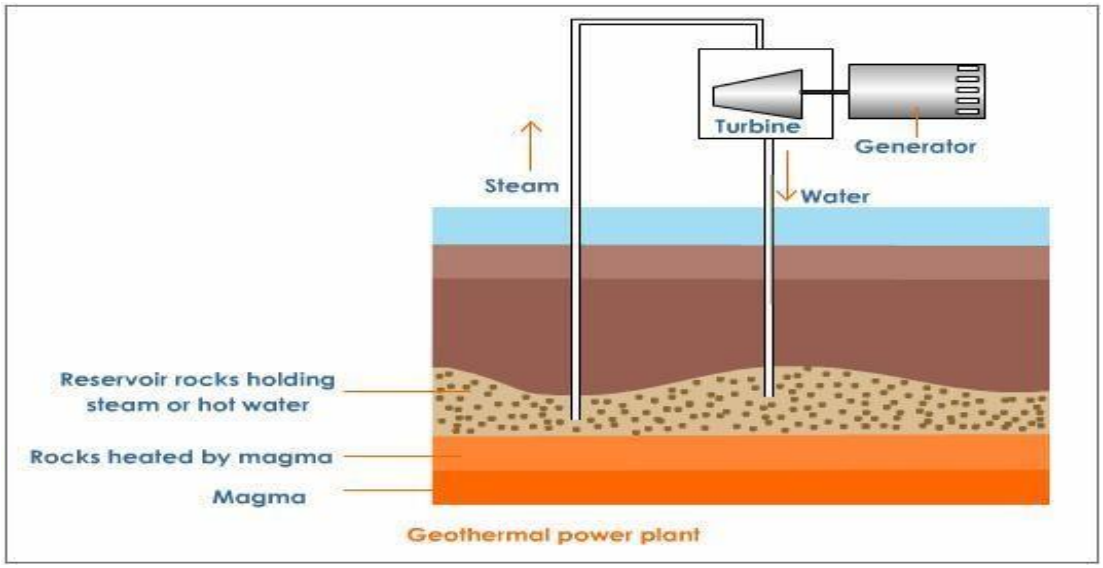
Wind to Produce Electricity- The differences in the angles of the sun's rays hitting the earth between the equator and the poles create different amounts of solar heating; together with the earth's rotation, this creates flows of air called *wind. We can capture this indirect form of* solar energy with **wind turbines** on land and at sea that convert it into electrical energy. Such wind turbines are being erected in large numbers at some sites to create **wind farms**. **Denmark**, the world's most energy-efficient country, gets 20% of its electricity. Largest wind-power producers in 2009 were **China, the United States, Germany, Spain, and India.** Minimum wind speed required **15 km/h.**

Wind Energy:

A large number of wind mills are installed in clusters called wind farms Ideal locations are coastal regions, open grasslands, mountain passes where the winds are strong and steady The minimum wind speed required for satisfactory working of wind mill is 15 km/hr. Wind potential of our country is about 20,000 MW, we are generating about 1020 MW. The largest wind farm of our country is near Kanyakumari in Tamilnadu generating 380 MW of electricity.

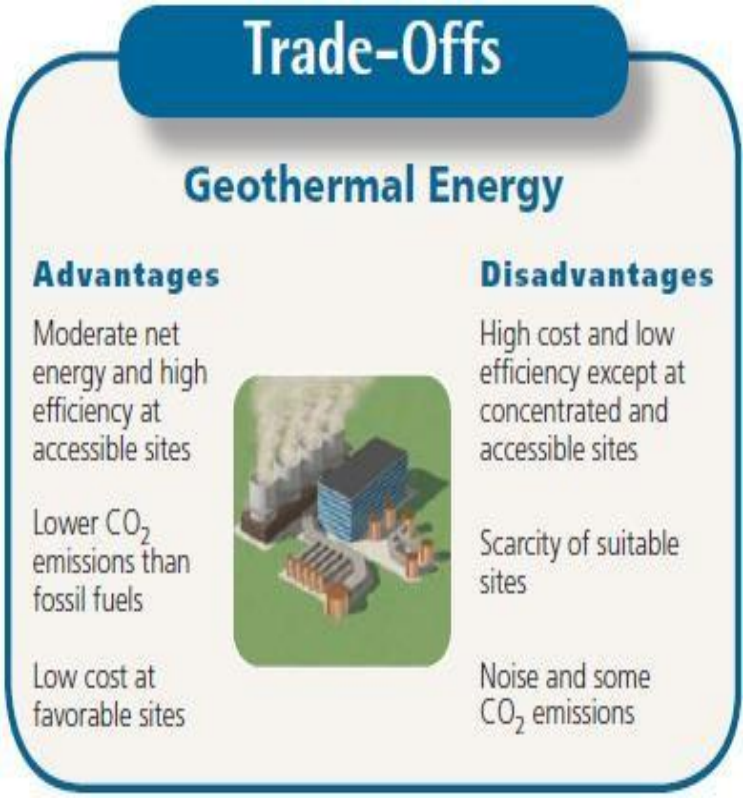
Geothermal Energy:

At places where there is superheated water below the earth's surface but steam remains trapped below the earth's surface, a different method is used. Two pipes are sunk into the earth. Through one pipe cold water is pumped which is then converted to steam and comes out through the other pipe as super heated steam and is used to rotate the turbines to generate electricity.- USA & NZ.



Geothermal Energy:

Geothermal energy is heat stored in soil, underground rocks, and fluids in the earth's mantle. Capture of geothermal energy is by using a *geothermal heat pump system. Hydrothermal reservoirs of geothermal energy. This is done* by drilling wells into the reservoirs to extract their dry steam (with a low water content), wet steam (with a high water content), or hot water, which are then used to heat homes and buildings.

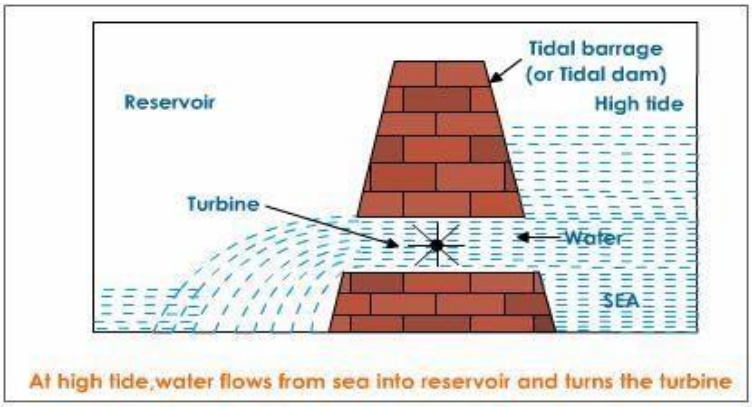


Tide Energy:

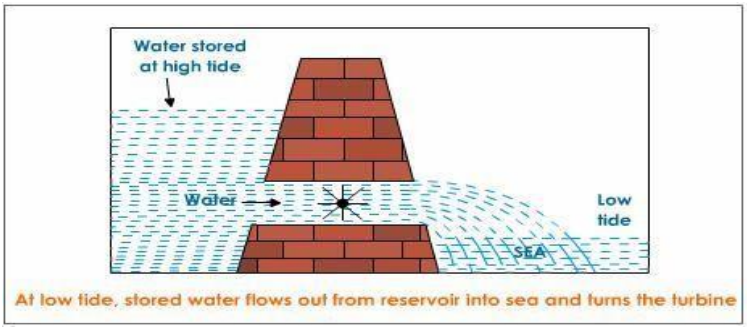
During high tide, when the level of water in the sea is high, sea-water flows into the reservoir of the barrage and turns the turbines. The turbines then turn the generator shaft to produce electricity.

During low tide, the sea-water stored in the barrage reservoir is allowed to flow out into the sea. This flowing water also turns the turbines and generates electricity.

There are only few sites in the world where tidal energy can be suitably harnessed. Bay of fundy, Canada La Rance, France Gulf of cambay, gulf of kutch and sunderban deltas in India.



At high tide,water flows from sea into reservoir and turns the turbine



At low tide, stored water flows out from reservoir into sea and turns the turbine

Biomass Energy:

Biomass is the organic matter produced by the plants or animals which includes wood, crop residues, cattle dung, sewage, agricultural wastes. Energy plantation; Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. Fast growing trees like cottonwood, poplar, crop plants like sugarcane are some of the important energy plantation. Petro-crops;Certain latex-containing plants like euphorbias and oil palms are rich in hydrocarbons can yield an oil like substance at high emperature and pressure. This oily material may be burnt in diesel engines directly or may be refined to form gasoline. Agrircultural and urban waste biomass: Crop residues, sugarcane residue, coconutshell etc., are some of the common agricultural wastes which produces nergy by burning. In rural areas these forms of waste biomass are burned in open furnaces called chulhas (efficiency < 8%)

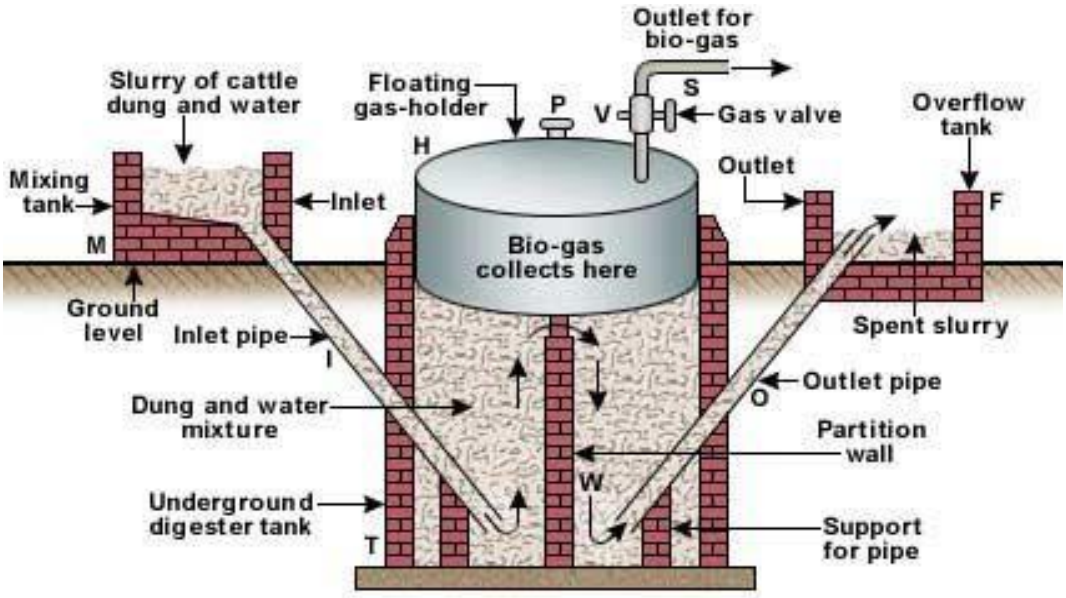
Biogas:

Biogas is a mixture of methane, carbon dioxide, hydrogen sulphide, major constituent being methane. It is produced by anaerobic degradation of animal waste in presence of water It is non-polluting, clean and low cost fuel Useful in rural areas since lot of animal waste is available India has the largest cattle population in the world (240 million).

Advantages:

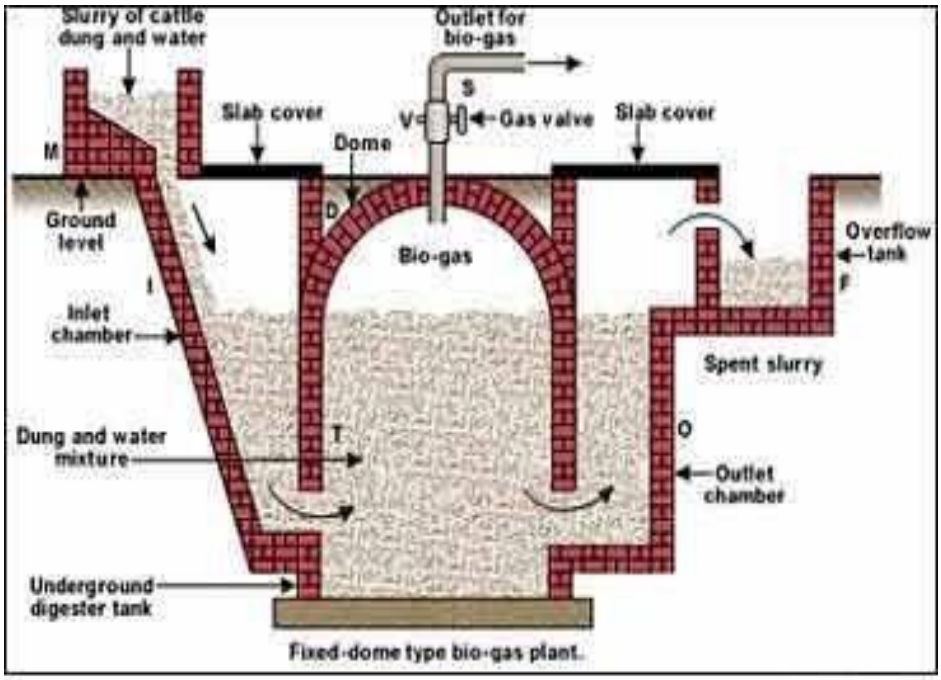
It is clean, non polluting and cheap. No storage problem since it is directly supplied from plant. The sludge left over is rich fertilizer.

Floating gas holder type biogas plant:



Floating gas-holder type bio-gas plant.

Fixed dome type biogas plant:



Fixed-dome type bio-gas plant.

Instead of steel gas holder there is dome shaped roof made of cement and bricks.

Biofuels:

Ethanol: It can be easily produced from carbohydrate rich substance like sugarcane, corn. It burns clean non-polluting.

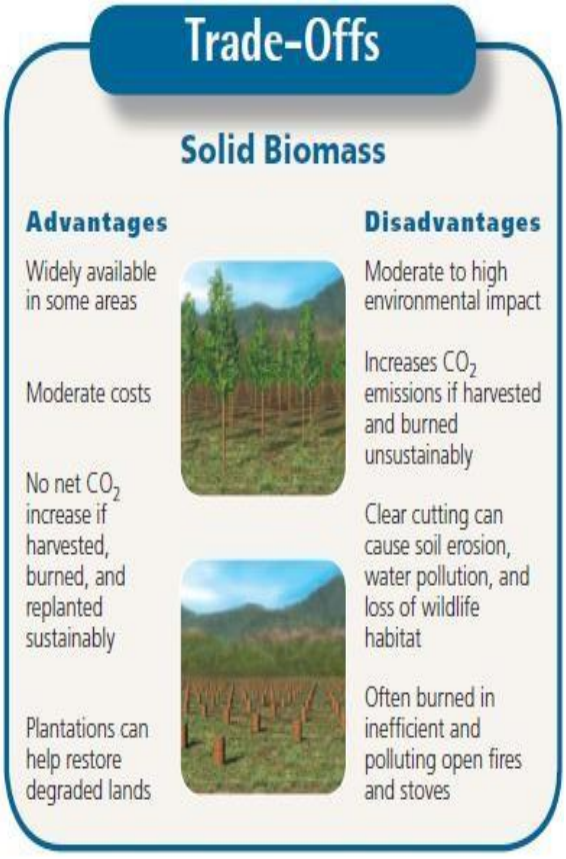
Gasohol: It's a mixture of ethanol and gasoline. Common fuel in brazil and Zimbabwe.

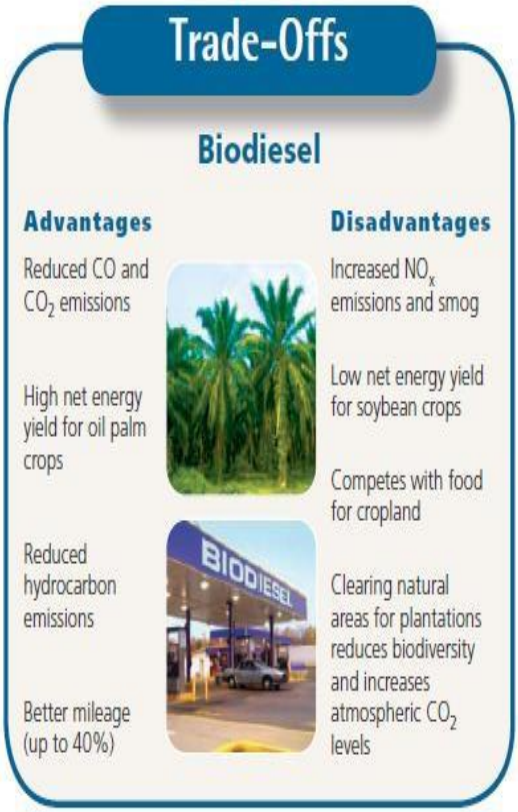
Methanol: Methanol can be easily obtained from woody plants. It is very useful since it burns at lower temperature than diesel and gasoline.

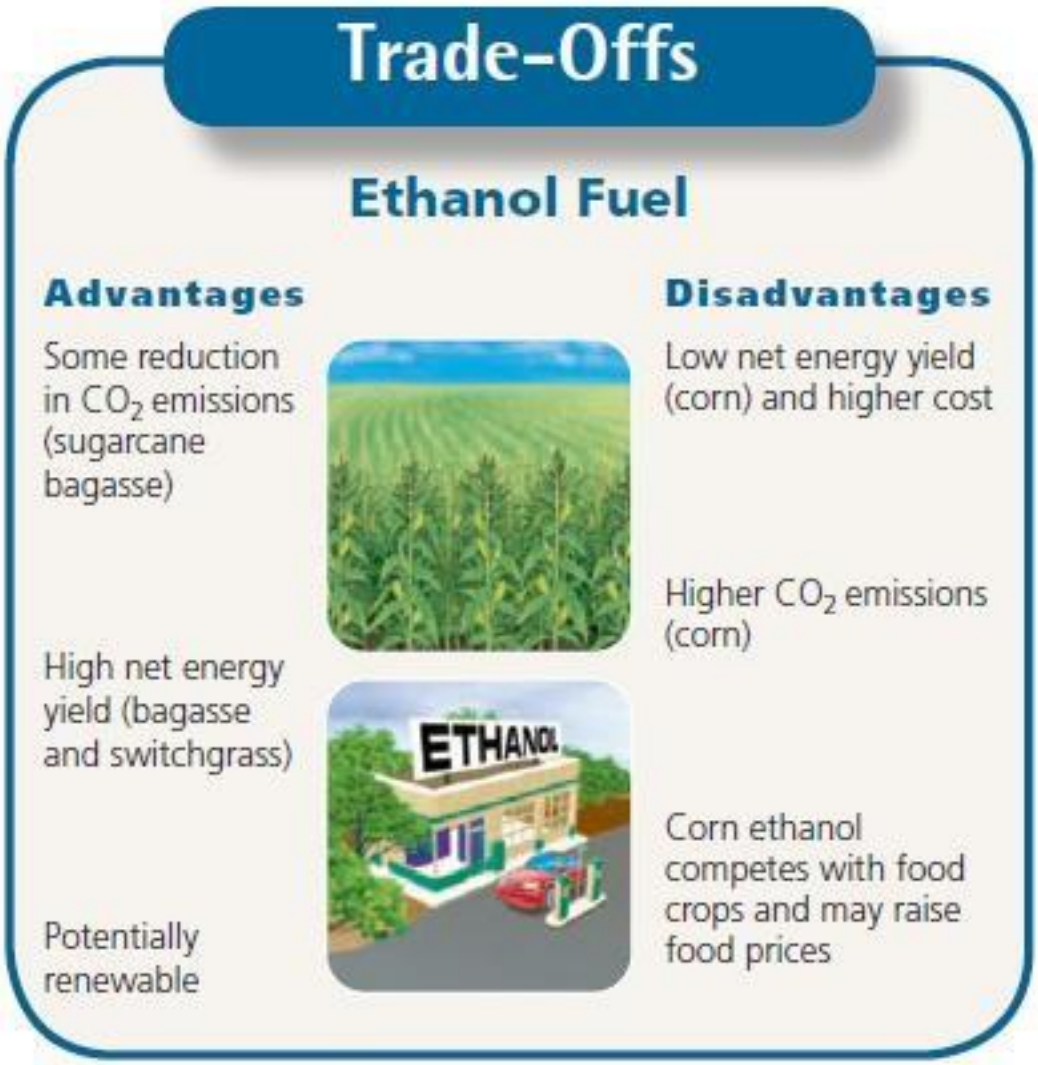
Biomass energy:

Solid biomass is a renewable resource for much of the world's population, but burning it faster than it is replenished produces a net gain in atmospheric greenhouse gases, and creating biomass plantations can degrade soil and biodiversity.

Biomass consists of plant materials (such as wood and agricultural waste) and animal wastes that we can burn directly as a solid fuel or convert into gaseous or liquid biofuels. crop residues (such as sugarcane and cotton stalks, rice husks, straw, corn cobs, and coconut shells) and animal manure can be collected and burned. Cottonwoods, willows, and poplars, and by growing shrubs, perennial grasses such as switchgrass, and water hyacinths in biomass plantations. Liquid biofuels such as biodiesel (produced from vegetable oils) and ethanol (ethyl alcohol produced from plants and plant wastes).







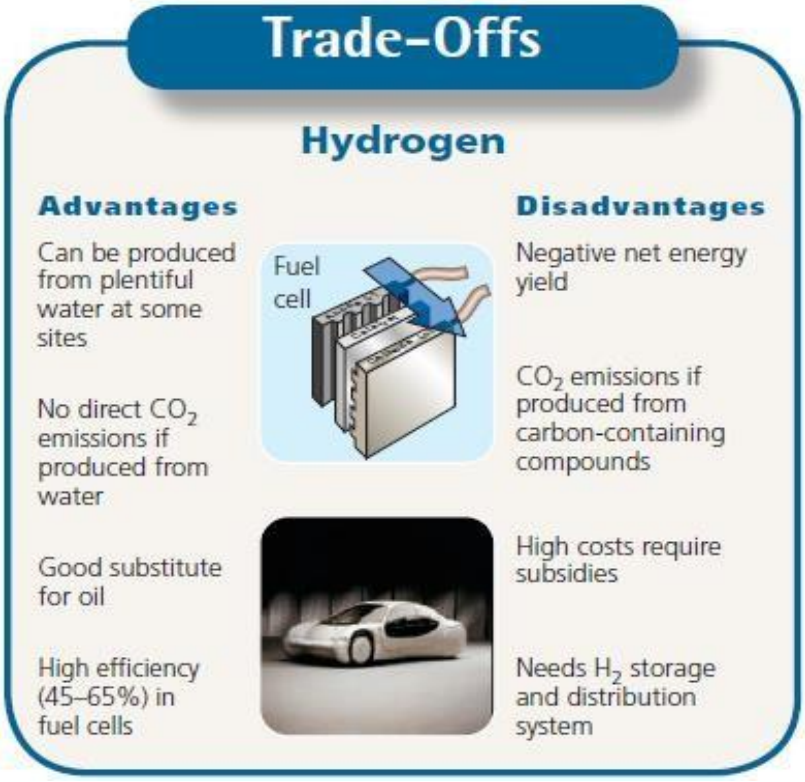
Hydrogen as fuel:

Due to highest calorific values it can serve as an excellent fuel. By thermal dissociation of water (at 3000 K and above). It is produced by chemical reaction of water with some other chemicals in 2-3 cycles. Electrolytic method dissociate water to hydrogen and oxygen by making current flow through it. Photolysis of water involves breakdown of water in the presence of sunlight to release hydrogen.

Hydrogen Fuel:

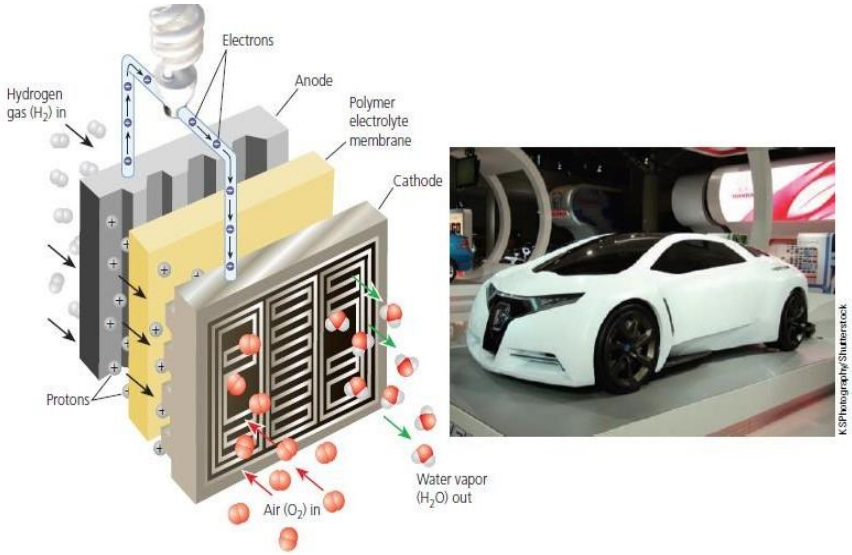
Hydrogen fuel holds great promise for powering cars and generating electricity, but for it to be environmentally beneficial, we would have to produce it without using fossil fuels. The sun produces its energy, which sustains life on the earth, through the nuclear fusion of hydrogen atoms. Fuel cells that combine H2 and oxygen gas (O_2) to produce electricity and water vapor ($2\ H_2 + O_2$ to $2\ H_2O$ + energy), which is emitted into the atmosphere. H_2 also provides more

energy per gram than any other fuel, therefore a lightweight fuel ideal for aviation. It is a fuel produced by using other forms of energy, and thus has a negative net energy yield. Fuel cells are best way to use H_2 to produce electricity, but current versions are expensive. Electricity from coal-burning and nuclear power plants to produce H_2 would add much more CO_2 to the atmosphere per unit of heat generated than does burning carbon-containing fuels directly.



H_2 could be used as fuel if it is made with electricity produced by low- polluting, renewable sources (Solar/ wind) that emit little or no CO_2. The basic ideas of a solar-hydrogen energy scheme are first that solar energy should be collected where it is most available. The electricity from solar panels thus obtained, would be used to electrolyze water. The H_2 from the electrolysis would be pumped up and piped to distant places.

A fuel cell takes in hydrogen gas and separates the hydrogen atoms' electrons from their protons. The electrons flow through wires to provide electricity, while the protons pass through a membrane and combine with oxygen gas to form water vapor. Note that this process is the reverse of electrolysis, the process of passing electricity through water to produce hydrogen fuel.



NON - Re - NEW - a - ble

NOT Able to be NEW again

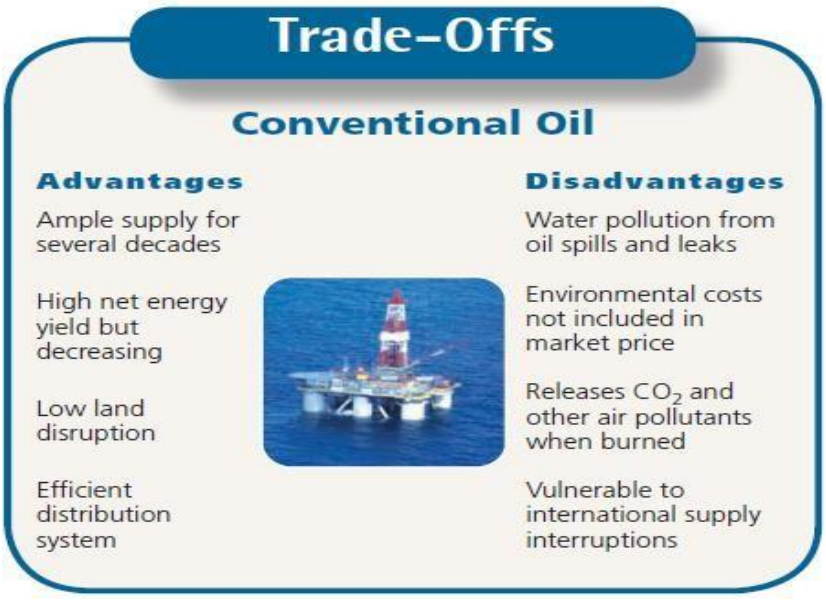
Petroleum, or crude oil (oil as it comes out of the ground), is a black, gooey liquid consisting of hundreds of different combustible hydrocarbons along with small amounts of sulfur, oxygen, and nitrogen impurities.

Oil supplies about one-third of the world's commercial Energy. We use oil to grow most of our food, transport people and goods, and make most of the things we use every day. The products of crude oil distillation, called petrochemicals, are used as raw materials in industries.

Conventional oil is currently abundant, has a high net energy yield, and is relatively inexpensive, but using it causes air and water pollution and releases greenhouse gases to the atmosphere. Heavy oils from tar sand and oil shale exist in potentially large supplies but have low net energy yields and higher environmental impacts than conventional oil has.

Petroleum:

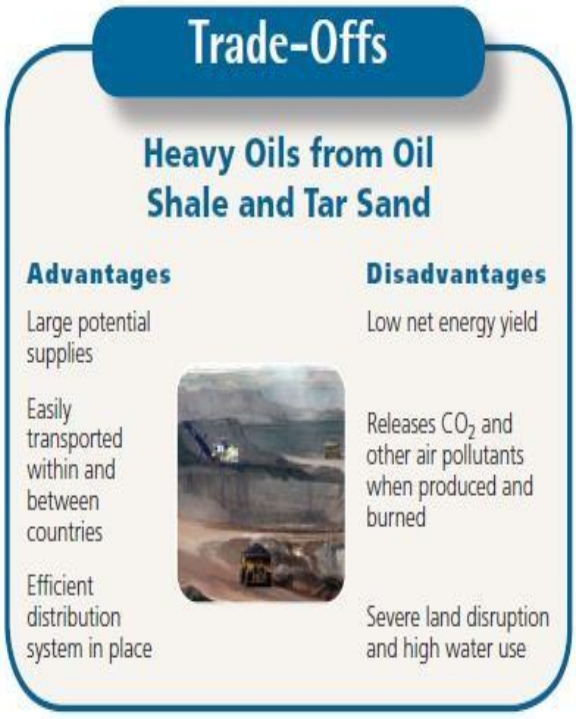
Saudi Arabia has the largest portion of the world's conventional proven crude oil reserves (20%). Saudi Arabia, with the world's largest proven conventional crude oil reserves, could supply the world's entire oil needs for only about 7 years. Get exhausted in 40 years.



Tar Sand and Oil Shale:

Heavy Oil from Tar Sand or oil sand:

-is a mixture of clay, sand, water, and a combustible organic material called bitumen- a thick, sticky, tarlike heavy oil with a high sulfur content.



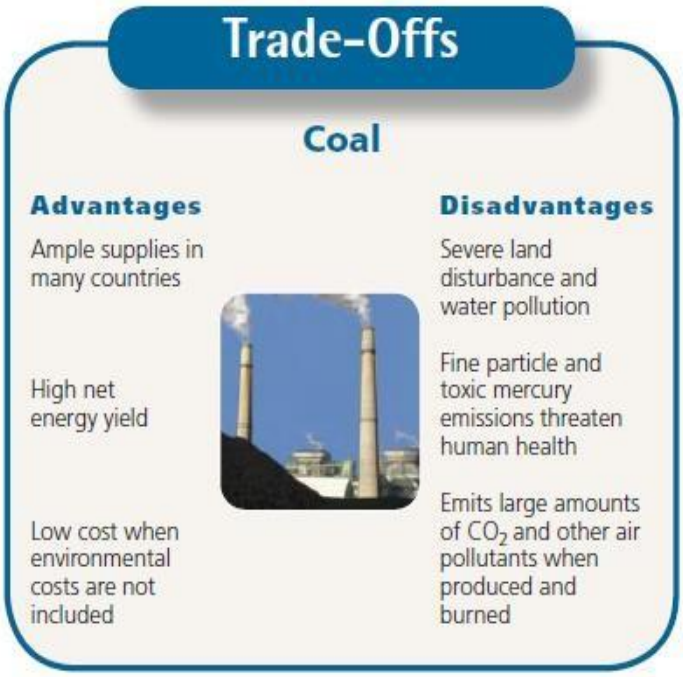
Oil Shale: Oily rocks are another potential supply of heavy oil. Such rocks, called oil shales, contain a solid combustible mixture of hydrocarbons called kerogen. It is extracted from crushed oil shales after they are heated in a large container-a process that yields a distillate called shale oil.

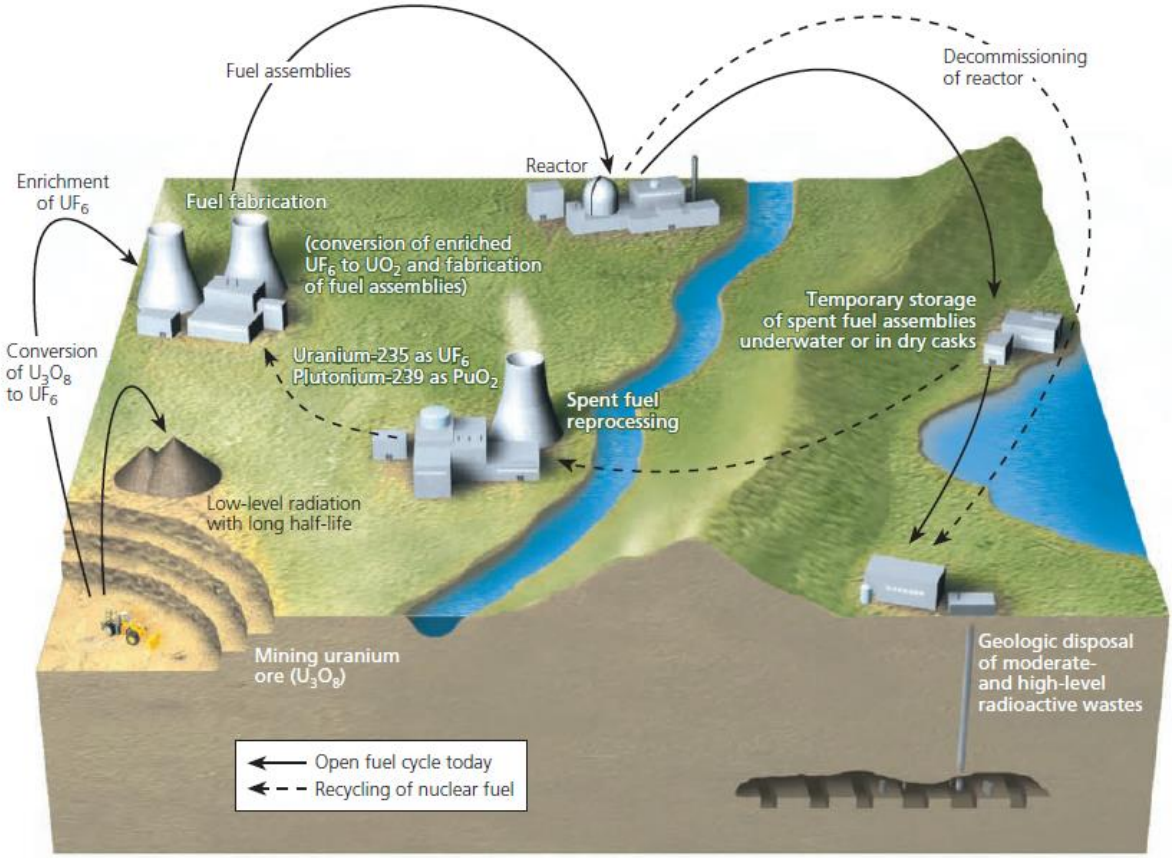
Liquefied petroleum Gas (LPG):

The main component of petrol is butane, the other being propane and ethane. Under pressure petroleum is converted to LPG. It is odourless. In domestic gas cylinders ethyl mercaptan, a foul smelling gas, is added. In India at Digboi (Assam), Gujaratplains, Bombay high, deltaic coasts of Godhavari, Krishna, Kaveri and Mahanadhi.

COAL:

Coal was formed 350 million years ago in the hot, damp regions of the earth during the carboniferous age. Anthracite [hard coal, 90% carbon, 8700 kcal/kg). Bituminous [Soft coal, 80% carbon]. Lignite [Brown coal, 70% carbon]. The coal reserves are likely to last for about 200 years, if the use increased by 2% per year, then it will last for another 65 years India has 5% of world's coal and Indian coal is not very good in terms of heat capacity Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli, Godavari valley The coal state of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andrhra pradesh, Maharashtra.





Trade-Offs

Conventional Nuclear Fuel Cycle

Advantages

Low environmental impact (without accidents)

Emits 1/6 as much CO_2 as coal

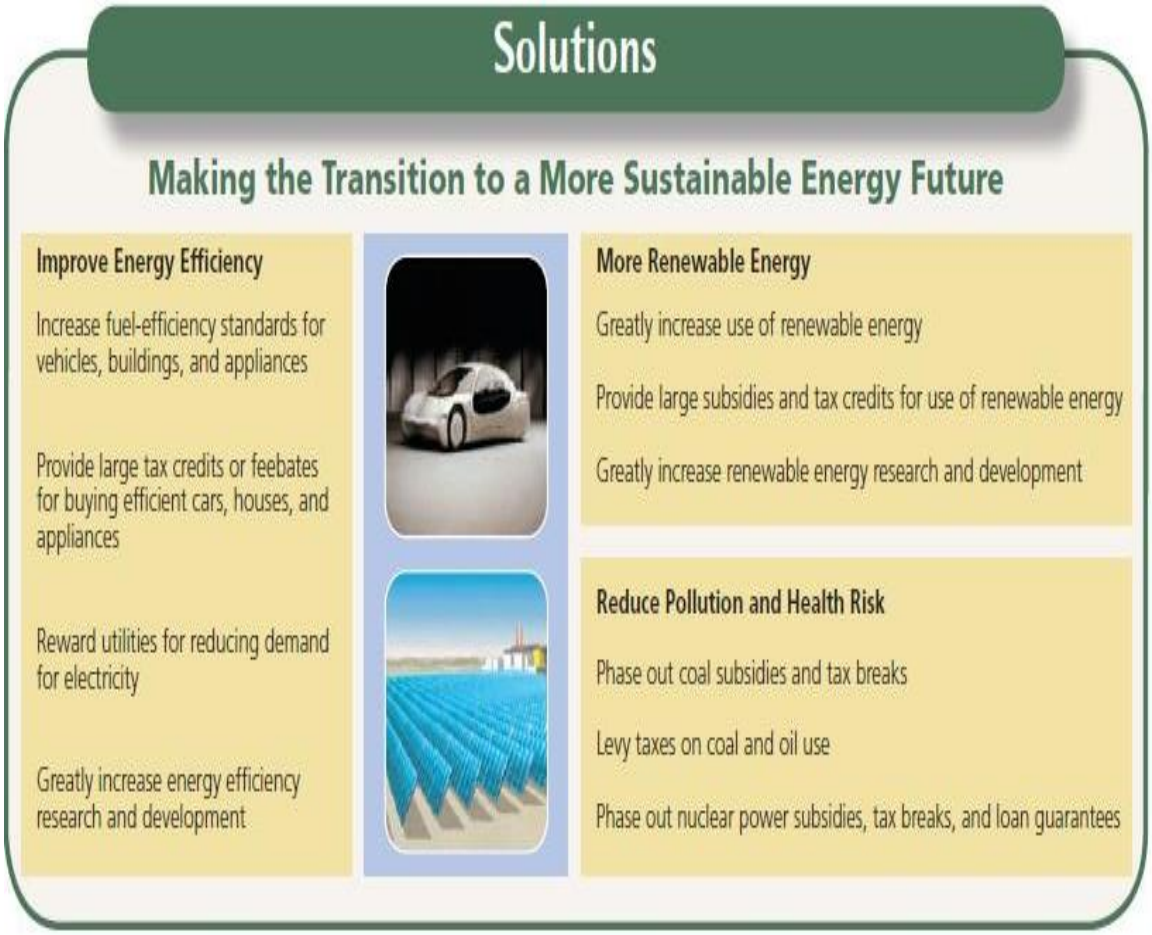
Low risk of accidents in modern plants

Disadvantages

Very low net energy yield and high overall cost

Produces long-lived, harmful radioactive wastes

Promotes spread of nuclear weapons



Module 4- Important questions:

1. Describe in detail the renewable energy resources are harnessed from ocean.
2. Recommend any three renewable energy techniques in detail which can meet the present and future India's energy demand.
3. Suggest some green alternative fuels which could be produced using plant matter, and water and mention their advantages and disadvantages.
4. Write a note on solid waste classification and management methods.
5. Explain the role of water electrolysis in Solar-Hydrogen revolution.
6. Bring out the differences between active solar energy and passive solar energy.
7. Write the advantages and disadvantages of nuclear energy.
8. Recommend any three renewable energy techniques in detail which can meet the present and future India's energy demand.
9. What are PV cells? Mention its application in terms of renewable energy resource harnessing device.
10. List out the ideal locations to install the windmill for wind energy. Write its merits and demerits compared with other renewable energy resources.

Module 5

Environmental Impact Assessment

- **Introduction to environmental impact analysis**
- **EIA guidelines**
- **Notification of Government of India**

Environmental Protection Act – Air, water, forest and wild life Act

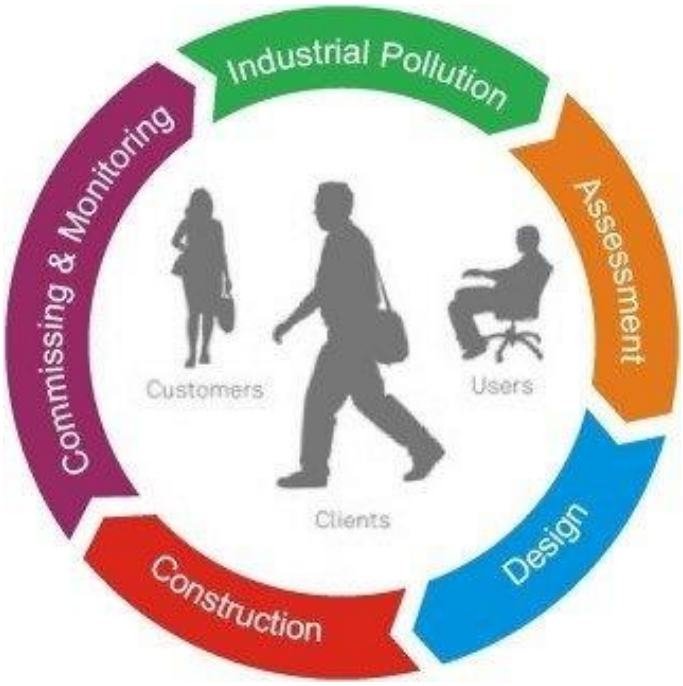
- **Impact assessment methodologies**
- **Public awareness**
- **Environmental priorities in India**
- **Sustainable development**

Environmental Impact Assessment

- Définition: « *A systematic process for evaluating and documenting information on the potentials, capacities and functions of natural systems and resources in order to facilitate sustainable development planning and decision making in general, and to anticipate and manage the adverse effects and consequences of proposed undertakings in particular.* » (Sadler, 1996)

or

- *« Systematic examination of the consequences of a project, with a view of improving overall environmental quality, by reducing or mitigating the negative consequences and capitalising on the positive ones. »* Other definitions emphasise the process, or integration of social impacts.



Environmental Impact Assessment (EIA)

- Environmental Impact Assessment is a widely accepted and important **tool for Environment Management for ensuring optimal use of natural resources for sustainable development.**
- It is being increasingly adopted in several countries.
- The aim of EIA is to identify and subsequently predict the **impacts of Commercial, Industrial and Legislative proposals, Policies and Operational procedures** and interpret and communicate information to all stake holders about these impacts.

Need for EIA

Any developmental activity in the form of new project proposals (e.g. setting up of chemical/ petrochemical complexes, Metallurgical plants like Iron and Steel mills, Mining activities, Atomic and Conventional Power Generating stations and research facilities, construction of a dam/railway line, introduction new regulations etc.) is likely to **affect Environmental quality and hence calls for the carrying out of an EIA**. In many countries EIA has become mandatory before allowing such project activities to start.

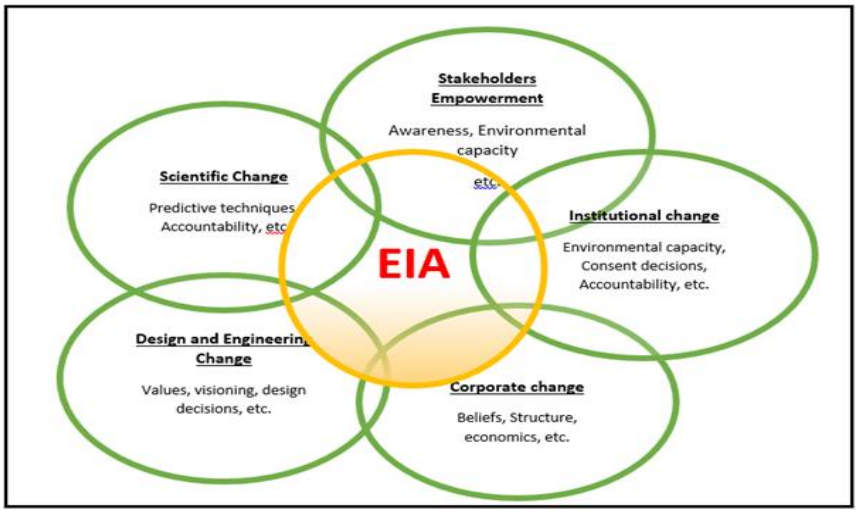
In India the **Ministry of Environment and Forests (MoEF)** has made EIA a statutory requirement in 1994 for 29 specific activities in different sectors like industries, mining, irrigation, power, transport, tourism etc.

- **Mining Projects**
- **Industrial Projects**
- **Thermal Power Projects**

- **River Valley, Multipurpose, Irrigation and H.E. Projects**
- **Infrastructure Development and Miscellaneous Projects**
- **Nuclear Power Projects**

Aims and objectives of EIA

- Modify and improve existing design
- Ensure efficient resource use
- Enhance social aspects
- Identify key impacts and measures for mitigating them
- Inform decision-making and condition-setting
- Avoid serious and irreversible damage to the environment
- Protect human health and safety



EIA—three core values

- Integrity - the EIA process will conform to agreed standards
- Utility - the EIA process will provide balanced, credible information for decision-making
- Sustainability - the EIA process will result in environmental safeguards

EIA Process

- ✓ **Screening** – EIA Required or not
- ✓ **Scoping** – Identify the key issues of concern at early stages of plan.
- ✓ **Impact Assessment** – Potential positive/negative environmental, social, economic and cultural impacts including cumulative, regional, temporal and spacial consideration.
- ✓ **Alternatives** – Alternative site/ alternative methodology (clean techniques)
- ✓ **Mitigation** – action to prevent, avoid or mitigate the adverse effect (Pollution control techniques)

Environmental Report – comprehensive document that repot

Steps involved in the EIA process

• **Identification and Selection of a competent coordinator for the EIA** and the collection of all relevant background information. This is done immediately after a project is identified.

• Broad analysis of the impacts of project activities with a view to **focus on issues** needing a detailed study.

• Collection of detailed data on the current environmental status of the project site and surroundings (prior to the project implementation) and preparation of the **environmental inventory describing comprehensively all the components of the environment existing** in the area where the proposed project is being considered to be implemented.

• Quantitative Impact evaluation terms including **potential mitigation measures**. Project alternatives should be kept ready before the impact evaluation.

• Impact Assessment taking into account environmental losses and gains as well as economic costs and benefits for each alternative proposed and preparation of an **Environmental Impact Statement (EIS) which will be a formatted public document** specified by authorized national, state and/or local agencies.

- **Public scrutiny** of the EIS and review at public hearings.

• **Detailed documentation** of the work done in the EIA with specific recommendations about the proposed project and **alternatives** with comments on the environmental and economic impacts of each.

• **Decision-making process** by the decision maker. The decisions normally fall into any one of the following categories.

(a) Proposal accepted

(b) Proposal accepted with amendments

(c) Alternate proposal accepted

(d) Proposal is rejected

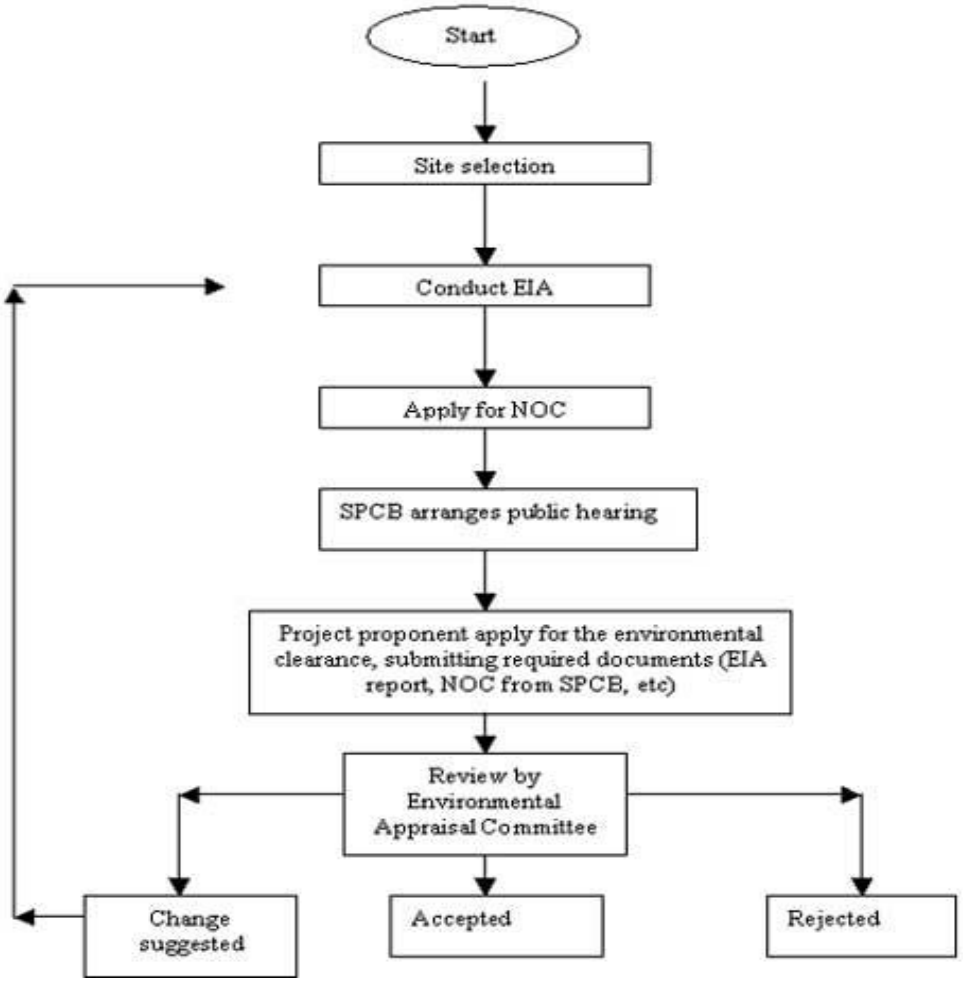
(e) Further study of the proposal.

- **Post monitoring:** Follow up and monitoring of the project activities during installation and operation phases and conduct audits to compare actual performance with the EIA predictions and suggest improvement measures.

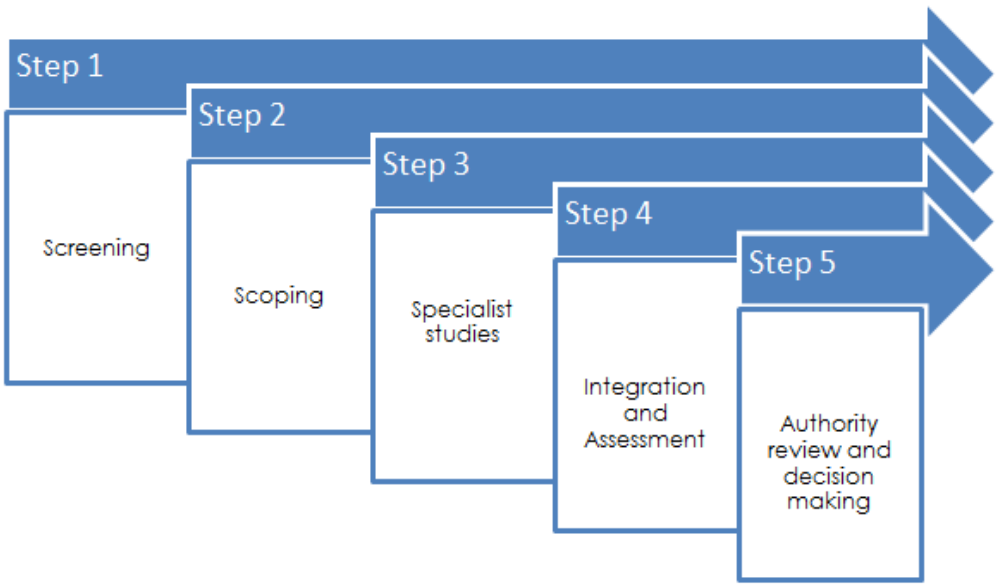
General and industry specific assessment methods are available :

- ***Industrial products*** - Product environmental **life cycle analysis (LCA)** is used for identifying and measuring the impact of industrial products on the environment. These EIAs consider activities related to extraction of raw materials, ancillary materials, equipment; production, use, disposal and ancillary equipment.
- ***Genetically modified plants*** - Specific methods available to perform EIAs of genetically modified organisms include GMP-RAM and INOVA.
- ***Fuzzy logic*** - EIA methods need measurement data to estimate values of impact indicators. However, many of the environment impacts cannot be quantified, e.g. landscape quality, lifestyle quality and social acceptance. Instead information from similar EIAs, expert judgment and community sentiment are employed. Approximate reasoning methods known as fuzzy logic can be used. A fuzzy arithmetic approach has also been proposed and implemented using a software tool (TDEIA).

- **Contents of EIA**
- **(1) Details of the proposed project/action and alternates including all phases of action**
- **(Construction, Operation, Shutdown).**
- **(2) Nature and magnitude of the predicted impacts of the proposed action under the following three categories.**
- ***(a) Physical: Air, water and land pollution, natural disasters like flood, earthquakes etc.***
- ***(b) Biological: Flora and fauna, biodiversity, endangered species.***
- ***(c) Socioeconomic.***
- **(3) Identification of human concerns.**
- **(4) Measurement criteria of the significance of the predicted environmental changes.**
- **(5) Estimate the significance of the impacts of the environmental changes.**
- **(6) Recommendations about the acceptability or otherwise of the proposed projects and alternates.**
- **(7) Monitoring procedures during and after implementation of the project.**
- **To quantitatively estimate the impacts of different factors the technique of LEOPOLD MATRIX is often used.**



Steps involved in EIA



Advantages of EIA

Benefits of EIA

• Cost and time saving in project implementation due avoidance of mid course design changes or corrections.

• Increases acceptability of the project among all stakeholders.

• Laws and regulations of the country/society is fully complied and hence no future conflicts.

• Improves project performance by decreased pollutant emissions, effective resource utilization and minimization of treatment and cleanup costs.

• A healthy environment (flora, fauna, biodiversity, clean air, water and land).

• Improved human health.

• Paves way for sustainable development.

The EIA Process comprises

- Screening - to decide if and at what level EIA should be applied
- Scoping - to identify the important issues and prepare terms of reference
- Impact analysis - to predict the effects of a proposal and evaluate their significance
- Mitigation - to establish measures to prevent, reduce or compensate for impacts
- Reporting - to prepare the information necessary for decision-making
- Review - to check the quality of the EIA report.
- Decision-making - to approve (or reject) the proposal and set conditions
- Follow up – to monitor, manage and audit the impacts of project implementation
- Public involvement - to inform and consult with stakeholders

ENVIRONMENTAL LEGISLATION

India is the first country in the world to have made provisions for the protection and conservation of environment in its constitution. On 5th June, 1972, environment was first discussed as an item of international agenda in the U.N. Conference on Human Environment in Stockholm and thereafter 5th June is celebrated all over the world as World Environment Day. Soon after the Stockholm Conference our country took substantive legislative steps for environmental protection.

- The Wildlife (Protection) Act was passed in 1972,
- followed by the Water (Prevention and Control of Pollution) Act 1974,
- the Forest (Conservation) Act, 1980,
- Air (Prevention and Control of Pollution) Act, 1981 and subsequently
- the Environment (Protection) Act, 1986.

- The provisions for environmental protection in the constitution were made within four years of Stockholm Conference, in 1976, through the 42nd amendment as follows :
- Article 48-A of the constitution provides: The state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country.
- Article 51A(g) provides:
- It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

- Thus our constitution includes environmental protection and conservation as one of our fundamental duties. Some of the important Acts passed by the Government of India are discussed here.

WILDLIFE (PROTECTION) ACT, 1972

The act, a landmark in the history of wildlife legislation in our country, came into existence in 1972. Wildlife was transferred from State list to concurrent list in 1976, thus giving power to the Central Govt. to enact the legislation.

The Indian Board of Wildlife (IBWL) was created in 1952 in our country, which after the enactment of the Wildlife (Protection) Act actively took up the task of setting up wildlife National Parks and sanctuaries. The major activities and provisions in the act can be summed up as follows:

(i) It defines the wild-life related terminology.

(ii) It provides for the appointment of wildlife advisory Board, Wildlife warden, their powers, duties etc.

(iii) Under the Act, comprehensive listing of endangered wild life species was done for the first time and prohibition of hunting of the endangered species was mentioned.

(iv) Protection to some endangered plants like Beddome cycad, Blue Vanda, Ladies Slipper Orchid, Pitcher plant etc. is also provided under the Act.

(v) The Act provides for setting up of National Parks, Wildlife Sanctuaries etc.

(vi) The Act provides for the constitution of Central Zoo Authority.

(vii) There is provision for trade and commerce in some wildlife species with license for sale, possession, transfer etc.

(viii) The Act imposes a ban on the trade or commerce in scheduled animals.

(ix) It provides for legal powers to officers and punishment to offenders.

(x) It provides for captive breeding programme for endangered species. Several Conservation Projects for individual endangered species like lion (1972) Tiger (1973), Crocodile (1974) and Brown antlered Deer (1981) were started under this Act. The Act is adopted by all states in India except J & K, which has it own Act.

Some of the major drawbacks of the Act include mild penalty to offenders, illegal wild life trade in J & K, personal ownership certificate for animal articles like tiger and leopard skins, no coverage of foreign endangered wildlife, pitiable condition of wildlife in mobile zoos and little emphasis on protection of plant genetic resources.

Water (Prevention & Control of pollution) Act, 1974: Functions

State Pollution Control Board: SPCB : Similar functions to be executed

- ❖ Either a fulltime or part time chairman having special knowledge
- ❖ Maximum of five state government officials
- ❖ Maximum of five representatives from among members of local authorities
- ❖ Maximum of three non-officials representing agriculture, fishery or trade or industry
- ❖ Two representatives of State Government companies or corporations

Powers; Every industry has to obtain consent from the board.

- Power to obtain information from individuals regarding removal or discharge of water.
- Power to enter and inspect any plant, record, register, document and conduct search of a place if the authority has reason to believe that an offence under this Act has been committed
- Power to grant, and discharge of sewage or industrial effluents and to impose conditions with regard to discharge.

Remedial Measures

- In times of emergency, the board has powers to take appropriate remedial action which includes restraining or prohibiting a person from discharging polluting matters.
- In all other instances the board has to make an application to a court not lower than that of a first class Magistrate.

Penalties

- Imprisonment for a period extending to 3 months or fine up to Rs. 5000 or both In case of continuing violations,
- An additional fine extending to Rs. 1000 per day of violation.

- **FOREST (CONSERVATION) ACT, 1980**

This act deals with the conservation of forests and related aspects. Except J & K, the act is adopted all over India. The Act covers under it all types of forests including reserved forests, protected forests or any forested land irrespective of its ownership.

- **The salient features of the Act are as follows:**

(i) The State Govt. has been empowered under this Act to use the forests only for forestry purposes. If at all it wants to use it in any other way, it has to take prior approval of central Government, after which it can pass orders for declaring some part of reserve forest for non-

forest purposes (e.g mining) or for clearing some naturally growing trees and replacing them by economically important trees (reforestation).

(ii) It makes provision for conservation of all types of forests and for this purpose there is an Advisory committee which recommends funding for it to the Central Government.

(iii) Any illegal non-forest activity within a forest area can be immediately stopped under this Act.

(iv) Non-forest activities include clearing of forest land for cultivation of any type of plants/crops or any other purpose (except re-afforestation).

(v) However, some construction work in the forest for wildlife or forest management is exempted from non-forest activity (e.g. fencing, making water-holes, trench, pipelines, check posts, wireless communication etc.) 1992 Amendment in the Forest Act

(vi) In 1992, some amendment was made in the Act which made provisions for allowing some non-forest activities in forests, without cutting trees or limited cutting with prior approval of Central Govt. These activities are setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects. The last activity involves large scale destruction of forest, for which prior approval of the Centre is necessary.

(vii) Wildlife sanctuaries, National Parks etc. are totally prohibited for any exploration or survey under this Act without prior approval of Central Govt. even if no tree-felling is involved.

(vii) Cultivation of tea, coffee, spices, rubber and plants which are cash-crops, are included under non-forestry activity and not allowed in reserve forests. Even cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in forest area need to be first approved by the Central Govt. This is because newly introduced species in the forest area may cause an imbalance in the ecology of the forest. If the species to be planted is a native species, then no prior clearance is required.

(viii) Tusser cultivation (a type of silk-yielding insect) in forest areas by tribals as a means of their livelihood is treated as a forestry activity as long as it does not involve some specific host treelike Asan or Arjun. This is done in order to discourage monoculture practices in the forests which are otherwise rich in biodiversity. Plantation of mulberry for rearing silkworm is considered a non-forest activity. The reason is same as described above.

(ix) Mining is a non-forestry activity and prior approval of Central Govt. is mandatory. The Supreme Court in a case T.N. Godavarman Thirumulkpad Vs. Union of India (1997) directed all on-going mining activity to be ceased immediately in any forest area of India if it had not got prior approval of Central government Removal of stones, bajri, boulder etc from river-beds located within the forest area fall under non-forest activity.

(x) Any proposal sent to central govt. for non-forest activity must have a cost-benefit analysis and Environmental Impact statement (EIS) of the proposed activity with reference to its ecological and socio-economic impacts.

(xi) Thus, the Forests (Conservation) Act has made ample provisions for conservation and protection of forests and prevent deforestation**.**

Salient features of CPCB and SPCB

It provides for the establishment of Central and State Boards for pollution control. It confers them with powers and functions to control pollution. The Central and State Pollution Control Boards are widely represented and are given comprehensive powers to advise, coordinate and provide technical assistance for prevention and control of pollution of water. The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards. The Act makes provisions for various penalties for the defaulters and procedure for the same. The main regulatory bodies are the Pollution Control Boards, which have been, conferred the following duties and powers:

- **Central Pollution Control Board (CPCB):**
- (i) It advises the central govt. in matters related to prevention and control of water pollution. Coordinates the activities of State Pollution Control Boards and provides them technical assistance and guidance.
- (ii) Organizes training programs for prevention and control of pollution. Organizes comprehensive programs on pollution related issues through mass media.
- (iii) Collects, compiles and publishes technical and statistical data related to pollution. Prepares manuals for treatment and disposal of sewage and trade effluents. Lays down standards for water quality parameters.
- (iv) Plans nation-wide programs for prevention, control or abatement of pollution. Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.
- **State Pollution Control Boards (SPCB)**

The State Pollution Control Boards also have similar functions to be executed at state level and are governed by the directions of CPCB.

(i) The Board advises the state govt. with respect to the location of any industry that might pollute a stream or a well. It lays down standards for effluents and is empowered to take samples from any stream, well or trade effluent or sewage passing through an industry.

(ii) The State Board is empowered to take legal samples of trade effluent in accordance with the procedure laid down in the Act. The sample taken in the presence of the occupier or his

agent is divided into two parts, sealed, signed by both parties and sent for analysis to some recognized lab.

(iii) If the samples do not conform to the prescribed water quality standards (crossing maximum permissible limits), then consent is refused to the unit.

(iv) Every industry has to obtain consent from the Board (granted for a fixed duration) by applying on a prescribed Proforma providing all technical details, along with a prescribed fee following which analysis of the effluent is carried out.

(v) The Board suggests efficient methods for utilization, treatment and disposal of trade effluents. The Act has made detailed provisions regarding the power of the Boards to obtain information, take trade samples, restrict new outlets, restrict expansion, enter and inspect the units and sanction or refuse consent to the industry after effluent analysis.

(vi) While development is necessary, it is all the more important to prevent pollution, which can jeopardize the lives of the people. Installation and proper functioning of effluent treatment plants (ETP) in all polluting industries is a must for checking pollution of water and land. Despite certain weaknesses in the Act, the Water Act has ample provisions for preventing and controlling water pollution through legal measures.

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

- **Salient features of the act are as follows:**

(i) The Act provides for prevention, control and abatement of air pollution.

(ii) In the Act, air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.

(iii) Noise pollution has been inserted as pollution in the Act in 1987.

(iv) Pollution control boards at the central or state level have the regulatory authority to implement the Air Act. Just parallel to the functions related to Water (Prevention and Control of Pollution) Act, the boards performs similar functions related to improvement of air quality.

(v) The boards have to check whether or not the industry strictly follows the norms or standards laid down by the Board under section 17, regarding the discharge of emission of any air pollutant. Based upon analysis report consent is granted or refused to the industry.

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(vi) Just like the Water Act, the Air Act has provisions for defining the constitution, powers and function of Pollution Control Boards, funds, accounts, audit, penalties and procedures.

(vii) Section 20 of the Act has provision for ensuring emission standards from automobiles. Based upon it, the state govt. is empowered to issue instructions to the authority in charge of

registration of motor vehicles (under Motor Vehicles Act, 1939) that is bound to comply with such instructions.

(vii) As per Section 19, in consultation with the State Pollution Control Board, the state government may declare an area within the state as air pollution control area and can prohibit the use of any fuel other than approved fuel in the area causing air pollution. No person shall, without prior consent of State Board operate or establish any industrial unit in the .air pollution control area.

(viii) The Water and Air Acts have also made special provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An Appellate Authority consisting of a single person or three persons appointed by the Head of the State, Governor is constituted to hear such appeals as filed by some aggrieved party (industry) due to some order made by the State Board within 30 days of passing the orders.

The Appellate Authority after giving the appellant and the State Board an opportunity of being heard, disposes off the appeal as expeditiously as possible.

- **THE ENVIRONMENT (PROTECTION) ACT, 1986**

  The Act came into force on Nov. 19, 1986, the birth anniversary Late Prime Minister Indira Gandhi, who was a pioneer of environmental protection issues in our country. The Act extends to whole of India. Some terms related to environment have been described as follows in the Act:

(i) Environment includes water, air and land and the inter-relationships that exists among and between them and human beings, all other living organisms and property.

(ii) Environmental pollution means the presence of any solid, liquid or gaseous substance present in such concentration, as may be, or tend to be, injurious to environment.

(iii) Hazardous Substance means any substance or preparation which by its physico-chemical properties or handling is liable to cause harm to human beings, other living organisms, property or environment. The Act has given powers to the Central Government to take

measures to protect and improve environment while the state governments coordinate the actions. The most important functions of Central Govt. under this Act include setting up of:

(a) The standards of quality of air, water or soil for various areas and purposes.

(b) The maximum permissible limits of concentration of various environmental pollutants (including noise) for different areas.

(c) The procedures and safeguards for the handling of hazardous substances.

(d) The prohibition and restrictions on the handling of hazardous substances in different areas.

(e) The prohibition and restriction on the location of industries and to carry on process and operations in different areas.

(f) The procedures and safeguards for the prevention of accidents which may cause environmental pollution and providing for remedial measures for such accidents.

(g) The power of entry and inspection, power to take sample etc. under this Act lies with the Central Government or any officer empowered by it.

(h) For the purpose of protecting and improving the quality of the environment and preventing and abating pollution, standards have been specified under Schedule I- IV of Environment (Protection) Rules, 1986 for emission of gaseous pollutants and discharge of effluents/waste water from industries.

- (i) These standards vary from industry to industry and also vary with the medium into which the effluent in discharged or the area of emission. For instance, the maximum permissible limits of B.O.D. (Biochemical Oxygen Demand) of the waste water is 30 ppm if it is discharged into inland waters, 350 ppm if discharged into a public sewer and 100 ppm, if discharged onto land or coastal region.
- (j) Likewise, emission standards vary in residential, sensitive and industrial area. Naturally the standards for sensitive areas like hospitals are more stringent. It is the duty of the Pollution Control Board to check whether the industries are following the prescribed norms or not.
- Under the Environmental (Protection) Rules, 1986 the State Pollution Control Boards have to follow the guidelines provided under Schedule VI, some of which are as follows:
- (a) They have to advise the Industries for treating the waste water and gases with the best available technology to achieve the prescribed standards.
- (b) The industries have to be encouraged for recycling and reusing the wastes.
- (c) They have to encourage the industries for recovery of biogas, energy and reusable materials.
- (d) While permitting the discharge of effluents and emissions into the environment, the State Boards have to take into acthe assimilative capacity of the receiving water body.
- (e) The Central and State Boards have to emphasize on the implementation
- of clean technologies by the industries in order to increase fuel efficiency and reduce the generation of environmental pollutants. Under the Environment (Protection) Rules, 1986 an amendment

- **Roles of Central Pollution Control Board (CPCB) in short**
- advises to central govt.
- - coordination of state PCBs – providing technical guidance
- - training programs – defining functions
- - creating awareness through mass media
- - technical and statistical data collection
- - manuals for treatment of sewage and industrial effluents
- - standards for water quality parameters
- - Establish and recognize labs for analysis

State Pollution Control Board (SPCB) in short

- advises to state govt.
- - other activities similar to CPCB
- - empowered to take samples for testing from
- any water body or effluent – how testing
- conducted?
- - any new industry should get consent from
- SPCB – all technical details in prescribed
- format and fees should be submitted
- **<u>Enforcement of environmental legislation - drawbacks</u>**
- Drawbacks in wild life protection act
- Drawbacks in forest conservation act
- Powers are with central govt. action is delayed
- Penalty is lesser then cost of pollution treatment
- Not included in right to information act
- Legal delays – 60 days notice to central govt.
- Lack of funds
- Out of court settlements
- ETPs are costly for small industries
- Weak govt. policy – political influences on the board heads

Public awareness

- Education does not provide knowledge about environmental and pollution related aspects
- Policy makers – politicians – unaware of environmental and pollution aspects and impacts
- General public are thinking about development but not about the impacts of such development on environment

How to propagate public awareness?

- Among students – through education All stages including school and college level, following the directives of the Supreme Court
- Among the masses through mass media

Articles, environmental rallies, plantation campaigns, street plays, real eco-disaster stories and success stories of conservation efforts. TV serials like *Virasat, Race to save the Planet, Heads and Tails, Terra-view, Captain planet*

- Among policy makers – orientation and training

Workshops and training programmes, Publication of environment - related resource material in the form of pamphlets or booklets

Sustainable Development\

Why did we become a threat to the nature?

- We tried to improve our quality of life
- We want to 'DEVELOP'
- In the process of development we created problems
- Is development wrong? What actually went wrong?
- **What is wrong in development?**
- If a country has sound economy we called it developed – if it does not then it is undeveloped or developing
- We considered "improvement in our economy" as development – That is wrong!
- Economic Development is not the only factor which will decide the quality of life

Focus on Economic development alone led to…

- Over exploitation of natural resources
- Loss of biodiversity
- Human oriented thinking – not bothered about environment and other living beings
- A mentality that don't care about future generation
- Increased economic differences in nations within as well as between different nations

What kind of development we are looking for?

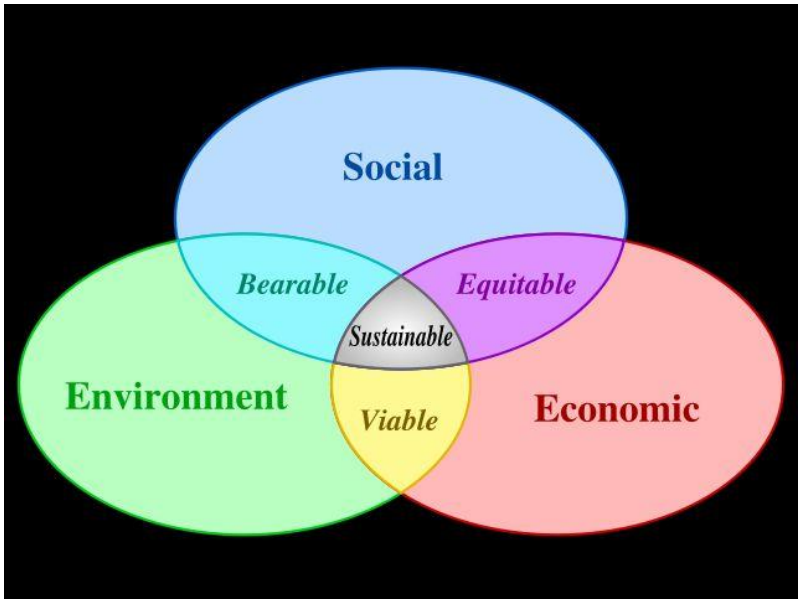
- Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- Brundtland G.H, former Norweign PM and Director of WHO

- Two decades back it has been realized that the development should be a "**Sustainable development"**

- A sustainable development is a development in which a balance is maintained between three types of development

- Social
- Environment
- Economic



- That means, before going for any developmental activity we should verify,

How will our action impact people?

How will our action impact the environment?

How will our action impact economy?

Key aspects of sustainable development

i. Inter-generational equity

We should hand over a safe, healthy and resourceful environment to our future generations

ii. Intra-generational equity

Decreasing the wealth gap between rich and poor, within the country and between the countries should be decreased

Technological developments should aim to solve the problems of poor countries & not always the sophistication of rich

Measures to sustainable development -How to achieve sustainable development

1. Using appropriate technology
   - Technology employed should be Locally adaptable, eco-friendly, and culturally suitable
   - It involves local resources and local labour – design with nature (ROSATOM)
2. The 3 R's, Reduce, Reuse and Recycle Minimize resource use, reuse again and again, Recycle if not possible to reuse.
3. Prompting environmental education, public awareness and training
4. Resource utilization should be limited to Carrying Capacity

Sustainable development –

Indian context

1. In the last 50 years our economy has grown – rich poor gap also has grown
2. We have become self sufficient in food production
3. Our food self-sufficiency came with indiscreet use of fertilizers and pesticides
4. We are the largest contributor to population growth – 17 million every year
5. Our economy has grown because of increased industries
6. Pollution of air, water and land also increased because of these industries
7. In the recent past migration from villages to cities has increased tremendously – results in increased need for shelter, food, water, energy-all are concentrated in a small area – threatening the carrying capacity
8. India with rich biodiversity and huge population has a long way to go for sustainable development.

9. **The National Council of Environmental Planning and Coordination (NCPC)** set up in 1972 was the focal agency in this regard.
10. **The Ministry of Environment & Forests (MoEF)** , set up in 1985 has formulated guidelines for various developmental activities keeping in view the sustainability principles.

Module 5- Important Questions:

1. What is EIA? Explain different steps involved in EIA?
2. What are the objectives of EIA?
3. Explain in details of wild-life protection act?
4. Explain in details of water act?
5. Explain in details of forest act?
6. Explain in details of air act?
7. What is environmental legislation? Explain the advantages
8. Disadvantages of environmental legislation?
9. Discuss the salient features of CPCB and SPCB?
10. What is called sustainable development?
11. How to achieve sustainable development?
12. What is public awareness?
13. How to propagate public awareness?

Module-6

Human Population Change and Environment

>Urban environmental problems;

> Consumerism and waste products;

> Promotion of economic development

> Impact of population age structure

> Women and child welfare,

>Women empowerment.

> Sustaining human societies: Economics, environment, policies and education.

Urban environmental problems

Half of the World's People Live in Urban Areas

- Today 79% of Americans and about 50% of the world's people live in urban areas. Urban areas grow in two ways—by natural increase (more births than deaths) and by immigration, mostly from rural areas.
- Rural people are pulled to urban areas in search of jobs, food, housing, educational opportunities, better health care, entertainment, and freedom from religious, racial, and political conflicts. Some are also pushed from rural to urban areas by factors such as poverty, limited land for growing food, declining agricultural jobs, famine, and war.

Four major trends are important for understanding the problems and challenges of urban growth.

- First, the proportion of the global population living in urban areas is increasing. Between 1850 and 2009, the percentage of people living in urban areas increased from 2% to 50% and could reach 60% by 2030. About 88% of this growth will occur in already overcrowded and stressed cities in developing countries.
- Second, the number and sizes of large urban areas is mushrooming. Each week, 1 million people are added to the world's urban areas. More than 400 urban areas each have 1 million or more people.
- Third, urban growth is much slower in developed countries than in developing countries. Still, developed countries, now with 75% urbanization, are projected to reach 81% urbanization by 2030.

- Fourth, poverty is becoming increasingly urbanized, mostly in developing countries. The United Nations estimates that at least 1 billion people in developing countries live in crowded and unsanitary slums and shantytowns within most cities or on their outskirts; within 30 years this number may double.

Urbanization Has Advantages: Urbanization has many benefits.

> From an economic standpoint, cities are centers of economic development, innovation, education, technological advances, and jobs.

- They serve as centers of industry, commerce, and transportation. Urban residents in many parts of the world tend to live longer than do rural residents and to have lower infant mortality rates and fertility rates.
- They also have better access to medical care, family planning, education, and social services than do their rural counterparts. However, the health benefits of urban living are usually greater for the rich than for the poor. Urban areas also have some environmental advantages.
- Recycling is more economically feasible because concentrations of recyclable materials and funding for recycling programs tend to be higher in urban areas. Concentrating people in cities helps to preserve biodiversity by reducing the stress on wildlife habitats. And central cities can save energy if residents rely more on energy efficient mass transportation, walking, and bicycling**.**
- **Urbanization Has Disadvantages Most Urban Areas are Unsustainable Systems.**
- Although urban populations occupy only about 2% of the earth's land area, they consume about 75% of its resources and produce about 75% of the world's climate-changing carbon dioxide emissions from human activities, according to the Worldwatch Institute. Because of this high resource input of food, water, and materials and the resulting high waste output most of the world's cities have huge ecological footprints and are not self-sustaining systems
- **Cities Lack Vegetation**. In urban areas, most trees, shrubs, or other plants are destroyed to make way for buildings, roads, parking lots, and housing developments. So most cities do not benefit from vegetation that would absorb air pollutants, give off oxygen, help cool the air through transpiration, provide shade, reduce soil erosion, muffle noise, supply food, provide wildlife habitats, and give aesthetic pleasure. As one

observer remarked, “Most cities are places where they cut down most of the trees and then name the streets after them.”

- **Cities Have Water Problems.** As cities grow and their water demands increase, expensive reservoirs and canals must be built and deeper wells must be drilled. This can deprive rural and wild areas of surface water and can deplete underground water supplies.
- **Flooding also tends to be greater in some cities** that are built on floodplains near rivers or along low-lying coastal areas subject to natural flooding. And covering land with buildings, asphalt, and concrete causes precipitation to run off quickly and overload storm drains. In addition, urban development has often destroyed or degraded large areas of wetlands that have served as natural sponges to help absorb excess water.
- **They Concentrate Pollution and Health Problems.** Because of their high population densities and high resource consumption, cities produce most of the world’s air pollution, water pollution, and solid and hazardous wastes. Pollutant levels are generally higher because pollution is produced in a smaller area and cannot be dispersed and diluted as readily as pollution
- **They Affect Local Climates and Cause Light Pollution.** On average, cities tend to be warmer, rainier, foggier, and cloudier than suburbs and nearby rural areas. The enormous amount of heat generated by cars, factories, furnaces, lights, air conditioners, and heat absorbing dark roofs and streets in cities creates an urban heat island that is surrounded by cooler suburban and rural areas.
- **Life Is a Desperate Struggle for the Urban Poor in Developing Countries** Poverty is a way of life for many urban dwellers in developing countries. At least 1 billion people live under crowded and unsanitary conditions in cities in developing countries and according to a 2006 U.N. study, that number could reach 1.4 billion by 2020.
- **Some of these people live in slums—areas dominated by tenements** and rooming houses where several people might live in a single room. Others live in squatter settlements and shantytowns on the outskirts of these cities. the streets
- **They build shacks from corrugated metal, plastic sheets, scrap wood, cardboard**, and other scavenged building materials, or they live in rusted shipping containers and junked cars.
- **Still others live or sleep on Poor people living in shantytowns and squatter settlements** usually lack clean water supplies, sewers, electricity, and roads, and are subject to severe air and water pollution and hazardous wastes from nearby factories.

- **Many of these settlements are in locations especially prone to landslides**, flooding, or earthquakes. Some city governments regularly bulldoze squatter shacks and send police to drive illegal settlers out. The people usually move back in or develop another shantytown elsewhere.

Population growth

How many people can the earth support?

Earth's carrying capacity for humans without seriously degrading the life-support system that keeps us and many other species alive – not known

What factors influence the size of the human population?

Population size increases through births and immigration, and decreases through deaths and emigration. The average number of children born to women in a population (*total fertility rate) is the key factor that* determines population size.

How does a population's age structure affect its growth or decline?

The numbers of males and females in young, middle and older age groups determine how fast a population grows or declines.

How can we slow human population growth?

We can slow human population growth by reducing poverty, elevating the status of women and encouraging family planning

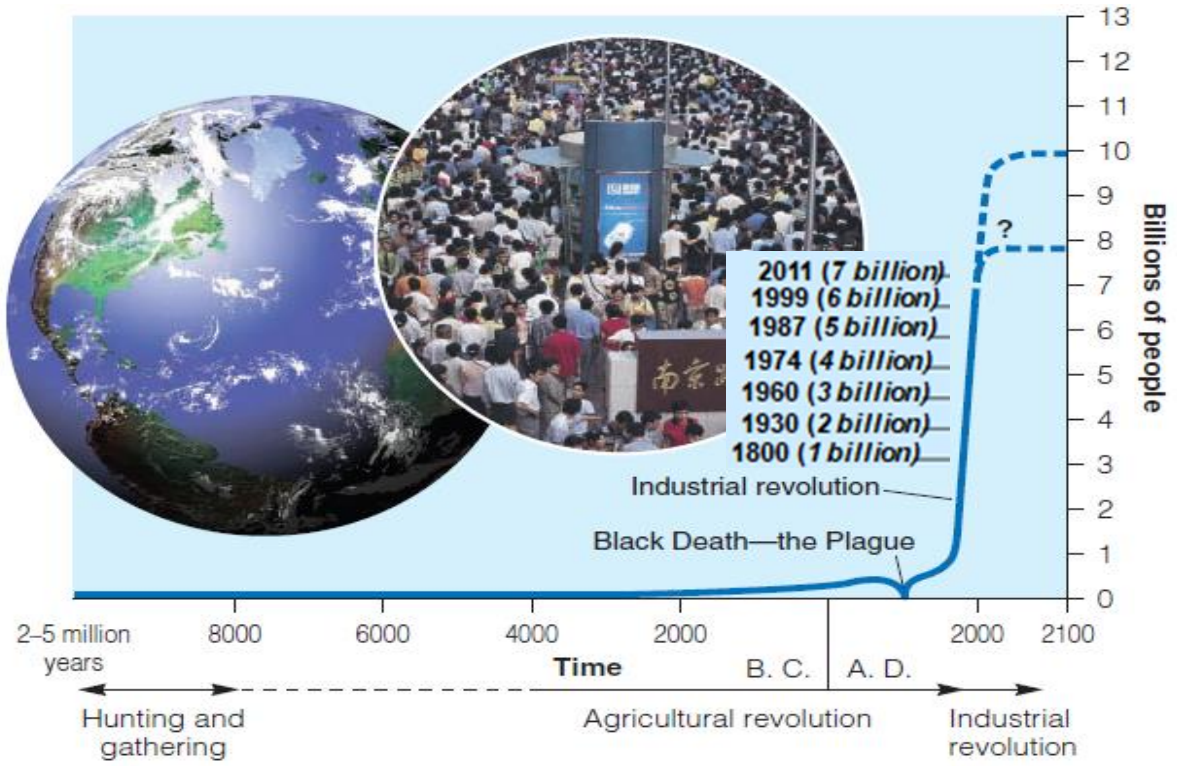
What is exponential growth?

- Exponential growth occurs when a quantity such as the human population increases at a fixed percentage per unit of time, such as 2 % per year. Exponential growth starts off slowly.
- But eventually, it causes the quantity to double again and again. After only a few doublings, it grows to enormous numbers because each doubling is twice the total of all earlier growth. Because of exponential growth in the human population in 2010 there were about 6.9 billion people on the planet.
- Collectively, these people consume vast amounts of food, water, raw materials and energy, producing huge amounts of pollution and wastes in the process. Each year, we add more than 80 million people to the earth's population. Unless death rates rise sharply, there will probably be 9.5 billion of us by 2050.

This projected addition of 2.6 billion more people within your lifetime is equivalent to about 8 times the current U.S. population and twice that of China, the world's most populous nation. For most of history, the human population grew slowly.

> But for the past 200 years, the human population has grown rapidly, resulting in the characteristic J-curve of exponential Growth. Three major factors account for this population increase.

- First, humans developed the ability to expand into almost all of the planet's climate zones and habitats.
- Second, the emergence of early and modern agriculture allowed us to grow more food for each unit of land area farmed.
- Third, death rates dropped sharply because of improved sanitation and health care and development of antibiotics and vaccines to help control infectious diseases.



Thus, most of the increase in the world's population during the last 100 years took place because of a sharp drop in death rates—not a sharp rise in birth rates.

About 10,000 years ago, when agriculture began, there were roughly 5 million humans on the planet; now there are about 6.9 billion of us.

- It took from the time we arrived on the earth until about 1927 to add the first 2 billion people to the planet; less than 50 years to add the next 2 billion (by 1974); and just 25 years to add the next 2 billion (by 1999). This is an illustration of the

awesome power of exponential growth. By 2012 we will be trying to support 7 billion people and perhaps 9.5 billion by 2050.

- The rate of population growth has slowed, but the world's population is still growing exponentially at a rate of about 1.21% a year.
- This means that about 83 million people were added to the world's population during 2010—an average of more than 227,000 people each day, or 2 more people every time your heart beats. This is roughly equal to adding

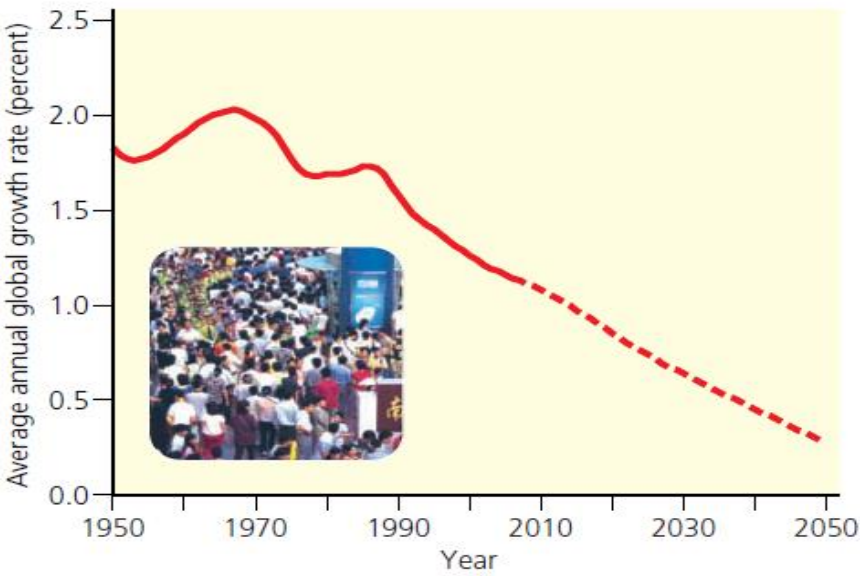
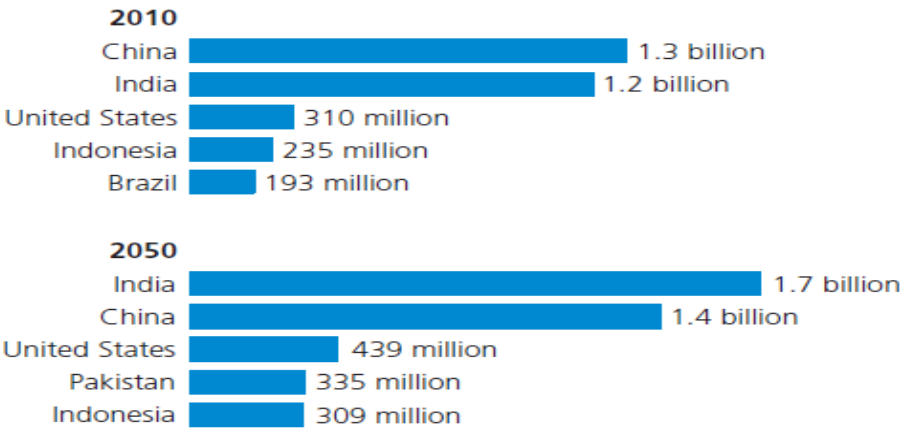


Figure 6-2 This graph tracks the annual growth rate of world population, 1950–2010, with projections to 2050. (Data from United Nations Population Division and U.S. Census Bureau)

Human Population Growth Continues but

Is Unevenly Distributed



World's five most populous countries will be in 2010 and in 2050 (projected)

Human Population Growth Continues but Is Unevenly Distributed

Geographically, this growth is unevenly distributed and this pattern is expected to continue. About 1 % of the 83 million new arrivals on the planet in 2010 were added to the world's more-developed countries, which are growing at 0.17 % a year.

The other 99 % were added to the world's middle- and low-income, less developed countries, which are growing 9 times faster at 1.4 % a year, on average. And at least 95 % of the 2.7 billion people likely to be added to world's population by 2050 will be born into less-developed countries.

Human Population - Grow, Decline or Remain Stable

The basics of global population change are quite simple. If there are more births than deaths during a given period of time, the earth's population increases and when the reverse is true, it decreases.

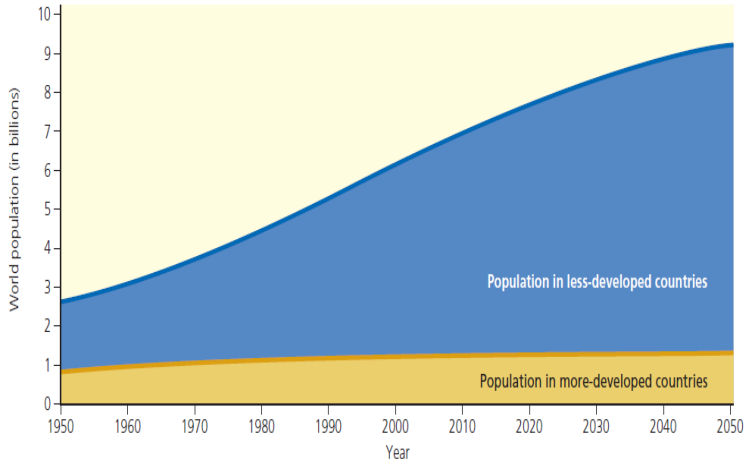


Figure 6-3 Most of the world's population growth between 1950 and 2010 took place in the world's less-developed countries. This gap is projected to increase between 2010 and 2050. (Data from United Nations Population Division, *The 2008 Revision* and Population Reference Bureau, *2010 World Population Data Sheet*)

Zero population growth (ZPG)

When the number of births equals the number of deaths during a particular time period, the global population size does not change. Instead of using the total numbers of births and deaths per year, demographers use the *birth rate, or* crude birth rate (the number of live births per 1,000 people in a population in a given year), and the *death rate, or crude death rate (the number of deaths per* 1,000 people in a population in a given year).

Human populations grow or decline

Human populations grow or decline in particular countries, cities, or other areas through the interplay of three factors: *births (fertility), deaths (mortality) and migration. We can calculate the population change of* an area by subtracting the number of people leaving a population (through death and emigration) from the number entering it (through birth and immigration) during a specified period of time (usually one year).

Population change = (Births + Immigration) – (Deaths + Emigration).

> When births plus immigration exceed deaths plus emigration, a population increases; when the reverse is true, a population declines.

Women Are Having Fewer Babies but Not Few Enough to Stabilize the World's Population (Women empowerment)

> Another measurement used in population studies is the fertility rate, the number of children born to a woman during her lifetime. Two types of fertility rates affect a country's population size and growth rate.

Replacement-level fertility rate

> The first type, called the replacement-level fertility rate, is the average number of children that couples in a population must bear to replace themselves. It is slightly higher than two children per couple (2.1 in more developed countries and as high as 2.5 in some less developed countries), mostly because some children die before reaching their reproductive years. Does reaching replacement-level fertility bring an immediate halt to population growth? No, because so many future parents are alive. If each of today's couples had an average of 2.1 children, they would not be contributing to population growth. But if all of today's girl children grow up to have an average of 2.1 children as well, the world's population would continue to grow for 50 years or more (assuming death rates do not rise) because there are so many girls under age 15 who will be moving into their reproductive years.

Total fertility rate (TFR)

The second type of fertility rate, the total fertility rate (TFR), is the average number of children born to women in a population during their reproductive years.

> This factor plays a key role in determining population size. Between 1955 and 2010, the average TFR dropped from 2.8 to 1.7 children per woman in more-developed countries and from 6.2 to 2.7 in less-developed countries.

> The average TFR for less developed countries is projected to continue dropping , while that for more-developed countries is likely to rise slightly. Many factors affect a country's average birth rate and TFR. One is the importance of children as a part of the labor force, especially in less-developed countries

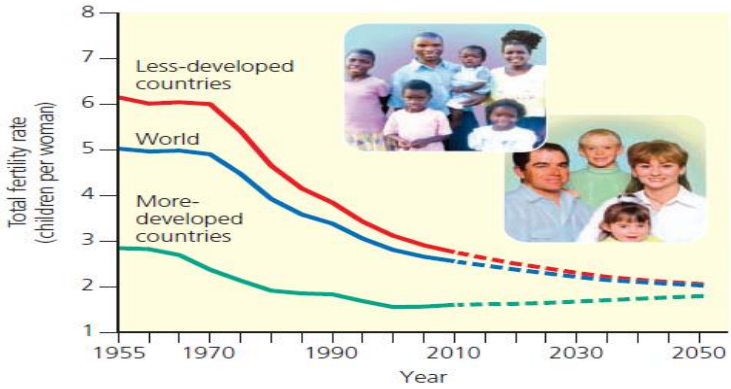


Figure 6-5 This graph tracks the total fertility rate for both the more-developed and less-developed regions of the world, 1955–2010, with projections to 2050 (based on medium population projections). Although the world's average TFR has dropped to 2.5, it will have to drop to around 2.1 to eventually halt the world's population growth. (Data from United Nations Population Division)

Several Factors Affect Birth Rates and Fertility Rates

This is a major reason for why it makes sense for many poor couples in those countries to have a large number of children. They need help with hauling daily drinking water, gathering wood for heating and cooking, and tending crops and livestock.

> Another economic factor is the *cost of raising and educating children. Birth and fertility rates tend to be lower* in more-developed countries, where raising children is much more costly because they do not enter the labor force until they are in their late teens or twenties.

(In the United States, for example, it costs more than $220,000 to raise a middle-class child from birth to age 18.)

> By contrast, many children in poor countries receive little education and instead have to work to help their families survive.

> The *availability of, or lack of, private and public pension systems can influence the decision of some couples on* how many children to have, especially the poor in less developed countries. *Pensions reduce a couple's need to* have many children to help support them in old age There are more *infant deaths in poorer countries,*

> *So* having several children might insure survival of at least a few—somewhat like having an insurance policy. *Urbanization plays a role. People living in urban areas* usually have better

access to family planning services and tend to have fewer children than do those living in rural areas.

> This is especially true in less developed countries where children are often needed to help raise crops and carry daily water and fuel wood supplies.

Another important factor is the *educational and employment opportunities available for women. Total fertility* rates tend to be low when women have access to education and paid employment outside the home.

> In less developed countries, a woman with little or no forma education typically has two more children than does a woman with a high school education.

> In nearly all societies, better-educated women tend to marry later and have fewer children. *Average age at marriage (or, more precisely, the average* age at which a woman has her first child) also plays a role. Women normally have fewer children when their average age at marriage is 25 or older.

Several Factors Affect Death Rates

> The rapid growth of the world's population over the past 100 years is not primarily the result of a rise in the birth rate. Instead, it has been caused largely by a decline in death rates, especially in less-developed countries.

> More people in these countries started living longer and fewer infants died. This happened because of increased food supplies and distribution, better nutrition, medical advances such as immunizations and antibiotics, improved sanitation, and safer water supplies (which curtailed the spread of many infectious diseases).

> Two useful indicators of the overall health of people in a country or region are life expectancy (the average number of years a newborn infant can be expected to live) and the infant mortality rate (the number of babies out of every 1,000 born who die before their first birthday).

Between 1955 and 2010, the global life expectancy increased from 48 years to 69 years (77 years in more-developed countries and 67 years in less-developed countries) and is projected to reach 74 by 2050. In 2010, Japan had the world's longest life expectancy of 83 years.

Between 1900 and 2009, life expectancy in the United States

increased from 47 to 78 years and, by 2050, is projected to reach 83 years. In the world's poorest countries, however, life expectancy is 57 years or less and may fall further in some countries because of more deaths from AIDS and internal strife.

Migration Affects an Area's Population Size

The third factor in population change is migration: the movement of people into (*immigration) and out of (emigration) specific geographic areas.*

In 2009, more than 190 million people migrated from one country to another—more than 60 million of them from less developed countries to more-developed countries.

>Most people migrating from one area or country to another seek jobs and economic improvement. But religious persecution, ethnic conflicts, political oppression, wars, and certain types of environmental degradation such as soil erosion and water and food shortages drive some to migrate.

> According to a UN study and another study by environmental scientist Norman Myers, in 2008 there were at least 40 million *environmental refugees*— people who had to leave their homes because of water or food shortages, drought, flooding, or other environmental crises. An estimated 1 million more are added to this number every year.

Age structure

A Population's Age Structure Helps Us to Make Projections

> As mentioned earlier, even if the global replacement level fertility rate of 2.1 children per woman were magically achieved tomorrow, the world's population would keep growing for at least another 50 years (assuming no large increase in the death rate).

- This continued growth results mostly from a population's age structure: the numbers or percentages of males and females in young, middle, and older age groups in that population.
- middle, and older age groups in that population. Population experts construct a population age structure diagram by plotting a given population's percentages of males and females in each of three age categories:

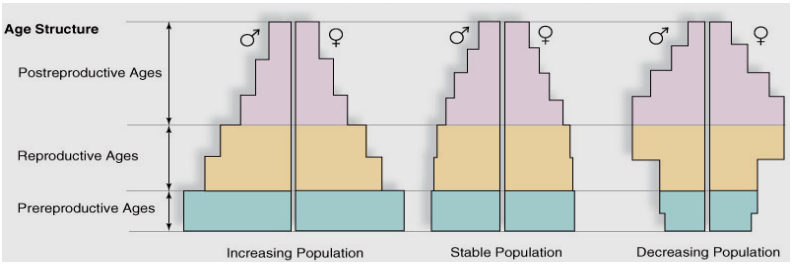
- Pre-reproductive (ages 0–14): consisting of individuals normally too young to have children;
- Reproductive: (ages 15–44), consisting of those normally able to have children; and
- Postreproductive (ages 45 and older), with individuals normally too old to have children.

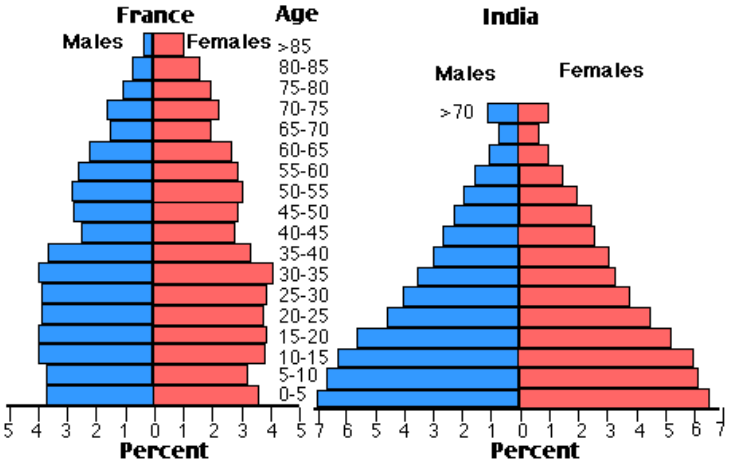
- > More developed countries—was under age 15. Over the next 14 years, these 1.8 billion young people—amounting to about 1 of every 4 persons on the planet— are poised to move into their prime reproductive years.
- > The dramatic differences in population age structure between less- and more-developed countries show why most future human population growth will take place in less-developed countries.

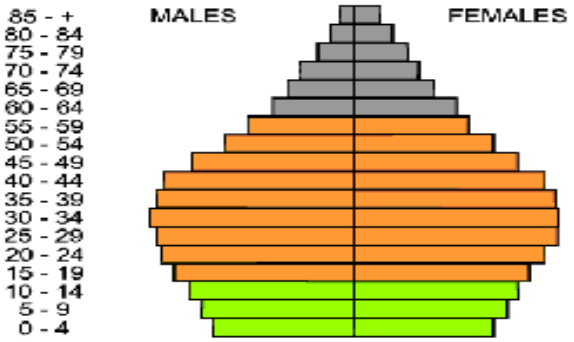
> However, the fastest growing age group is seniors— people who are 65 and older, according to a 2009 report from the U.S. Census Bureau. The global population of seniors is projected to triple by 2050, when one of every six people will be a senior. This graying of the world'shave extended our lifespans. Some analysts worry about how societies will support this growing group of elderly people. Population is largely declining due to less birth rates and medical advances. In China (Core Case Study) currently has 16 seniors per 100 workers. By 2025, it will have roughly 30 seniors per 100 workers, and by 2050, this ratio will be 61 to 100.

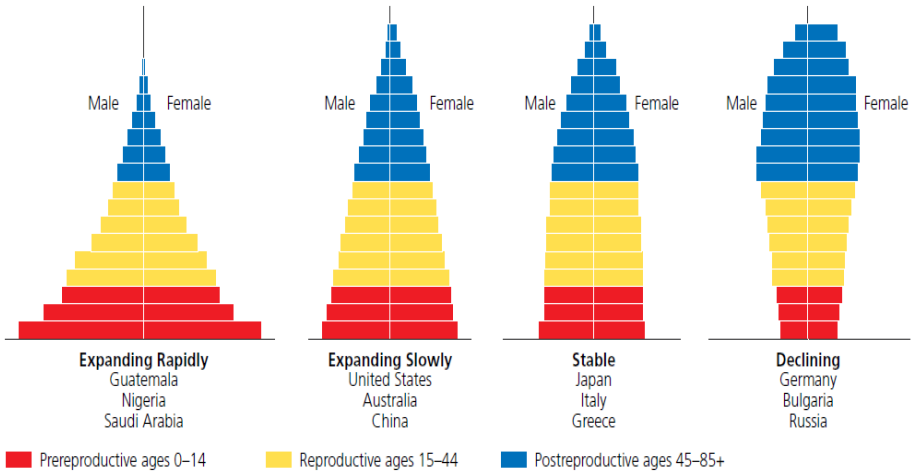
Population Characteristics

- Age structure: Different types -Pyramid, bell and urn shapes – population growth can be predicted









CENGAGENOW™ **Active Figure 6-12** This chart represents the generalized population age-structure diagrams for countries with rapid (1.5–3%), slow (0.3–1.4%), zero (0–0.2%), and negative (declining) population growth rates. A population with a large proportion of its people in the prereproductive age group (far left) has a significant potential for rapid population growth. *See an animation based on this figure at* CengageNOW. **Question:** Which of these diagrams best represents the country where you live? (Data from Population Reference Bureau)

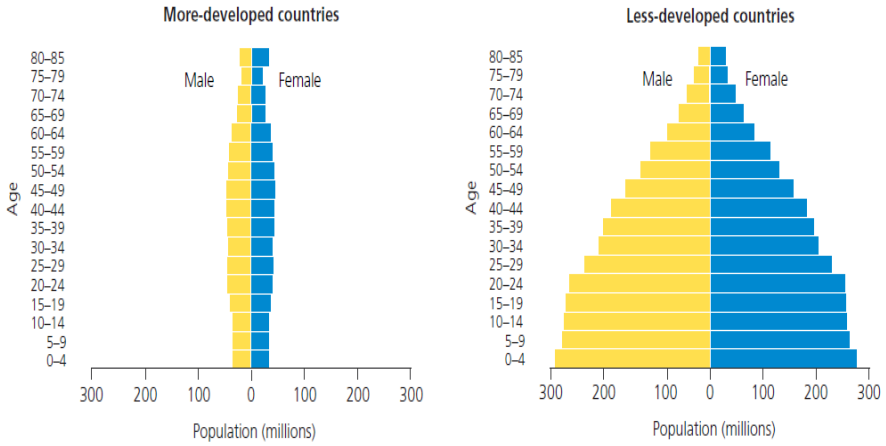


Figure 6-13 *Global outlook:* These charts illustrate population structure by age and sex in less-developed countries and more-developed countries for 2010. **Question:** If all girls under 15 were to have only one child during their lifetimes, how do you think these structures would change over time? (Data from United Nations Population Division and Population Reference Bureau)

How Can We Slow Human Population Growth?

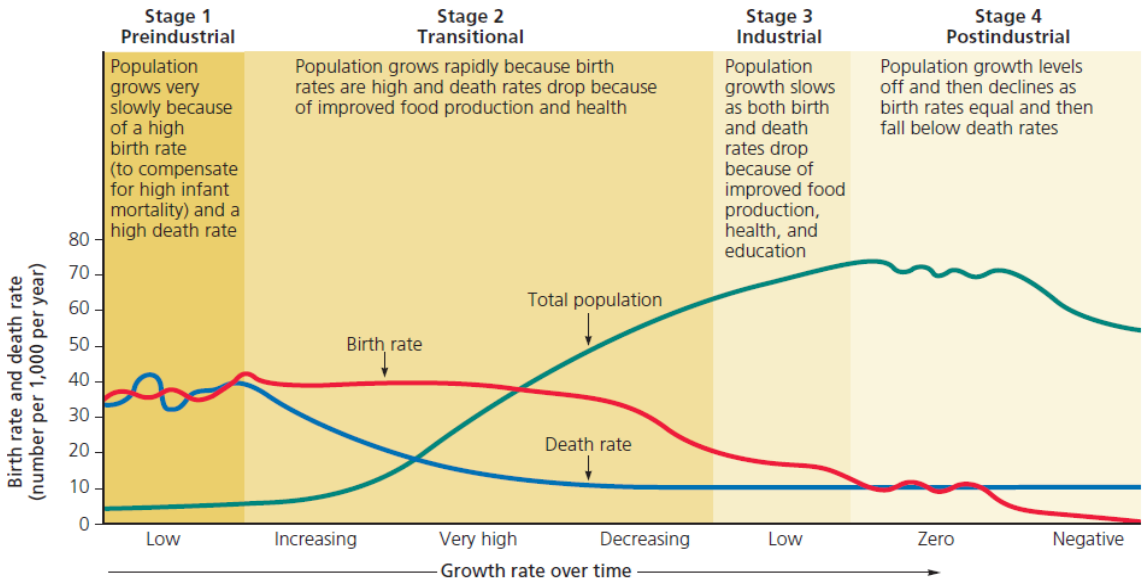
The First Step Is to Promote Economic Development:

Is there any limit to the growth of he human population on our planetary home? Assuming that our population will eventually exceed the ability of the earth's resources to support us, even though no one knows when that would be, many scientists argue for adopting a precautionary approach by taking steps to slow or stop population growth. Scientific studies and experience have shown that the three most important steps to take toward that goal are

(1) to reduce poverty primarily through economic development and universal primary education, (2) to elevate the status of women, and (3) to encourage family planning and reproductive health care.

(2) Demographers, examining birth and death rates of western European countries that became industrialized during the 19th century, developed a hypothesis of population change known as the demographic transition: As countries become industrialized and economically developed, first their death rates decline and then their birth rates decline. According to the hypothesis based on such data, this transition takes place in four distinct stages.

(3) > Figure 6-18 shows the progress of two countries— the United States and Bangladesh— in making a demographic transition in terms of the average number of births per woman (TFR). The United States is in the early phase of stage 4 and Bangladesh is approaching the early phase of stage 4. Due to demographic transition - developed countries growing rate 0.5% with doubling time 118 yrs In developing countries – where more than 90% population living – growth rate more than 2%- doubling time less than 35 yrs



CENGAGENOW™ **Active Figure 6-17** The *demographic transition*, which a country can experience as it becomes industrialized and more economically developed, can take place in four stages. *See an animation based on this figure at* CengageNOW. **Question:** At what stage is the country where you live?

Empowering Women Helps to Slow Population Growth

- A number of studies show that women tend to have fewer children if they are educated, have the ability to control their own fertility, earn an income of their own, and live in societies that do not suppress their rights. Although women make up roughly half of the world's population, in most societies they have fewer rights and educational and economic opportunities than men have.
- For example, in 2008 the government of Afghanistan passed a law that allows a man to withhold food from his wife if she refuses to have sex with him; it also forbids any woman from going out of her home without her husband's permission.
- Women do almost all of the world's domestic work and child care for little or no pay and provide more unpaid health care (within their families) than do all of the world's organized health care services combined.

- An increasing number of women in less developed countries are taking charge of their lives and reproductive behavior. As it expands, such bottom-up change by individual women will play an important role in stabilizing populations, reducing poverty and environmental degradation, and allowing more access to basic human rights.
- **Promote Family Planning Family planning provides educational and clinical**

> Services that help couples choose how many children to have and when to have them. Such programs vary from culture to culture, but most provide information on birth spacing, birth control, and health care for pregnant women and infants.

> Family planning has been a major factor in reducing the number of births throughout most of the world. It has also reduced the number of abortions performed each year and has decreased the numbers of mothers and fetuses dying during pregnancy.

Figure 6-20 These women from a village in the West African country of Burkina Faso are bringing home fuelwood. Typically, they spend two hours a day, two or three times a week, searching for and hauling fuelwood.

> Studies by the UN Population Division and other population agencies indicate that family planning is responsible for a drop of at least 55% in total fertility rates (TFRs) in less-developed countries, from 6.0 in 1960 to 2.7 in 2010.

> For example, family planning, coupled with economic development, played a major role in the sharp drop in average number of children per woman (TFR) in Bangladesh from around 6.8 to 2.4 by 2010. Between 1971 and 2010, Thailand also used family planning to cut its annual population growth rate from 3.2% to 0.6%, and to reduce its TFR from 6.4 to 1.8 children per family. According to the UN, had there not been the sharp drop in TFRs since the 1970s, with all else being equal, the world's population today would be about 8.5 billion instead of 6.9 billion.

WOMEN WELFARE – WHY CONSIDERATION

- ✖ Women suffer in many ways because they are physically weak and harassed
  - + For cultural reasons, domestic violence, mental torture, physical work
- ✖ They are often denied of even their fundamental rights
- ✖ Gender discrimination exists in many parts of the world – girl children are not sent to school, often not given even enough food and women are not permitted to come out of the house.
- ✖ Displacement causes special problems to women. When men go to other places in search of jobs, women are left behind. They do not get any compensation. They will become dependent on males for wages or they may have to take up less decent jobs which are humiliating and give less income.

INTERNATIONAL LEVEL

- ✖ United Nations Decade for Women (1975-85)
- ✖ It held an international convention on the elimination of all forms of Discrimination Against Women, 1979

ORGANIZATIONS FOR WOMEN

- ✖ There is a need for more stringent laws
- ✖ These aspects are looked into in Ministry of Women and Child development
  - + Works for education, family planning, health care and awareness.
- ✖ Many women groups have formed which take up women welfare issues
- ✖ There are legally constituted "women cells" to take care of legal problems of women
- ✖ Displacement of women due to mining and associated problems are taken care of by National Network for Women and Mining" – 20 groups in different states
- ✖ NGO's like Mahila Mandals – trying to create awareness amongst women of remote villages about their rights.

WHAT PROBLEMS DO CHILDREN HAVE?

- ✖ Out of 21 million born, 1 million are abandoned
  - + Social and economic reasons

CHILDREN RELATED PROBLEMS

- ✖ Children are more prone to diseases – especially water borne diseases
- ✖ Childhood cancer rates are increasing at the rate of 6%/year
- ✖ Toxic pollutants are causing birth defects
- ✖ 20 million are estimated to be child labours in India

- ✖ Some in hazardous industries
- ✖ Brass, match making, fireworks…

CHILD LABOUR

- ✖ Main cause is poverty
    - ✚ They do not get nutritive food even
    - ✚ They are often forced to work and not paid well for their work
    - ✚ Their working conditions are unhealthy
    - ✚ They do not get any education

SOLUTION

UN General Assembly in 1959 adopted the "Declaration of the Rights of a Child"

- ✖ It became **INTERNATIONAL LAW** in 1990
- ✖ The law defines the rights of children
    - ✚ Survival, protection, development and participation

1. Right to survival: Good standard of living, good nutrition and health
2. Right to protection: Freedom from exploitation, abuse and inhuman treatment
3. Right to development: Access to education, early child care and support, social security and right to leisure and recreation
4. Right to participation: Freedom of thought, conscience and religion and right to appropriate information
5. World summit on children in 1990
6. Agenda for the well being of children – to be achieved by the new millennium ndia also signed to agree with it.
7. Ministry of Human Resource Development has formulated the plan for child development

STRATEGIC PLAN FOR CHILD DEVELOPMENT

- ✖ Priority is given for
    - ✚ Health, education, nutrition, clean and safe drinking water, sanitation and good environment
    - ✚ Access to schooling, specially for girls
    - ✚ Education including health and nutrition, diseases and their causes
    - ✚ Up gradation of home-based skills for girls,

+ Mid-day meals scheme
+ Low cost early childhood development activities

CONSUMERISM

- Consumer - someone who buys and uses goods and services
- Consumerism

- a theory that a progressively greater consumption of goods is economically beneficial
- a preoccupation with and an inclination towards the buying of consumer goods
- refers to consumption of resources by people

- ❑ Problem of improper consumerismUncontrolled manufacture of goods leading to inferior quality
- ❑ Rampant adulteration leading to health and hygiene problems
- ❑ Improper services resulting in dissatisfaction and stress
- ❑ Production of lots of waste leads to depletion of natural resources and environmental imbalance

Consumerism

– increasing exponentially due to increase in population
- more demanding life-style

Two types of conditions

(i) People over-population: per capita consumption less
- more people than available resources
- over-exploitation of resources
– environmental degradation
– poverty, premature deaths, under-nourishment
- (ii) Consumption over-population

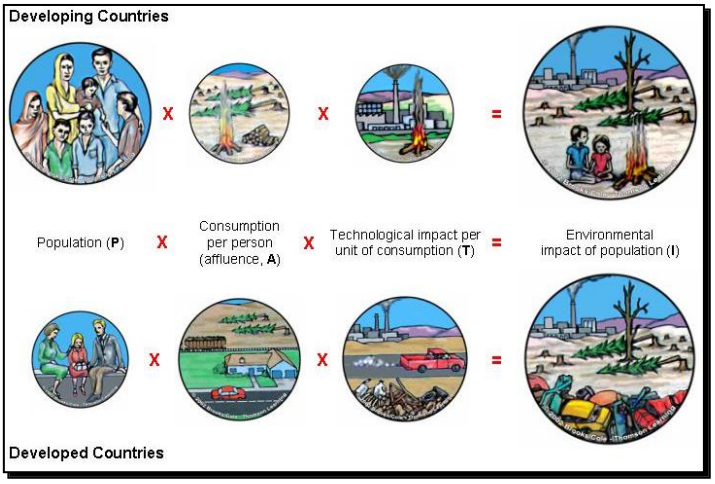
Less developed countries (LDCs)

- over all consumption is high – Less population but consumption of more resources
- Per capita consumption is high – luxurious life style
- More consumption of resources and hence more waste generation

CONSUMERISM AND IMPACT ON ENVIRONMENT:

Paul Ehrlich and John Holdren developed a simple model showing how population size (P), affluence or resource consumption per person (A), and the beneficial and harmful environmental effects of technologies (T) help to determine the environnmental impact (I) of human activities

Environnemental Impact (I) = (P) X (A) X (T)



Economic Systems

Supported by Three Types of Resources

- **Natural capital**

- resources and services produced by the earth's natural processes, which support all economies and all life.

- **Human capital, or human resources, includes**

-people's physical and mental talents that provide labor, organizational and management skills, and innovation.

- **Manufactured capital, or manufactured resources**

- items such as machinery, equipment, and factories made from natural resources with the help of human resources.

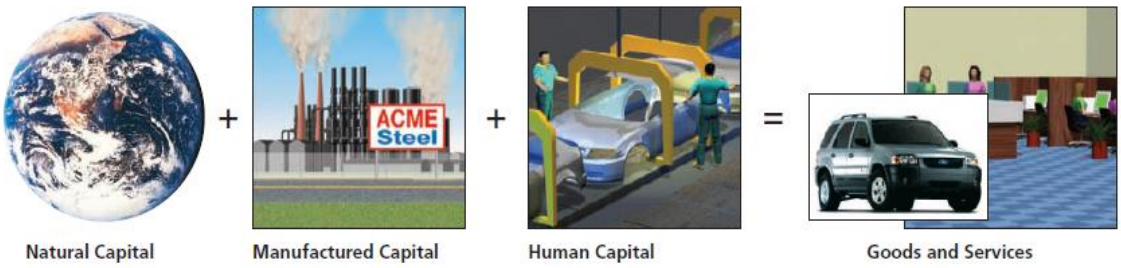
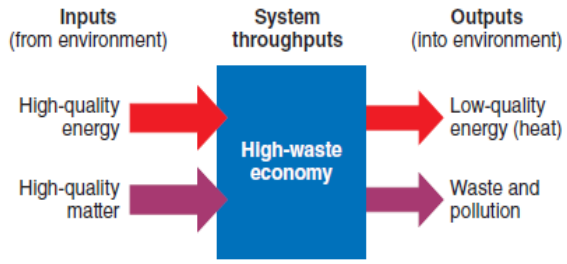
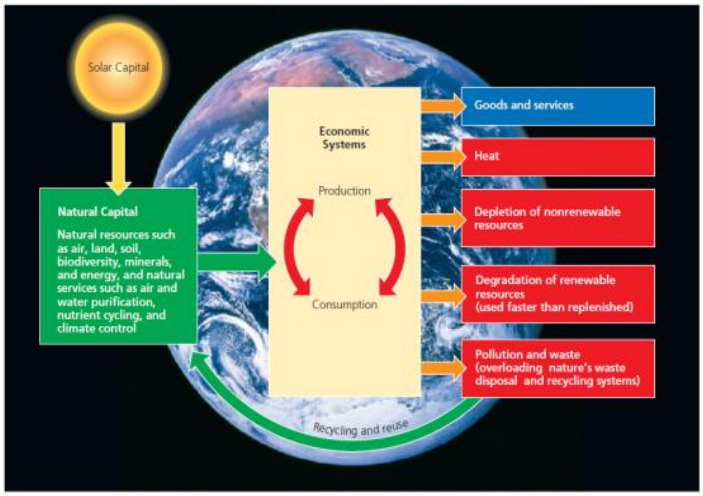


Figure 23-2 In an economic system, we use three types of resources to produce goods and services.

High throughput Economy

(Negative impact on Environment





CENGAGENOW™ **Active Figure 23-5** *Ecological economists* see all human economies as subsystems of the biosphere that depend on natural resources and services provided by the sun and earth. *See an animation based on this figure* at CengageNOW. **Question:** Do you agree or disagree with this model? Explain.

<u>Ecological economists suggest that:</u>

1. **Resources are limited and we should not waste them**, and there are no substitutes for most types of natural capital.

2. We should **encourage environmentally beneficial and sustainable forms of economic development**, and discourage environmentally harmful and unsustainable forms of economic growth.

3. The harmful environmental and health effects of producing economic goods and services should be included in their market prices **(full-cost pricing),** *so* that consumers will have more accurate information about the harmful environmental and health effects of the goods and services they buy.

Economic Tools for Environmental Protection

- Economic growth is usually measured by the percentage change in a country's GDP.
- **Gross domestic product (GDP): the annual market value of all goods and services** produced by all firms and organizations, foreign and domestic, operating within a country.
- Changes in a country's economic growth per person are measured by **per capita GDP: the GDP divided by a country's total** population at midyear.

- New indicators—called environmental indicators—to help monitor environmental quality and human well-being.
- One such indicator is the **genuine progress indicator (GPI)—**GDP plus the estimated value of beneficial transactions that meet basic needs, but in which no money changes hands, minus the estimated harmful environmental, health, and social costs of all transactions.

$$\text{Genuine progress indicator} = \text{GDP} + \text{benefits not included in market transactions} - \text{harmful environmental and social costs}$$

- **Gross national happiness (GNH)** as a measure of its efforts toward sustainable economic development. Its GNH is based on an evaluation of the country's conservation of its natural environment, preservation of cultural values, fairness in access to its wealth (equity), and good governance

Ways to Sustainable Environment

- Environmental Economic Indicators Could Help Us Reduce Our Environmental Impact
- Include the Harmful Environmental Costs of Goods and Services in Their Prices
- Label Environmentally Beneficial Goods and Services
- Reward Environmentally Sustainable Businesses
- Tax Pollution and Wastes Instead of Wages and Profits
- Environmental Laws and Regulations Can Discourage or Encourage Innovation
- Use the Marketplace to Reduce Pollution and Resource Waste
- Reduce Pollution and Resource Waste by Selling Services Instead of Things

Trade-Offs

Tradable Environmental Permits

Advantages

Flexible

Easy to administer

Encourage pollution prevention and waste reduction

Permit prices determined by market transactions

Disadvantages

Big polluters and resource wasters can buy their way out

May not reduce pollution at dirtiest plants

Caps can be too high and not regularly reduced to promote progress

Self-monitoring of emissions can allow cheating

Trade-Offs

Environmental Taxes and Fees

Advantages

Help bring about full-cost pricing

Encourage businesses to develop environmentally beneficial technologies and goods to save money

Easily administered by existing tax agencies

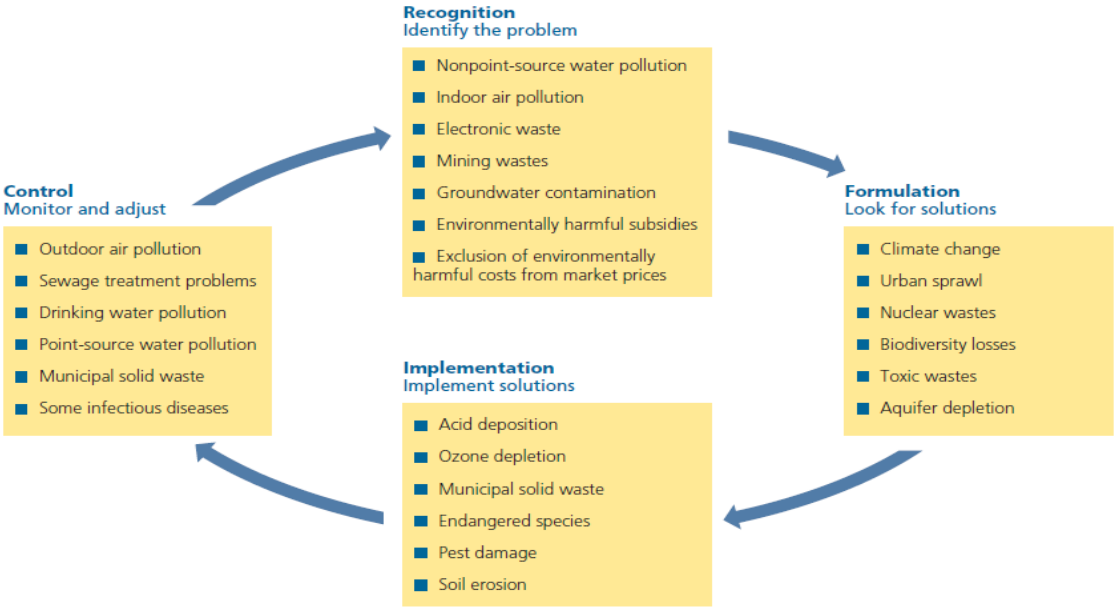
Disadvantages

Low-income groups are penalized unless safety nets are provided

Hard to determine optimal level for taxes and fees

Governments may use money as general revenue instead of improving environmental quality and reducing taxes on income, payroll, and profits

Environment policy recognition



Poverty and Environmental Issues

Reducing poverty can help us to reduce population growth, resource use, and environmental degradation.

- Mount a massive global effort to combat **malnutrition and the infectious diseases** that kill millions of people prematurely

• Provide universal **primary school education** for the world's nearly 800 million illiterate adults (a number that is 2.5 times the size of the U.S. population).

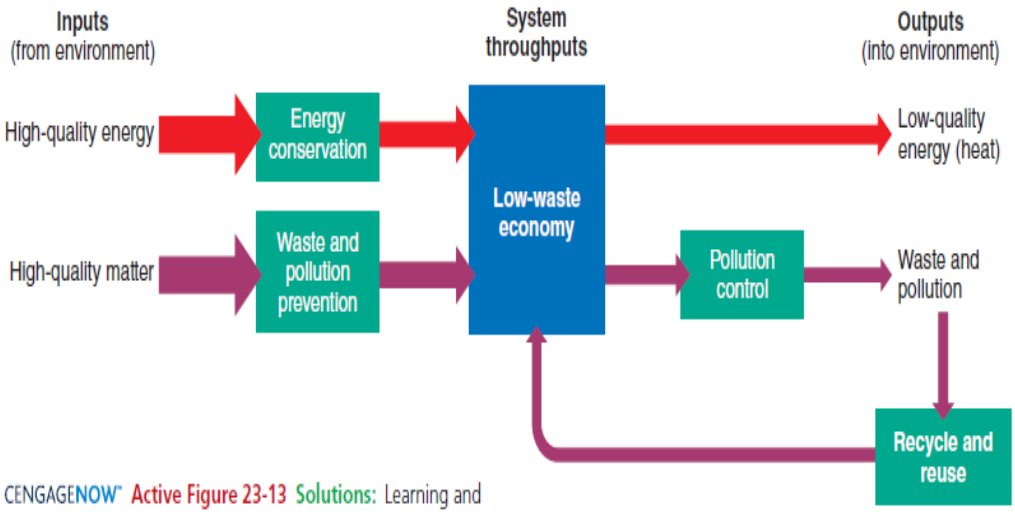
According to Nobel Prize–winning economist Amartya Sen, **"Illiteracy and innumeracy are a greater threat to humanity than terrorism."** Illiteracy can also foster terrorism and strife within countries by creating large unemployed individuals who have little hope of improving their lives or those of their children.

• Provide assistance to stabilize population growth in less-developed countries as soon as possible, mostly by investing in **family planning, reducing poverty, and elevating the social and economic status of women**. Focus on sharply reducing the total and per capita ecological footprints of their own countries as well as those of rapidly growing less-developed countries such as China and India.

• Make large investments in small-scale infrastructure such as **solar-cell power facilities in villages, as well as sustainable agriculture projects** that would enable less-developed nations to work towards more energy-efficient and sustainable economies.

• Encourage **lending agencies to make small loans to poor people** to increase their income.

Sustainable Economy – A Low throughput Economy



CENGAGENOW* Active Figure 23-13 Solutions: Learning and applying lessons from nature can help us design and manage more sustainable economies. A *low-throughput economy*, based on

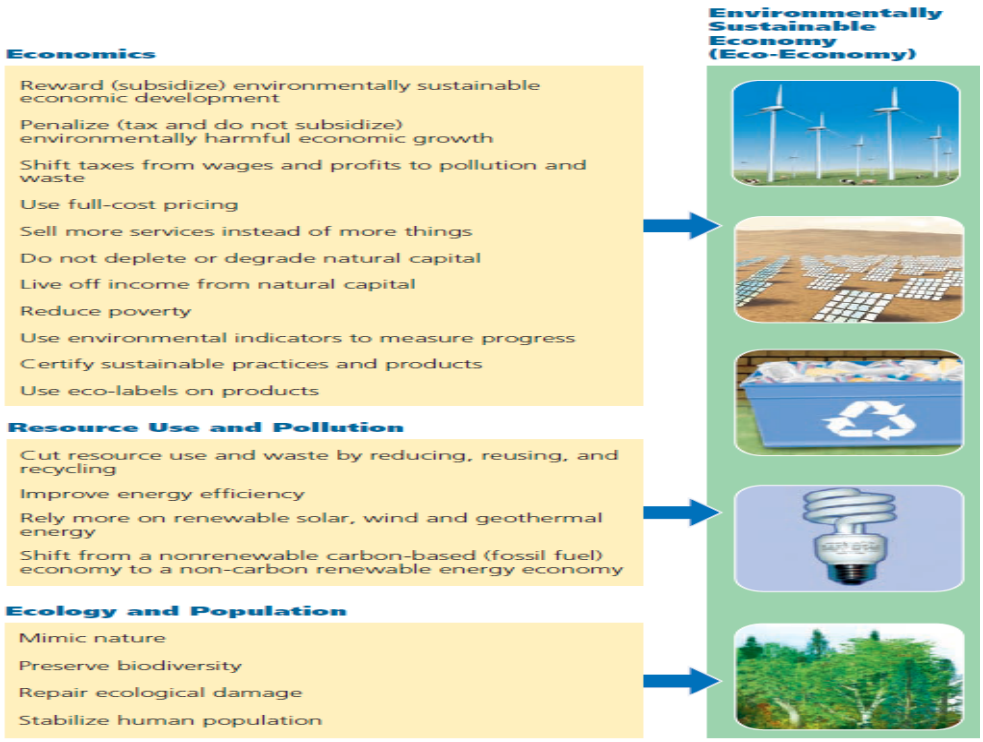


Figure 23-14 Solutions: We can use certain principles for shifting to more environmentally sustainable economies, or *eco-economies*, during this century.

Environmentally Sustainable Economies

We can use the three principles of sustainability as well as various economic and environmental strategies to develop more environmentally sustainable economies**.**

- To estimate and include the harmful environmental and health costs of producing goods and services in their market prices.

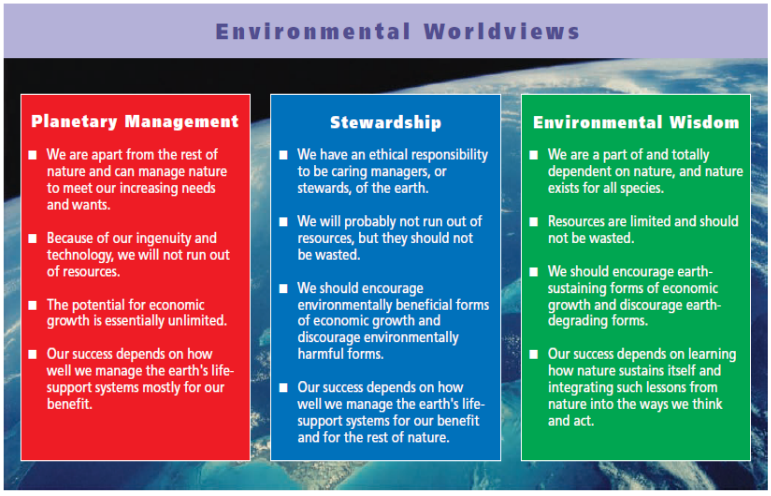
■ Phasing out environmentally harmful subsidies and tax breaks, and replacing them with environmentally beneficial subsidies and tax breaks.

■ Tax pollution and wastes instead of wages and profits, and to use most of the revenues from these taxes to promote environmental sustainability and to reduce poverty.

We Can Become More Environmentally Literate:

Learning how to live more sustainably requires a foundation of environmental education aimed at producing environmentally literate citizens. Here are some key goals for each person seeking environmental literacy:

- Understand as much as we can about how the earth works and sustains itself, and use such knowledge to guide our lives, communities, and societies. •
- Understand the relationships between the economy and the earth's natural support systems and the role of economics in making the transition to more sustainable economies and societies. •
- Use critical thinking skills (p. 2) to become seekers of environmental wisdom instead of overfilled vessels of environmental information and misinformation. •
- Understand and evaluate our environmental worldviews and continue this as a lifelong process.
- We can literate ourselves by environmental wisdom view



Major component of environmental education

Module 6 - Important Questions:

2. Explain urban environmental problems?
3. Discuss the benefits of urbanisation?
4. Discuss the dis-advantages of urbanisation?
5. What is exponential growth? Describe the past, current, and projected exponential growth of the world's human population?
6. Explain the different age structure for different country?
7. What is consumerism? How is it related environmental impact? How it is differ from developed to developing county?
8. How to slow the world population growth?
9. What is necessity of women empowerment?
10. How women empowerment and child welfare related to population growth?
11. How women could stabilize the population growth?
12. Explain the definition of sustainability? How can we live more sustainably?
13. What is called demographic transition? How demographic transition is related to zero population growth?
14. What is RFR and TFR? How is it related to population growth?
15. What is zero population growth? How zero population growth could be achieved?
16. What is economics? Distinguish among natural capital, human capital (human resources), and manufactured capital (manufactured resources). What is a high-throughput economy?

17. List eight principles that ecological and environmental economists would use to make the transition to more sustainable eco-economies.
18. Define and distinguish between gross domestic product (GDP) and per capita GDP. What is the genuine progress indicator (GPI) and how does it differ from the GDP economic indicator?
19. What is poverty and how is it related to population growth and environmental degradation? List three ways in which governments can help to reduce poverty.
20. What is an environmental worldview? What are environmental ethics? Distinguish among the following environmental worldviews: planetary management, stewardship, and environmental wisdom
21. Define politics, policies, and democracy. Describe eight principles that decision makers can use in making environmental policy?

Module 7

Global Climate Change and Mitigation

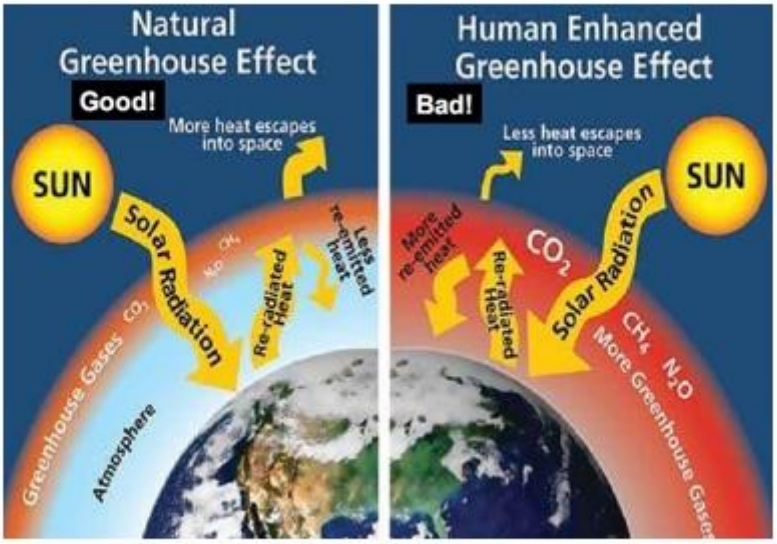
- Climate disruption
- Greenhouse effect
- Ozone layer depletion
- Kyoto protocol, Carbon credits
- Carbon sequestration methods
- Montreal Protocol
- Acid rain
- Role of Information technology in environment
- Case Studies

Climate disruption and Greenhouse effect:

The progressive heating up of atmosphere and earth's surface due to IR trapping gases like CO_2 is called greenhouse effect. Part of the sun's radiation falling on earth's surface is reflected and another part is absorbed. The absorbed radiation is later radiated out. If all the absorbed light is radiated out earth should cool very much in the night.

But day and night temperatures in many places differ very little. This is because of Greenhouse effect by certain gases like Carbon dioxide, Methane, Chlorofluorocarbons, Nitrous oxide, Ground level Ozone in the atmosphere that can absorb IR radiation emitted by the earth. Thus earth does not cool as much as it does without them.

Greenhouse gases can absorb upto 70% of the radiation. If there are more Green House gases than the natural level, Earth gets heated up beyond normal temperatures and this is called Global warming.



Bad Effects of Global warming:

1. Land and ocean temperatures rise
2. North and south pole Glaciers melt
3. Sea levels rise (due to oceans warming in “swells” and due to melting of polar regions)
4. Ocean currents change
5. Weather patterns change

6. Ecological disturbance
7. Effect on Agriculture
   Uncertain weather – severe changes in precipitation

   Droughts and famine (some areas)

   Excessive rains in other regions cause floods and loss of crops.

   Soil moisture will change

   Pest growth is altered

   Pests adapt better than crops

8. Effect on biodiversity
   Extinction of Polar Bears: Require pack ice to live
   Sea turtles : Breed on the same islands as their birth ; Could go extinct on some islands as beaches are flooded

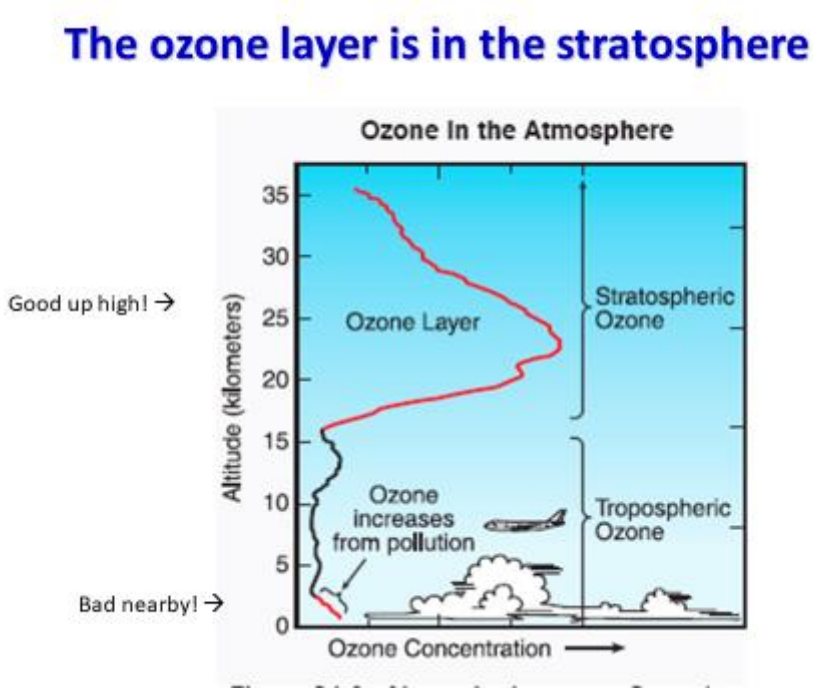
   Other species may go extinct as rainfall patterns change throughout the world

9. Effect on human health
   Fewer deaths from cold, more from heat
   Since more mosquitoes, snails and insects can grow (as more fish which eat them die due to increase in temperature of the water) – diseases like malaria will be on high.
   Higher temperature and humidity increase sweating and cause skin diseases and respiratory diseases.

Steps to Prevent Global Warming:

- Plant more trees
- Control population growth
- Cut down rate of CFC's and fossil fuels
- Use non-conventional (renewable) sources of energy
- Shift from coal to natural gas
- Reduce carbon dioxide from smoke
- Use photosynthetic algae to remove carbon dioxide
- Adopt sustainable agriculture – grow heat resistant crops

Ozone layer depletion



Ozone Layer is located in the stratosphere and it protects the Earth from ultraviolet rays emitted by the sun. The wavelengths of ultraviolet radiation are absorbed by the ozone molecules.

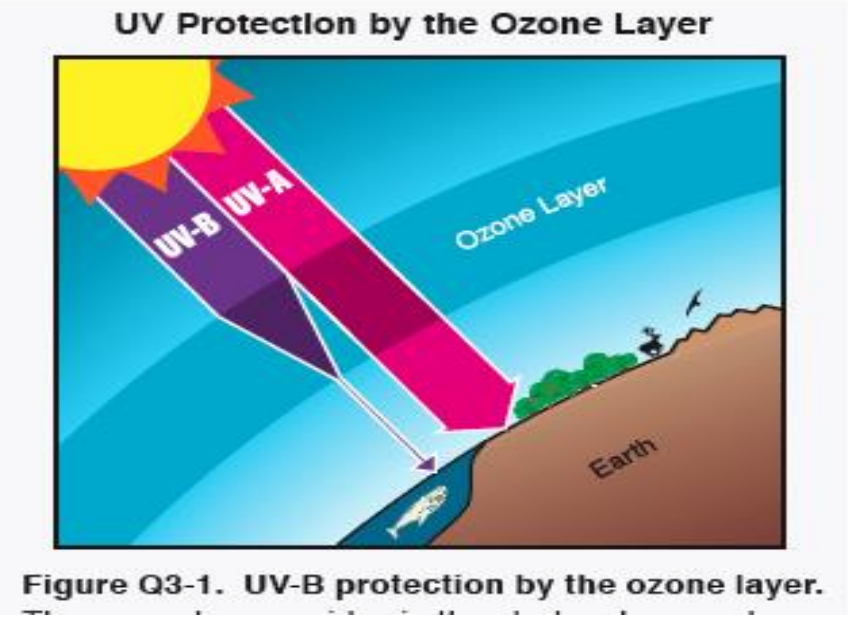
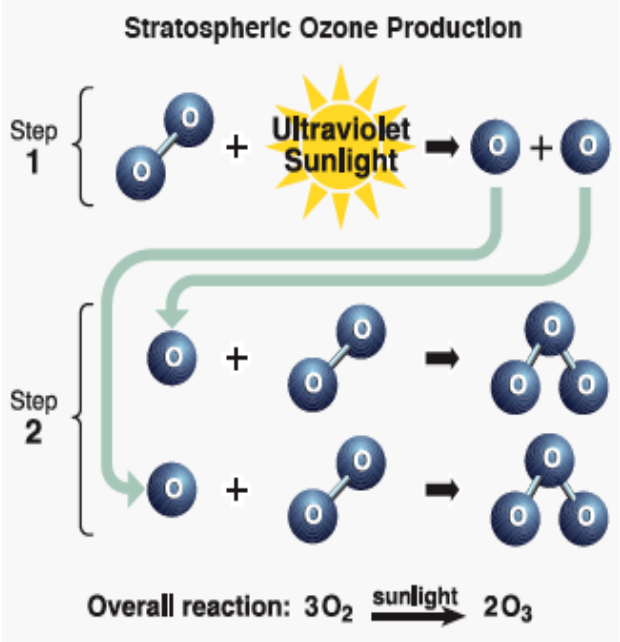


Figure Q3-1. UV-B protection by the ozone layer.

-Ozone absorbs UV-B radiation

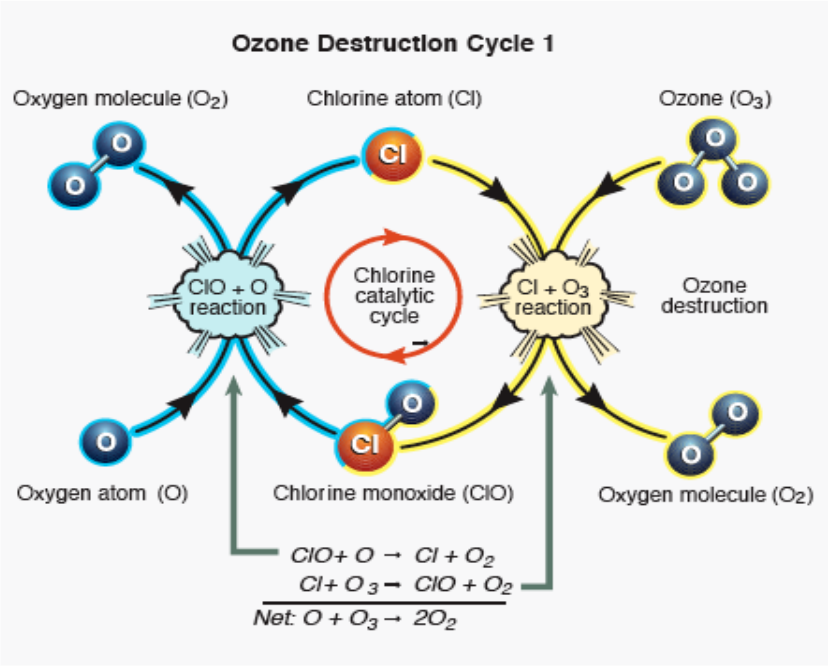
Natural cycle of formation and depletion of ozone:



Chlorofluoro carbons (CFC's) and other halogenated hydrocarbons(HCFCs, methyl bromide, carbon tetrachloride, NO2, and methyl chloroform) contribute to the destruction of stratospheric ozone. Just one chlorine and bromine atom can catalyze the destruction of 100,000 ozone molecules.

CFCs were used in refrigerators, home insulation, aerosols, plastic foam, and throwaway food containers. Both chlorine and bromine from halogenated hydrocarbons deplete the ozone.

Chlorine and bromine-containing compounds (CFC's) are stable in the troposphere, but degraded under intense ultraviolet light in stratosphere. UV rays release the chlorine (Cl) from the CFCs, causing ozone (O3) to be depleted.



Natural Capital Degradation

Effects of Ozone Depletion

Human Health

- Worse sunburns
- More eye cataracts and skin cancers
- Immune system suppression

Food and Forests

- Reduced yields for some crops
- Reduced seafood supplies from reduced phytoplankton
- Decreased forest productivity for UV-sensitive tree species

Climate Change

- While in troposphere, CFCs act as greenhouse gases

Wildlife

- Increased eye cataracts in some species
- Decreased populations of aquatic species sensitive to UV radiation
- Reduced populations of surface phytoplankton
- Disrupted aquatic food webs from reduced phytoplankton

Air Pollution and Materials

- Increased acid deposition
- Increased photochemical smog
- Degradation of outdoor paints and plastics

Kyoto protocol, Carbon credits

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. It aims at reduction of Green House Gases (GHGs) and others like CFCs

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. Currently, there are 192 Parties (191 States and 1 regional economic integration organization) to the Kyoto Protocol to the UNFCCC. Countries have committed to cut emissions of CO_2

Other Green house gases such as Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFC's), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

Goals of Kyoto Protocol:

- To reduce emissions of greenhouse gases by **5.2% by 2012**
- Individual countries were assigned higher or lower targets
- Due to more than 150 years of industrial activity, developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere
- The total percentage of developed countries emissions is 63.7%
- Protocol places a heavier burden on developed nations
- Any country that fails to meet its **Kyoto Protocol** target will be penalized

Characteristics of Kyoto Protocol:

- India and China are not obligated to reduce greenhouse gas production at the moment as they are developing countries
- The Protocol allows developed countries to meet their GHG emission limitations by several "flexible mechanisms"
  - Emissions trading (in terms of carbon credits/Kyoto credits)
  - Clean Development Mechanism (CDM)
  - Joint implementation

Carbon Credits

Carbon credits and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of greenhouse gases (GHGs).One carbon credit is equal to reduction of one ton of carbon dioxide.

The goal is to allow market mechanisms to drive industrial and commercial processes in the direction of low emissions of GHGs into the atmosphere. During Kyoto protocol, allocation of carbon credits or Kyoto credits was made to different countries. Each credit gives the owner the right to emit one metric tonne of carbon dioxide or other equivalent greenhouse gas.

If a country exceeds its emission quota, it has to pay for it in three possible mechanisms to get back the credits:-

- Mechanims I – **Emission Trading**
- Mechanism II – **Clean Development Mechanism**
- Mechanism III – **Joint Implementation Mechanism**

Carbon credits can be gained even by individuals within a country by developing projects that reduce GHG emissions. Several private and government organizations are existing now for sale

and purchase of carbon credits. The actual value of each credit may vary, subject to the market position. Currently its value is about 12-20 Euros.

Carbon Credits – India Scenario:

India has generated approximately 30 Million carbon credits. About 140 million in run, the second highest transacted volumes in the world. India's carbon market is growing fast. 850 projects with a huge investment of Rs 650,000 million are in pipeline. The revenue from 200 projects is estimated at Rs. 97 billion till 2012 (As per the Prime Minister's Council on Climate Change). India has been able to register approximately 350 projects spread across various sectors .

Montreal Protocol

The Montreal Protocol aims at Substances That Deplete the Ozone Layer. It is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion. Treaty was opened for signature on September 16, 1987 and came into force on January 1, 1989. In 1987, representatives of 36 nations met in Montreal, Canada, and developed the *Montreal Protocol.* This treaty's goal was to cut emissions of CFCs by about 35% between 1989 and 2000.

About 36 countries signed the treaty and 196 countries has approved the treaty. The ozone layer is expected to recover to 1980 levels by 2050. Kofi Annan quoted as saying that "perhaps the single most successful international agreement to date has been the Montreal Protocol". Seasonal thinning of ozone layer above Antarctica in 1989. The largest Antarctic ozone hole recorded as of September 2006.

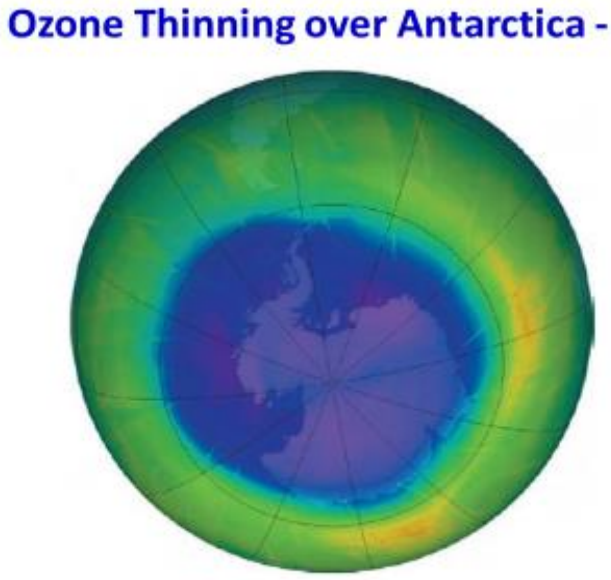


Figure 19-21 Natural capital degradation: This colorized satellite image shows massive ozone thinning over Antarctica during several months in 2009. The center of this image shows a large area where the concentration of ozone has decreased by 50% or more. (Data from NASA)

Carbon sequestration methods

Carbon sequestration is the general term used for the capture and long-term storage of carbon dioxide.

Capture can occur

- Point of Emission – Ex: Power plants
- Through natural resources – Ex: Photosynthesis

It removes carbon dioxide from the earth's atmosphere.

Sequestration methods include:

- Soil Sequestration - enhancing the storage of carbon in soil
- Plant Sequestration - enhancing the storage of carbon in forests and other vegetation
- Geosequestration - storing carbon in underground geological formations
- Ocean Sequestration - storing carbon in the ocean
- Mineral Carbonation - subjecting carbon to chemical reactions to form inorganic carbonates

Soil sequestration

Soils contain 700 gigatonnes (Gt, 109 tonnes) to 3000 Gt of carbon. When forests are converted to agricultural land, the soil carbon content decreases. Agricultural usages also tend to reduce soil carbon.

Current research is use of "biochar" to increase the soil carbon sink. Biochar is a type of charcoal that results from heating organic materials such as crop residue, wood chips, municipal waste or manure in an oxygen-limited environment. This process is known as "Pyrolysis".

Management practices that can retain or increase the carbon content of soils include

- low-tillage or no tillage
- use of manures and compost,
- conversion of monoculture systems to diverse systems
- crop rotations and winter cover crops
- establishing perennial vegetation on steep slopes.

Plant sequestration

Plants use the energy of sunlight to convert CO_2 from the atmosphere to carbohydrates for their growth and maintenance, via the process of photosynthesis. Uptake of CO_2 by vegetation will decrease with time as plants grow to their full capacity

Biological storage could be enhanced through agricultural and forestry practices and revegetation. It provide a significant shorter-term contribution to climate change mitigation.

Geosequestration

Geosequestration is the injection and storage of greenhouse gases underground, out of contact with the atmosphere.

Suitable site - geological formation

- Depleted oil and natural gas fields, coal beds.
- Deep natural reservoirs filled with saline water (saline aquifers)

Enhanced Oil Recovery (EOR) involves injecting CO_2 into the oil-containing reservoir to pressurize the reservoir and improve the rate of flow of oil. The displaced oil is pushed through the well bore

Ocean sequestration

The ocean represents the largest carbon store on earth. It has a significant sink for anthropogenic CO_2 emissions of similar magnitude to the land sink.

Proposed to bypass the natural ocean CO_2 uptake mechanism thro' inject CO_2 directly into the deep ocean. It would remain isolated from the atmosphere for several centuries

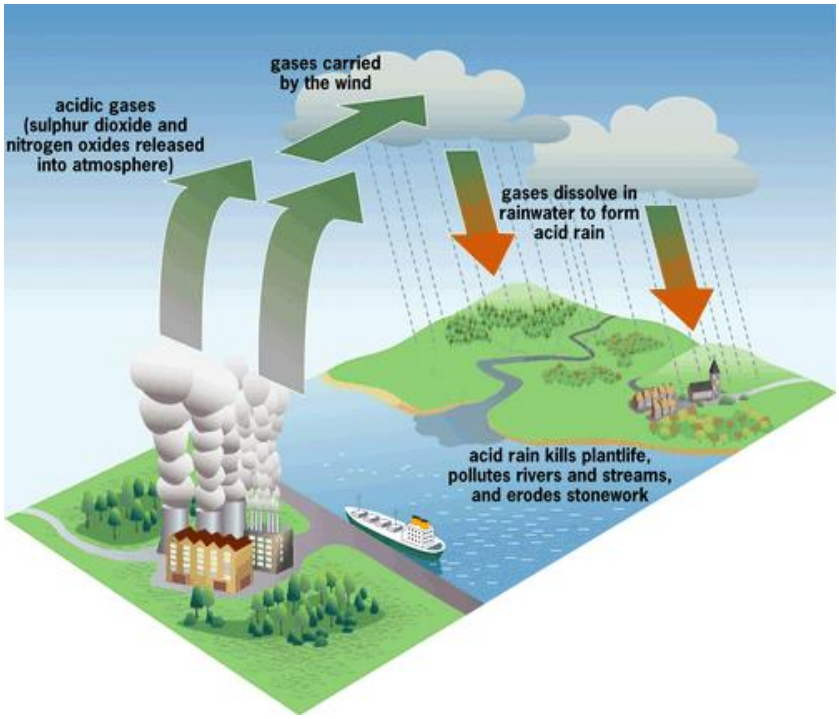
Alternative method - large scale ocean fertilisation with iron to stimulate phytoplankton growth and photosynthesis.

Mineral sequestration

It is also known as mineral carbonation. It involves reaction of CO_2 with metal oxides that are present in common, naturally occurring silicate rocks. It mimics natural weathering phenomena. There are sufficient reserves of magnesium and calcium silicate deposits to fix the CO_2.

Acid Rain

Normal rain water is slightly acidic because it contains dissolved carbon dioxide (CO_2), Sulphur dioxide (SO_2) and Nitrogen oxides (NO_x) which are normally present in the air. Acid rain contains more acidity than the normal value. Due to presence of acid ions & due to the dissolution of these gases present in higher concentration. Air pollution caused by gaseous emissions from **industrial sources**, **burning of fuels** (thermal plants, chimneys of brick-kilns or sugar mills) and **vehicular emissions**. Acid rain will occur locally near the sources of air pollution. Due to the movement of air, acid rain may occur for away from the source.



U.K. contributes 26% of the acidic sulphur deposited in the Netherlands, 23% in Norway and 12% in Sweden. Acid emissions arise naturally from volcanoes, forest fires and biological decomposition, especially in the oceans. SO_2 pollutions is mostly contributed by thermal power plants, refineries industry and NO_x form road transport, power stations and industry. Acid gas concentrations in the air will vary according to location, time and weather conditions.

Effects of Acid Rain:

- **Damage to aquatic life**
  - reduction in diversity and populations of fresh water species
  - soil organisms are killed in acid rain
- **Damage to Trees and Plants**
  - SO_2 has a direct toxic effect on trees
  - acidifying soils which may cause loss of essential nutrients such as magnesium, thus impairing plant growth
- **Damage to Buildings and Materials**
  - All historic buildings suffer damage and decay with time
  - SO_2 penetrated porous stones such as limestone and is converted to calcium sulphate

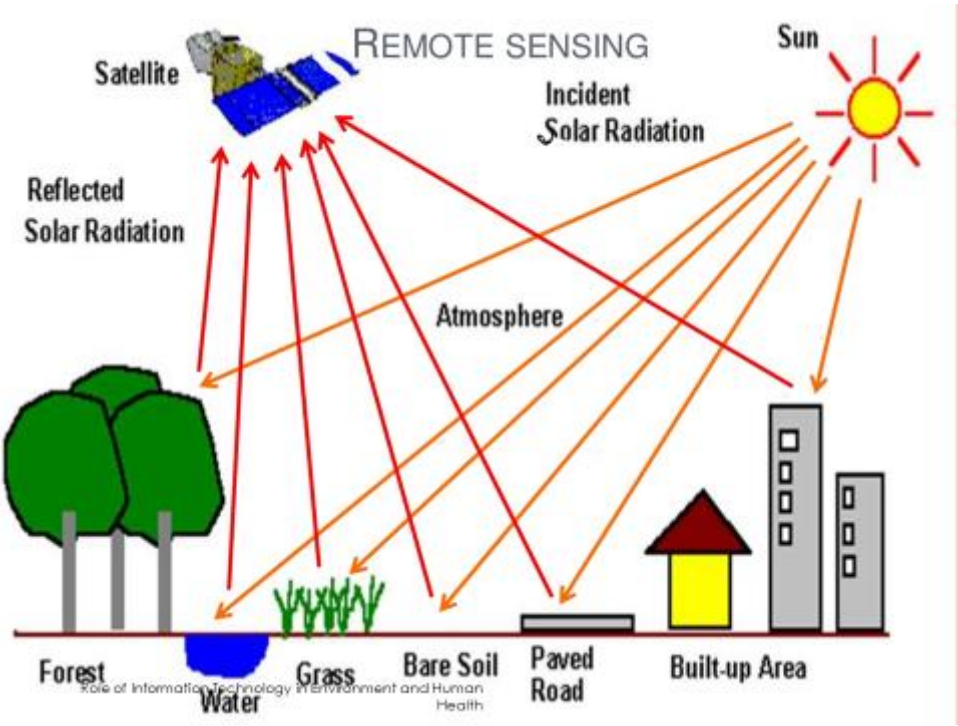
Reducing acid pollution:

- Fuels may be treated to reduce their sulphur content. Cut the eventual emissions of SO_2 by the introduction of a sorbent such as limestone

- No_x can be reduced by adding ammonia and passing it over a catalyst to produce nitrogen and water. This process is called **selective catalytic reduction** (SCR)
- Fitting a catalytic converter to the exhaust system reduces NOx emissions by up to 90%
- To develop non-fossil fuel energy sources such as nuclear power or renewable energy (solar, wind, tidal power, etc.)

Role of Information technology in environment

Development of internet facilities, worldwide web, Remote sensing, geographical information system (GIS) and information through satellites has generated a wealth of up-to-date information on various aspects of environment and health.



❖ **Database:**

The Ministry of Environment and Forests (MoEF), Government of India has compiled database on various biotic communities - wildlife database, conservation database, forest cover database and for diseases like HIV/AIDS, Malaria, Fluorosis.

❖ **National Management Information System (NMIS):**

NMIS of Department of Science and Technology has compiled a database on Research and Development Projects along with information about research scientists and personnel involved.

❖ **Environmental Information System (ENVIS):**

MoEF has created an Information System called Environmental Information System (ENVIS).

The ENVIS generates network of database in areas like pollution control, clean technologies, remote sensing, coastal ecology, biodiversity, western Ghats and eastern Ghats, environmental management, media related to environment, renewable energy, desertification, mangroves, wildlife, Himalayan ecology, mining, etc.

The National Institute of Occupational Health provides computerized information on occupational health i.e. the health aspects of people working in various hazardous and non-hazardous industries, safety measures.

- **World Wide Web**

www.mhhe.com/environmental science

- **Remote Sensing and Geographical Information System (GIS)**

Satellite imageries provide us actual information about various physical and biological resources, water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves.

Digital information on a number of aspects like water resources, industrial growth, human settlements, road network, soil type, forest land, crop land or grassland.

Monsoon, ozone layer depletion, inversion phenomena, smog.

We are able to discover many new reserves of oil, minerals.

Disease infested areas prone to vector-borne diseases malaria, schistosomiasis

IT related Case Studies

Ocean Monitoring Satellites:

IRS-P4 Ocean Color Monitor, IRS-P4 OCM is the first satellite sensor developed and launched by India for ocean color applications on 26 May 1999. India launched another similar ocean-monitoring satellite on Sept. 23, 2009. The main objectives of the satellites are to study surface winds and ocean surface strata, observation of chlorophyll concentrations in ocean waters, monitoring of phytoplankton blooms, study of atmospheric aerosols and suspended sediments in the water.

<u>HealthSAT project</u> by ISRO (Indian Space Research Organization) :

A project initiated by ISRO that provides infrastructure for rural areas as well as the communication bandwidth via its dedicated HealthSAT satellite. A telemedicine system in a small health centre consists of a personal computer with customized medical software connected to a few medical diagnostic instruments, such as an ECG or X-ray machine or an X-ray scanner for scanning X-ray photos. Through this computer, digitized versions of patients' medical images and diagnostic details (such as X-ray images and blood test reports) are dispatched to specialist doctors through the satellite-based communication link. The information, in turn, is received at the specialist centre where experienced doctors examine the reports, diagnose, interact with the patients (along with local doctors), and suggest appropriate treatment through video-conferencing.

KIOSK:

The Information Kiosk, is an IT based facility that rural communities avail of to examine the data they collected in different graphical forms and tables - without the support of an outsider.

The Kiosk software is totally touch screen driven (no physical keyboard) with large icons displaying limited but focused data supported by graphics and animations. Local language is used (though the system has multi-lingual capability) and has very simple and clear navigational paths.

Here, IT provides an opportunity to the rural communities to use tools that support them in decision making related to groundwater use and cropping system changes.

Software monitoring of wildlife:

New Delhi: In a bid to save the endangered big cats, the Centre is introducing M-Stripes, a software monitoring system to strengthen effectiveness of surveillance and anti-poaching measures, in all the 39 tiger reserves across the country. This program is already introduced in some reserves and a decline in poaching is already noticed in them.

Module 7- Important Questions

1. How carbon credits will help you to earn money from it? Explain.
2. Will it be easier for societies to mitigate climate change by implementing any protocol? Explain your answer.
3. Why has an "ozone hole" appeared over Antarctica when ozone depleting substances are present throughout the stratosphere?
4. What is carbon footprint? Why carbon capture and sequestration is important?
5. How does emission trading and clean development scheme help the countries to control the emission of GHG?
6. How earth's mountain glaciers are progressing and influencing warming world?
7. Ozone could be both good and bad for earth's environment? Explain.
8. Our government wants the net carbon emission of our country to be zero in the next few years. Suggest suitable methods to reach the goal.
9. If Montreal protocol is implemented in a developing country like China or developed country like Germany, who will be benefitted more with this? Write a proper explanation.
10. Why do we need to capture and store carbon dioxide? Discuss briefly any two methods of carbon sequestration.
11. If you are a policy maker, what are the steps you would take to minimize the emission of greenhouse gases?
12. What are the possible reasons you think that is behind the success of Montreal protocol.
13. Explain the role of information technology in environment and health.
14. Explain the reason for Artic sea ice is melting faster than predicted. Discuss the methods to control the Artic ice melting.
15. What are the environmental impact of CFC release and explain with mechanism.