Course Outcomes (CO's)

CO1. Environmental studies course will provide necessary information and knowledge about the various aspects of environment, ecosystems, and related biodiversity.

CO2. Students will be able to learn and understand about the availability and sustainable use of resources, environmental problems and their short term and long-term impacts to humans.

CO3. Course will help them to learn about environmental policies and protocols, social issues and role of human in conservation and protection of environment.

CO4. Overall course, will help students to develop skills and ability of understanding environment human relationship.

SYLLABUS

Unit 1.

Fundamentals: The multidisciplinary nature of environmental studies: Definition, components, scope and importance, need for public awareness, natural resources. Ecosystem: concept, Structure and function of an ecosystem, Types, Functional Components, Different ecosystems, biogeochemical cycle. Biodiversity: Introduction to biodiversity, biogeographical classification, India as a mega diversity nation, endangered and endemic species of India, threats to biodiversity and conservation of biodiversity. Bioprospecting and Biopiracy.

Unit 2

Environmental Pollution: (a) Air Pollution: Source, Types, effects on biosphere and Meteralogy, Air Quality Controi. (b) Water Pollution: Types and Sources. (c) Soil Pollution: Types and Control. (d) Noise Pollution: Effect, Control (e) Thermal Pollution. (f) Radiation Pollution (g) Solid waste Management, (h) Pollution Prevention, (i) Disaster Management

Unit 3

Social issues and Environment: Concept of Sustainable Development; Urban problem related to energy; Water Conservation; Wasteland reclamation; Resettlement and Rehabilitation; Climate Change; Nuclear Accidents; Consumerism and Waste Products; Laws related to Evironment, Pollution, Forest and-Wildlife; Environmental Impact Assessment.

Unit 4

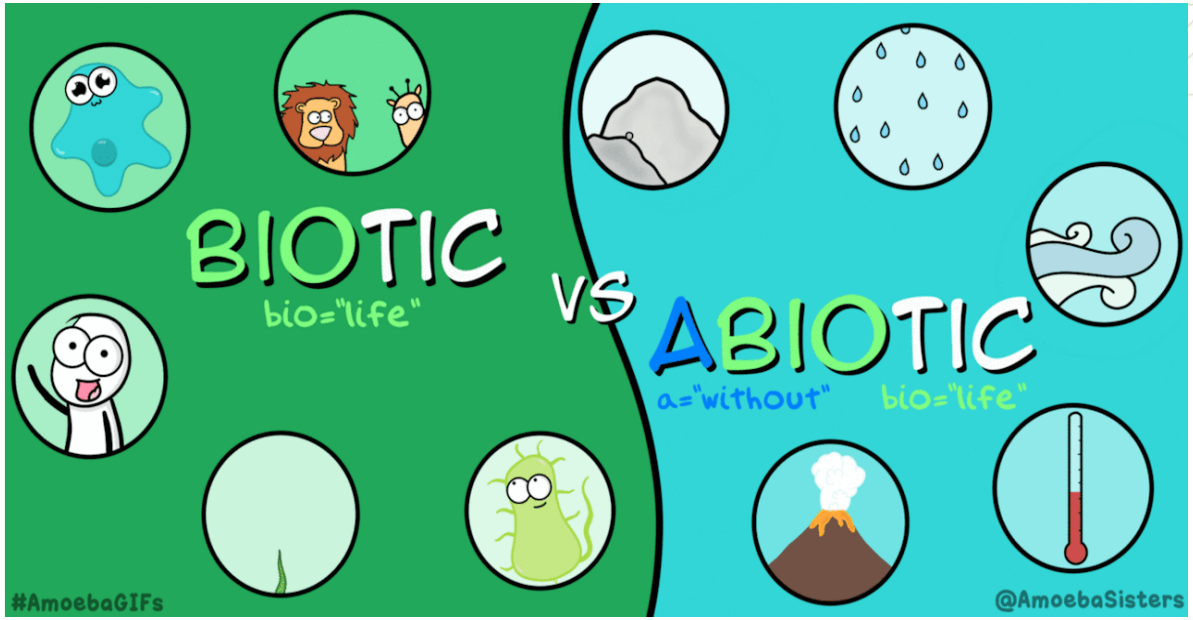
Human Population and Environment: Population Growth, Human Rights, Family Welfare Programmes, Environment and Human Health, HIV/AIDS, Women and Child Welfare, Role of IT.

Environment:

- It can be simply defined as one's surroundings. It includes everything that surrounds the organism- abiotic (non living) and biotic (living) environment.

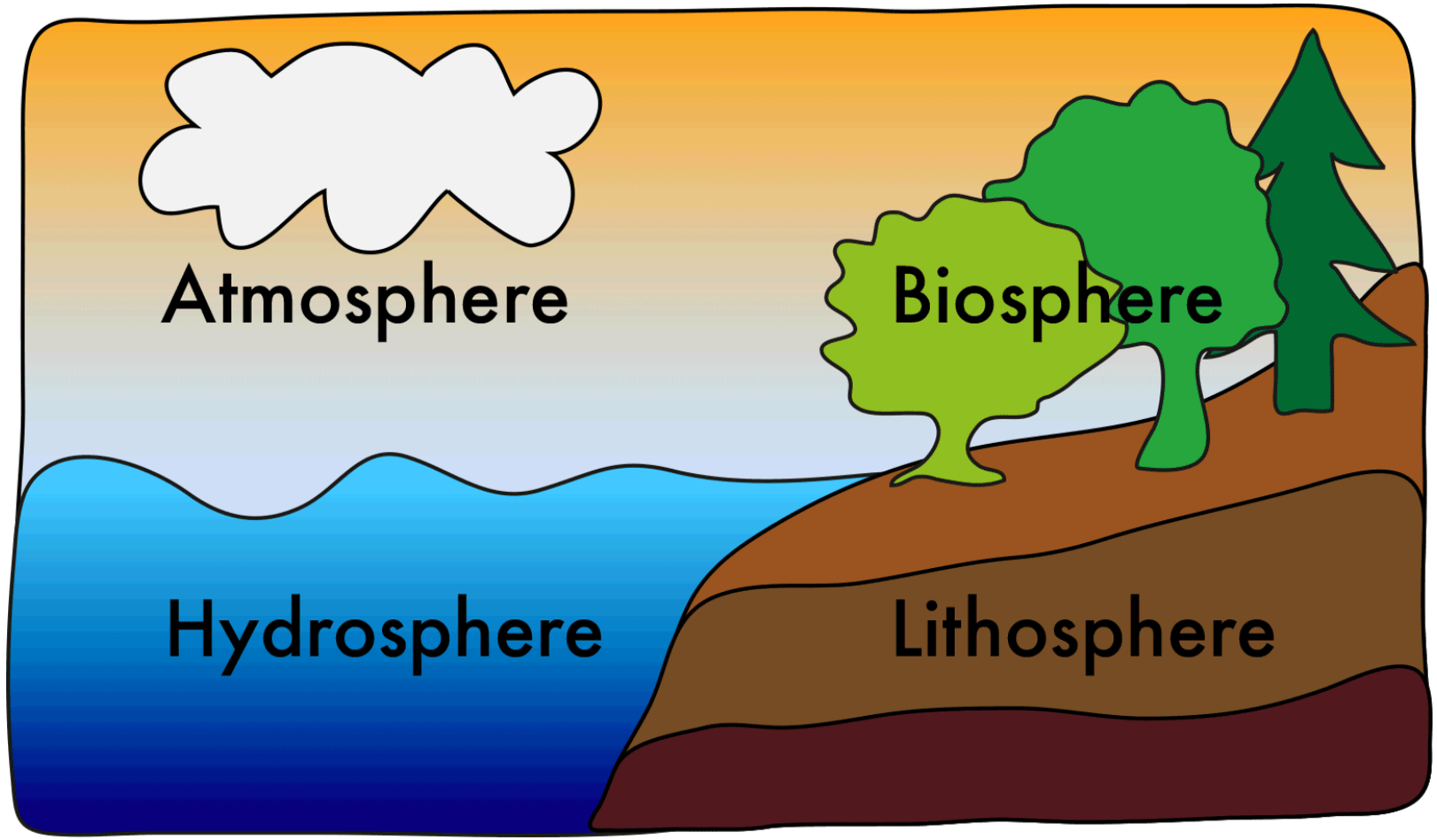
Abiotic environment: soil, water, air

Biotic environment: all living organisms with which the organism comes into contact



COMPONENTS OF ENVIRONMENT:

Atmosphere **Hydrosphere** **Lithosphere** **Biosphere**



Environment Activism

- **Environmental activism** involves the collaboration of different groups of individuals and organizations with the purpose of addressing environmental issues, such as climate change, resource depletion, pollution, toxic waste, and deforestation.

- **GOAL:** To create a harmonious living environment that can be handed down from generation to generation without degrading life quality →**SUSTAINABLE WORLD**

Famous Environmental Activists

- **Greta Thunberg - Climate Activist**

➢Home country: Sweden

➢ At just 15, she striked school on Fridays, and protested outside the Swedish Parliament as a demonstration for action to curb climate change.

➢In 2019 at the World Economic Forum, she delivered a speech that highlighted the fact that “our house is on fire.”

- **Paul Watson - Conservation Activist**

➢Canadian marine wildlife conservation

➢founded the Sea Shepherd Conservation Society, an anti-poaching and direct action group focused on marine conservation activism.

- **Jane Goodall**

➢Her multi-decade study on the social interactions of wild chimpanzees changed behavioral science.

- **Aditya Mukarji**

➢Removed more than 500,000 plastic straws from an India**.**

➢He accepted the invitation to join the UN Youth Climate Action Summit in 2019

- **Isatou Ceesay**

➢ "Queen of Recycling," is a Gambian activist who started the recycling movement called One Plastic Bag in the Gambia.

➢ founded a project that creates plastic yarn and forms bags out of the upcycled waste.

- **Vandana Shiva**

➢ In 1991, she founded Navdanya, a research institute that aims to protect the diversity and integrity of native seeds while also promoting fair trade practices.

Atmosphere:

It is a blanket of gases, suspended liquids and solids

It entirely envelops the earth, extending outwards to several kilometres

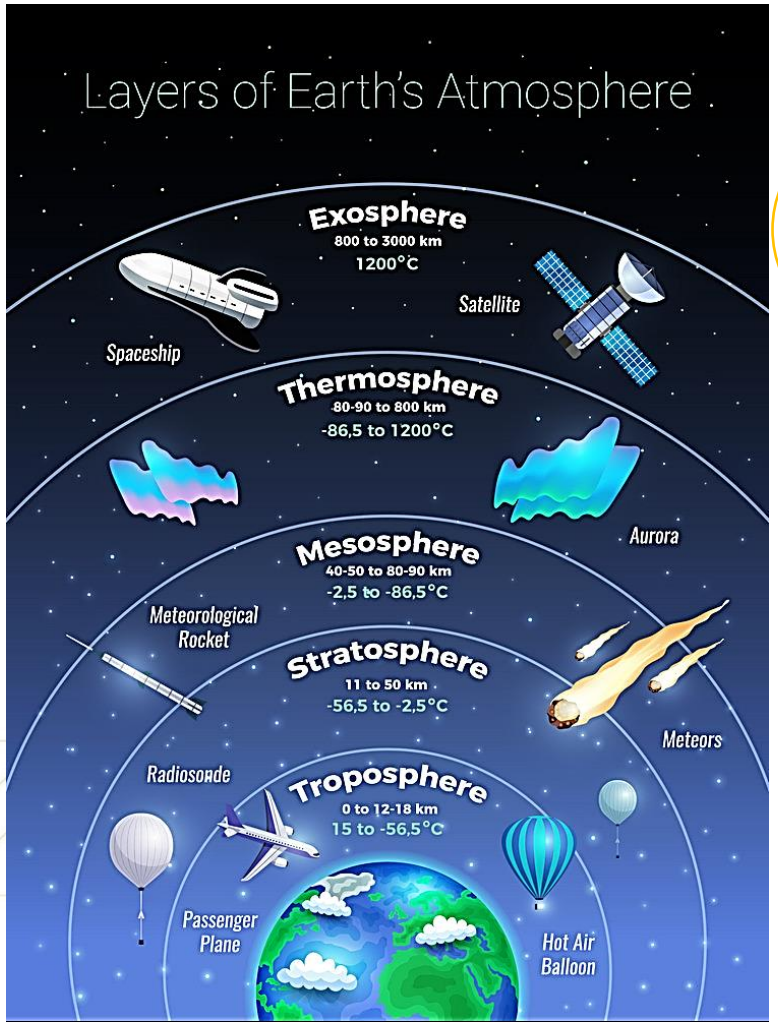
Pure air is colourless, odourless, tasteless and cannot be felt except in motion

Total mass: ~ 5 X 10^5 tonnes. About half of mass lies below 5.5 km

It is bound to earth by gravity. Satellites like moon, which have low gravity can't have atmosphere


THE EARTH'S
ATMOSPHERE

Importance of Atmosphere:



- Air is source of oxygen (essential for life), CO_2 (essential for photosynthesis) & nitrogen (essential for soil enrichment).
- Without atmosphere, there would be no clouds, winds or storms- no weather
- It maintains the heat balance of the earth & helps in maintaining habitable temperature

- Ozone layer in atmosphere acts as a screen that prevents sun's UV radiations from reaching earth
- Air acts as a medium for locomotion of flying animals (insects & birds) & for speedy aviation transport
- Air helps in dispersal of pollen, seeds, spores, etc
- Air transmits sound for communication among animals, including humans

- Air transmits sound for communication among animals, including human beings
- Ionosphere reflects radio waves back to earth, thus helps in long distance communication
- Wind power can be used as a source of energy
- Man made satellites used for communication are and weather monitoring are stationed in thermosphere at specific altitudes

Environmental Studies

- It is the systematic understanding of our environment and our existence in it.
- It includes many interconnected problems involving human population, earth's natural resources, environmental issue and problems
- EVS involves understanding of physics, chemistry, economics, ethics, philosophy, anthropology, political science, etc.

- Humans inhabit the natural world alongwith technological, social and cultural world

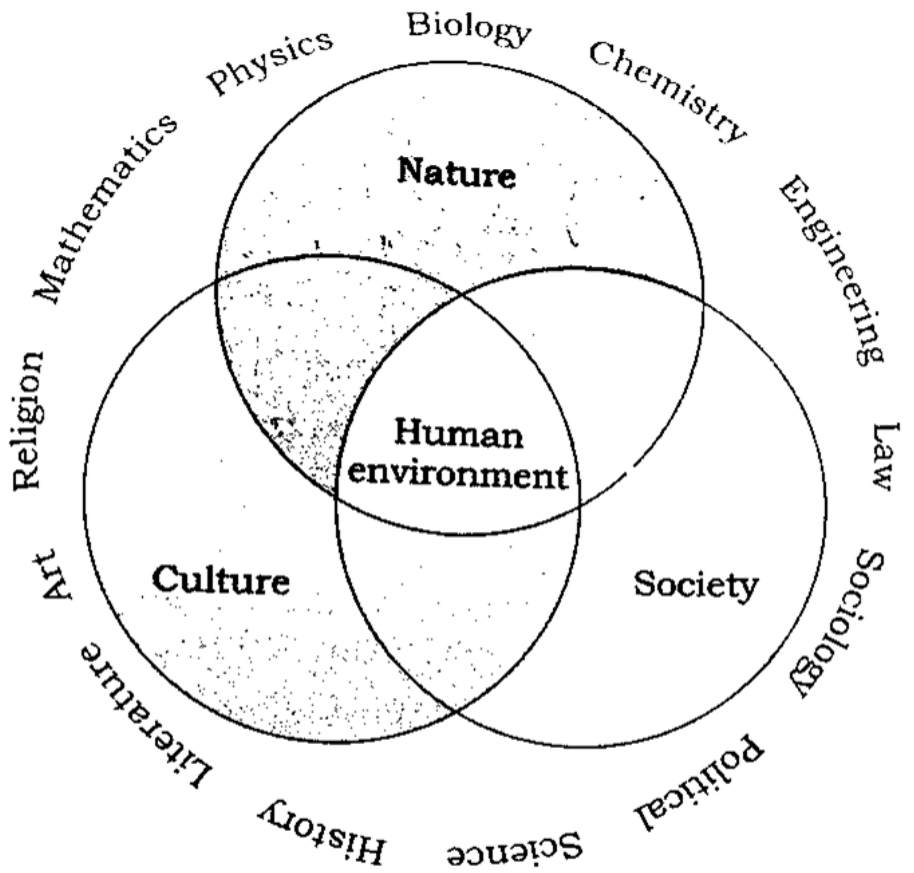


Fig. 1.1 The intersections of the natural world with the social and cultural worlds encompass our environment. Many disciplines contribute to environmental science and help us understand how our worlds intertwine as well as our proper role in them.

Scope & Importance of Environmental Science

- **The scope of EVS is systematic study of our environment and our proper place in it.**
- **PROBLEMS!!!**

→The unlimited exploitation of environment by mankind has threatened survival of not just humans but also other species too.

→Many species are endangered and some have extinct.

→Humans are also suffering from various health problems

Objectives of EVS

Objectives & guidelines of environmental studies are as follows:

[UNESCO, 1971]

- **Awareness:** to acquire an awareness and sensitivity to the total environment and its allied problems
- **Knowledge:** to gain experience and acquire basic understanding of environment and its associated problems

- **Attitude:** to acquire set of values and develop feelings of concern for environment and build motivation for active participation in environmental improvement and protection
- **Skill:** to develop skills in identifying and solving environmental problems
- **Participation:** to provide an opportunity to be actively involved at all levels in working towards resolving environmental problems

Importance of environmental education

- The survival of humans depends on knowledge of environment science.

- Various **benefits** that would result from propagation of environmental education are:

i. conservation of energy resources, improved technologies and processes compatible with environment.

ii. Increase in economic productivity through improved health of people

iii. Conservation of fast depleting natural resources

iv. Proper waste management, treatment and disposal techniques to keep away from hazards.

v. Develop social responsibility towards control of environmental pollution and protection.

vi. Awareness in people to control population.

vii. Inculcating attitude and values towards understanding the interdependence of nature and man

viii. Work towards sustainable development.

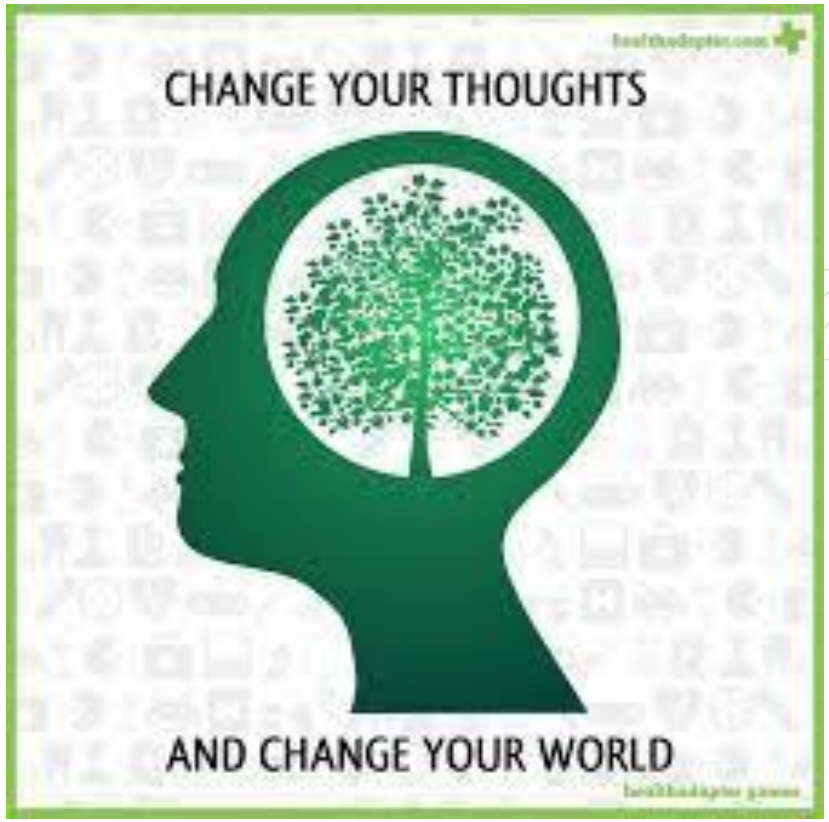
Major Global Environmental Problems

Rapid Population growth

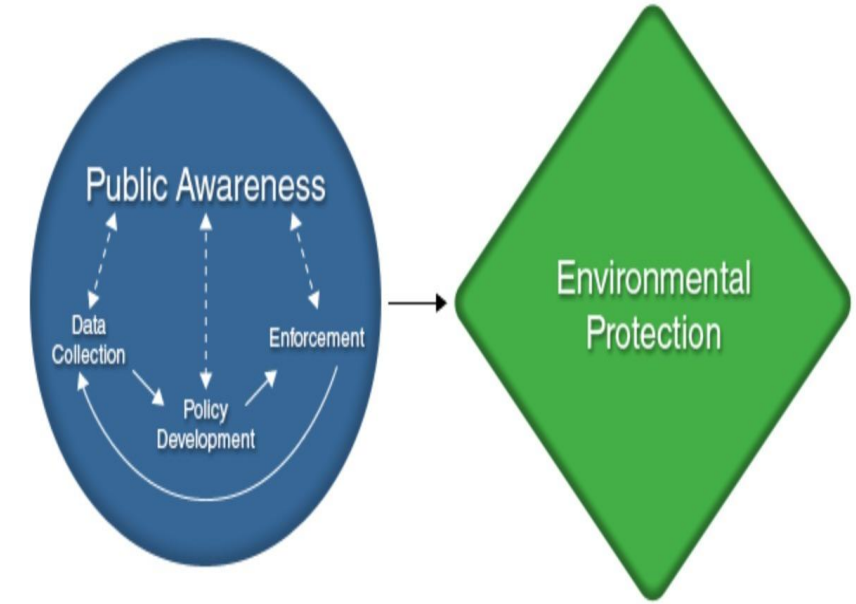
- Food shortage and famines
- Water shortage
- Depletion of non renewable fossil fuels
- Damage to the environment
- Deforestation and threat to biodiversity
- Disposal of solid and hazardous wastes

Need for Public Awareness

- Environmental studies/education creates an overall perspective which acknowledges the fact that man-made environment and natural environment are interdependent.
- Every person, organisation and institution has an obligation and duty to protect environment.
- Environmental protection encompasses not only pollution but also sustainable development and conservation of natural resources and eco-system.

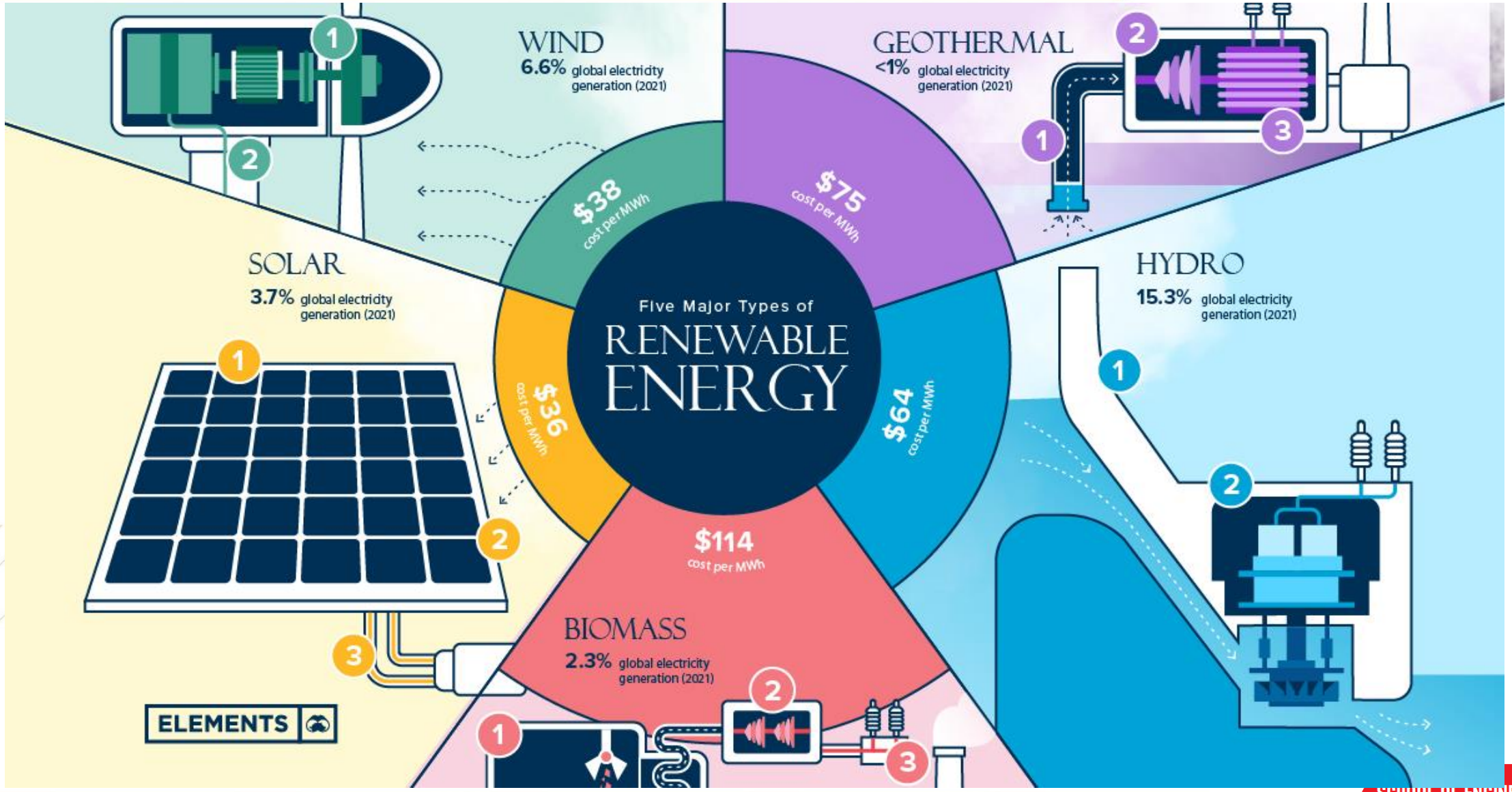


- To promote environmental education through existing educational /scientific/research institutions
- To encourage non-governmental organisations, mass media and other concerned organisations for promoting awareness among the people at all levels
- To mobilise people's awareness for the preservation and conservation of environment.
- It is inter disciplinary in nature and examines major environmental problems from local, national and international point of view.



Need for Social Awareness

- An informed citizen can raise voice against using unfit air and water resources and force the responsible agency to treat the resource before releasing it into the natural environment.
- This awareness ensures that everyone, from an environment conscious farmer in the village to a policy planner in the government knows about the consequences of his activities on nature.
- It can also encourage people to not waste the resources and use them judiciously.
- Social awareness can encourage people to use biogas and solar energy or non-conventional energy instead of fossil fuels.


WIND
6.6% global electricity generation (2021)
$38 cost per MWh
GEOTHERMAL
<1% global electricity generation (2021)
$75 cost per MWh
SOLAR
3.7% global electricity generation (2021)
$36 cost per MWh
Five Major Types of
RENEWABLE ENERGY
$64 cost per MWh
HYDRO
15.3% global electricity generation (2021)
$114 cost per MWh
BIOMASS
2.3% global electricity generation (2021)
ELEMENTS

PROTECTING OUR PLANET STARTS WITH YOU

BIKE MORE DRIVE LESS

reduce REUSE recycle

Cut down on what you throw away. Follow the three "R's" to conserve natural resources and landfill space.

choose sustainable

Learn how to make smart seafood choices at www.FishWatch.gov.

Trees provide food and oxygen. They help save energy, clean the air, and help combat climate change.

PLANT A TREE

EDUCATE

When you further your own education, you can help others understand the importance and value of our natural resources.

CONSERVE WATER

The less water you use, the less runoff and wastewater that eventually end up in the ocean.

Buy less plastic and bring a reusable shopping bag.

Don't send chemicals into our waterways.

Choose nontoxic chemicals in the home and office.

Volunteer!

Volunteer for cleanups in your community. You can get involved in protecting your watershed too!

Long-lasting light bulbs - ARE A - BRIGHT IDEA

Energy efficient light bulbs reduce greenhouse gas emissions. Also flip the light switch off when you leave the room!

oceanservice.noaa.gov

Sustainable Development Goals

- The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015 is based on 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership

Organisations working for environment

- There are several government and non-governmental organisations that are working for environment restoration and conservation. A few well known organisations are:
- **World Wide Fund for Nature- India (WWF-I)**
- **Centre for Science and Environment (CSE)**
- **Bombay Natural History Society (BNHS)**
- **Botanical survey of India (BSI)**
- **Zoological survey of India (ZSI)**
- **Wildlife Institute of India (WII)**
- **Centre for Environment Education (CEE)**

Schemes implemented for imparting environmental education are:

- **Formal environmental education**

Formal education is the mandate of Ministry of Human Resource Development (MHRD), the Ministry of Environment and Forests, NCERT, State Departments of Education, etc. The major initiatives taken by the ministry are:

1. Environmental education in school
2. Environmental education at college and university level
3. Environmental appreciation course
4. Environmental concepts in management and business studies

- **Non-formal environment education and awareness**

1. National Environment Awareness Campaign (NEAC)
2. Eco clubs
3. Global Learnings and Observations to benefit the Environment (GLOBE)
4. Mass awareness

ENVIRONMENTAL SCIENCE

VIPS Technical Campus
योगः कर्मसु कौशलम्
IN PURSUIT OF PERFECTION

SCHOOL OF ENGINEERING AND TECHNOLOGY

Paper Code: BS109/ BS110

Lecture 4

Natural Resources

- **Resources:** Any material that can be transformed into a more valuable and useful product or service.

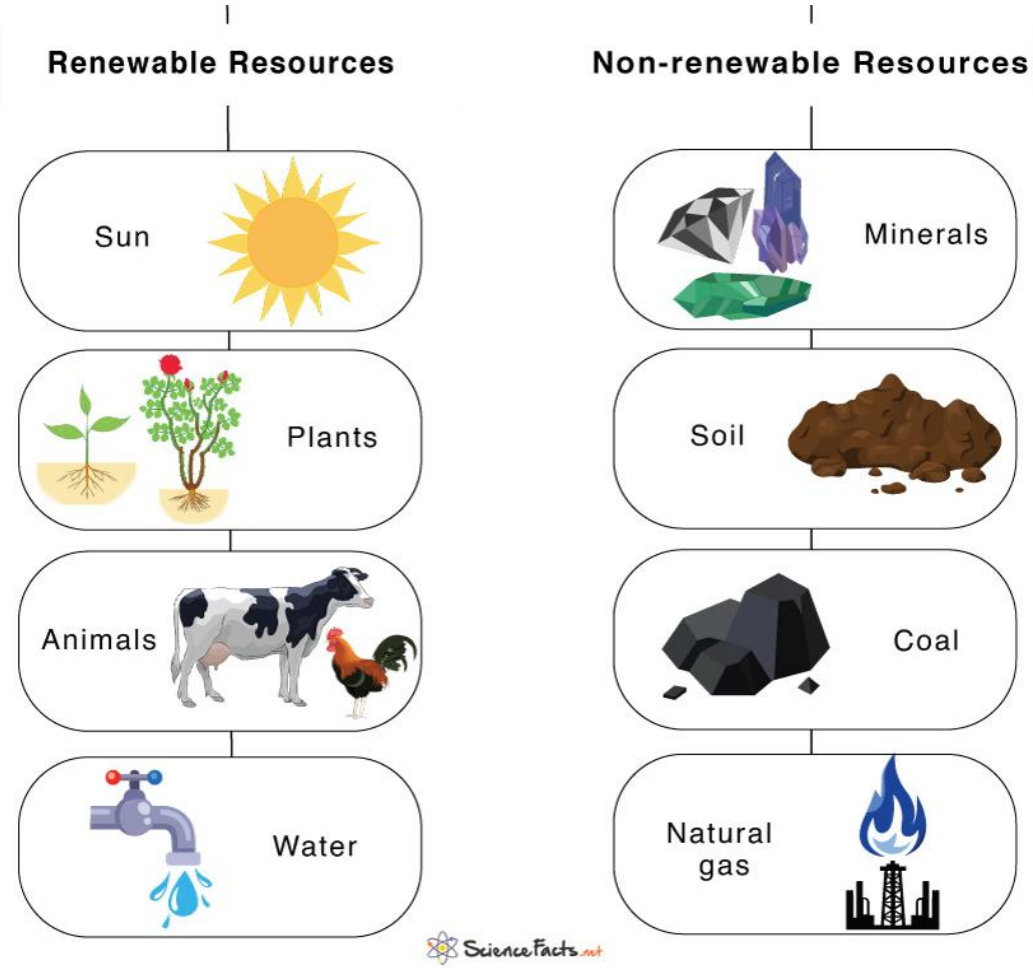
- **Types of natural resources on the** basis of **ORIGIN**:

i. Biotic Resources: → Obtained from biosphere and have originated from some living organisms or have life.

ii. **Abiotic resources:** → All those resources which are of non-living origin.

Types of natural resources on the basis of DURATION AND AVAILABILITY:

- **Renewable resources:** Those natural resources that will either never run out or those that have the inherent ability to renew within a reasonable time through natural processes.
- **Non-renewable resources:** Those natural resources that lack the ability for recycling and replacement. They are finite in quantity and quality.

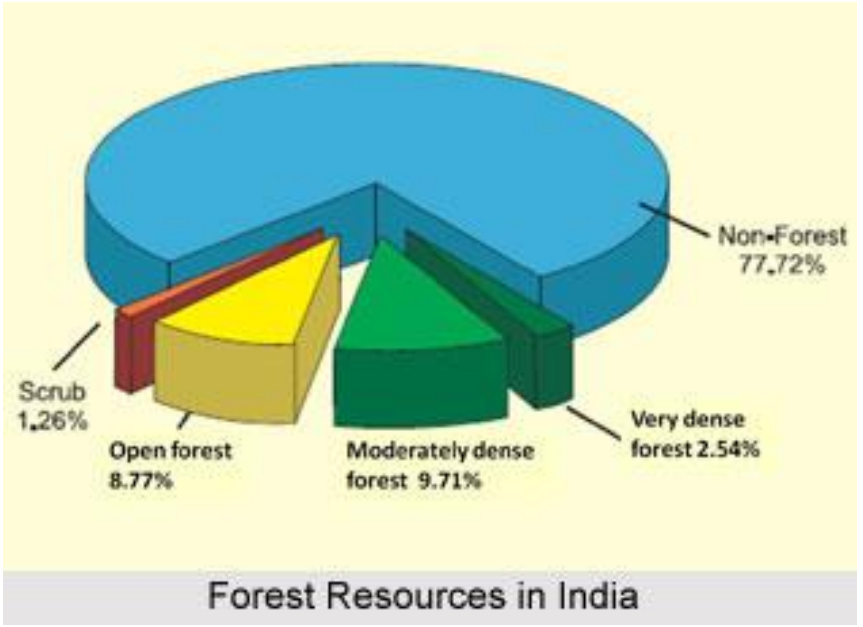


Why we should conserve resources?

- Resources are vital for any developmental activity.
- But irrational consumption or the development has plundered the earth's natural resources which have finally threatened human survival on earth.
- Thus conservation, i.e. judicious and planned use of resources becomes essential because it aims at sustainable benefit to the present generation.
- It also maintains a potential to meet the needs and aspirations of future generations.

Forest Resources

- Forest is a complex ecosystem consisting mainly of trees
- A major part of the earth's lithosphere is covered with forests.
- They clean the air, cool it on hot days, conserve heat at night, act as sound absorbers.
- Control soil erosion, regulate stream flow, support a variety of industries,
- Forests are also natural habitat of wildlife
- Wood is still a source of fuel for one-third of the human population.
- Tribals living in and around forests directly depend on forests for their lives and livelihood



Forest Resources in India

- **For the purpose of administration**, forests in India are classified into three types:

1. **Reserved forests:** → Permanently marked for timber production or other forest produce.

→Cultivation and grazing is not allowed

2. **Protected forests:** Rights are allowed subject to few minor restrictions

3. **Unclassed forests:** Inaccessible forests

Importance of Forests

- Functions of forests are broadly categorised as:

Protective Function: Protective role of forests against soil erosion, droughts, floods, intense radiation, etc.

Productive functions: Forests are the source of wood, gums, resins, fibres, medicines, honey, paper,

Accessory functions: **R**ecreation and as an abode of many animals and tribal people. It maintains the biodiversity of nature.

Importance of Forests

Ecological Significance

- Helps in balancing oxygen and carbon dioxide levels and regulates earth's temperature.
- Increases local precipitation and water holding capacity of soil, thus preventing drought situation.
- Vegetation cover over soil reduces soil erosion and silting and land slides thus reducing the chances of flood.
- The litter derived from fallen leaves maintains the fertility of soil by returning the nutrients in form of humus.
- Acts as refuge for wild animals and provide protection to them

Importance of Forests

Economic Significance

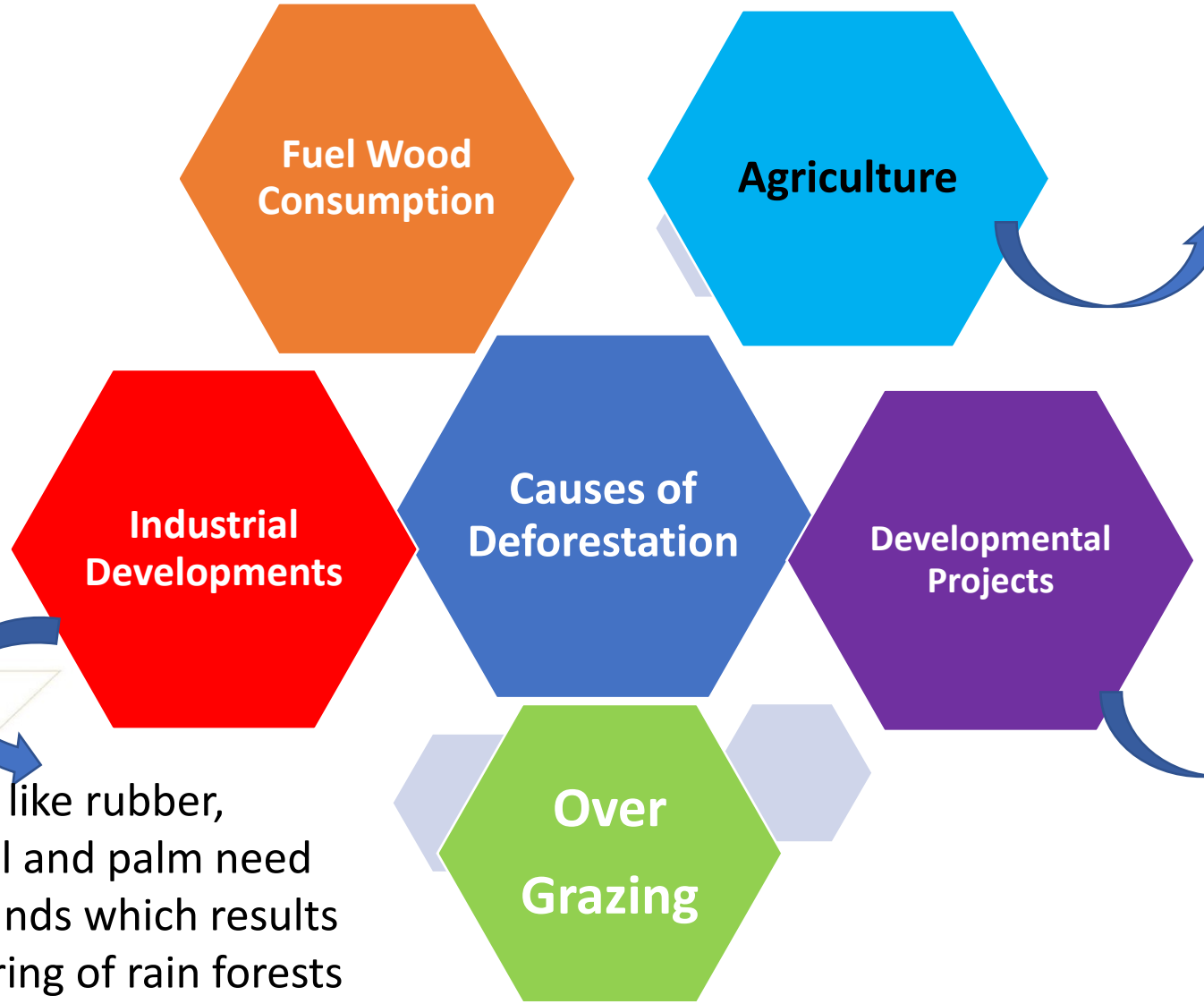
- Wood which is the chief product of forests, has various domestic and industrial applications
- Wood when used as fuel, has certain advantages over coal as its sulfur and ash contents are low
- **Timber** is an important material in building construction and day to day uses. Timber is used to make plywood, boards, doors, carts, etc. It is also a raw material for manufacturing of paper, rayon and films.
- Forests also provide raw material for various wood based industries- pulp and paper, composite wood, rayon and other man-made fibres, furniture, matches, sports good, etc.

WHAT DO WE GET FROM **ECOSYSTEMS**?

Deforestation

- **Deforestation is defined as purposeful clearing of forest land by cutting trees by human beings for non forest use.**
- There has been a tremendous pressure on forests for fire-wood, timber, furniture, agricultural implements, paper and pulp industries, etc.
- The forests are subjected to at least five times more pressure than what they can withstand.

Plausible causes of Deforestation



Shifting Cultivation: → Shifting cultivation is an agricultural practice in which a piece of land is farmed on, only to be abandoned later after an initial use.
→ practiced in Orissa and states of north east India.

Mining, industrialization, dams and hydroelectric projects also cause deforestation.

Cash crops like rubber, tobacco, oil and palm need marginal lands which results in the clearing of rain forests or dense forests.

Timber Extraction

- Good quality and durable wood which is used for making furniture and building material is commonly called as *Timber*
- With the growth of population and industrialisation, the demand for timber has increased which has lead to loss of forests.

Impact of Timber extraction

1. **Loss of biodiversity:** Removal of forest covers leads to loss of biodiversity.
2. **Loss of carbon storage capacity:** trees act as sink for CO_2 and thus when forests are destroyed, the carbon storage capacity is lost.

Dams and their effect on Forest and Tribal People

- India is one of the largest dam-building nations in the world, with as many as 4,291 dams either built or under construction.
- Large dams were built to solve problem of hunger, controlling flood and providing electricity.
- The forest area, which is supposed to get submerged, is cleared off. The people who are displaced, gets rehabilitation on the forest land.
- A recent government report based on a study of 110 projects stated that more than 50 per cent of the total 1.69 million people displaced by these projects were tribals.

- Tribals are socially, economically and politically the weakest and the most deprived community in India.
- Tribal people always forced to live without the basic amenities like roads, electricity, transport, communication, healthcare, drinking water or sanitation.
- Developmental projects have invariably led to the dispersal of communities, the breakdown of traditional support systems and the devaluation of their cultural identity.
- Government should devise a strategy to minimize tribal displacement.
- It must ensure 100 per cent rehabilitation and make sure that the fruits of development are shared with the dispersed people as well.

Case Study

Chipko-Movement

- Started in early 1970s in by Dasohli Gram Swarajya Sangh (DGSS).
- People of Chamoli district of Uttrakhand protested against the cutting of trees.
- In 1972, DGSS, the women of the area, under the leadership of an activist, Chandi Prasad Bhatt, went into the forest and formed a circle around the trees preventing the men from cutting them down.
- Dhoom Singh Negi, Bachni Devi and many other village women, were the first to save trees by hugging them. They coined the slogan: 'What do the forests bear? Soil, water and pure air'

- Chipko movement spread top nearby areas of Tehri region under the leadership of Sunderlal Bahuguna.
- Chipko movement has challenged the old belief that forests mean only timber.
- It emphasis that important gift of tree to us is water, oxygen and soil along with timber.
- It's slogan was planting five Fs- food, fodder, fuel, fiber and fertilizer trees.
- Other tribal communities of the country took inspiration from Chipko movement.
- One such movement also initiated in Karnataka, known as Apiko movement.

Forest Fires

- **Forest Fires:** It is one of the most dangerous sources of damage to forests and wildlife. About 8.92% of forest area is being affected by frequent fires and 44.25% by occasional fires.

Results of forest fires:

→loss of valuable timber resources.

→loss of biodiversity and extinction of plants and animals.

→loss of wildlife habitat and depletion of wildlife.

→loss of natural regeneration and reduction in forest cover.

Consequences of Deforestation

- Decreasing soil stability
- Increasing erosion and sediment transport into streams
- Reduction in biodiversity through loss of habitat
- Alterations in climate that increase local temperature because of loss of vegetation

Loss of Habitat

- Degradation of air quality regionally, if deforestation is done by burning down slash (in shifting cultivation). This promotes high levels of air pollution
- Cutting and burning of large forests leads to production of large amount of carbon and increase levels of green house gases.
- Removing forest vegetation further disrupts local carbon balance by eliminating the trees that serve as sink for carbon dioxide.

Conservation of Forests

Factors that have contributed for conservation of forests in India are:

- **The forest conservation Act, 1980**: This bans off unnecessary and avoidable forest conversion to non-forest uses. After its implementation, there has been tremendous decrease in the forest area being officially diverted for non forest uses.
- **Compensatory afforestation**: Any permission given for forest conversion must be accompanied by compensatory afforestation on the degraded land.
- **Establishment of National Parks and Wildlife Sanctuaries:** A vast area of forests has been dedicated to nature reserves

- **Afforestation Programme:** India has launched a large afforestation programmes in degraded forests, village commons and farm land.
- **Joint Forest Management:** Under the legislation of 1988 and 1990, a joint programme including local communities and Forest Department has been launched with the aim of protecting and promoting natural regeneration in degraded forest land. Under this, 191750 ha of land has been regenerated in three districts of West Bengal.

- **Removal or reduction of subsidies to industry:** Earlier, industries were guaranteed a supply of timber at low or nominal rates from forests. With the reduction in subsidies, industries are expected to use forest resources efficiently.
- **Environmental Movements, Free Press and Judiciary:** Environmental movements have spread to several states. ex- Chipko movement. India's free press and judiciary supports forest conservation and acts as a check on any indiscriminate deforestation.

National Forest policy, 1988

Following are the main objectives outlined in National Forest Policy of India, 1988:

- Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by depletion of the forests of the country.
- Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
- checking soil erosion and denudation in the catchments areas of rivers, lakes, reservoirs in the soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.

- Checking the extension of sand-dunes in the desert areas of Rajasthan and along the coastal tracts.
- Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
- Meeting the requirements of fuel-wood, fodder, minor forest produce and small timber of the rural and tribal populations.
- Increasing the productivity of forests to meet essential national needs.
- Encouraging efficient utilisation of forest produce and maximising substitution of wood.
- Creating a massive people's movement with the involvement of women, for achieving these objectives and to minimise pressure on existing forests

Water Resources

- Primary source of water on earth is precipitation (rainfall and snowfall).
- Rivers are the main source of surface water in India.
- The Indus, the Ganga and the Brahmaputra carry 60% of the total surface water
- The ground water is also an important source of water for drinking, irrigation, industrial use, etc.
- The demand for more water has forced human beings to use and overuse the natural water storage systems (aquifers). This has resulted in the destruction of nature's ecosystem.
- Water is overused in household chores, agricultural fields and industries.
- Dams and irrigation canals have been constructed on rivers for the production of hydroelectricity and year-round supply of water → OVEREXPLOITATION OF WATER!!!

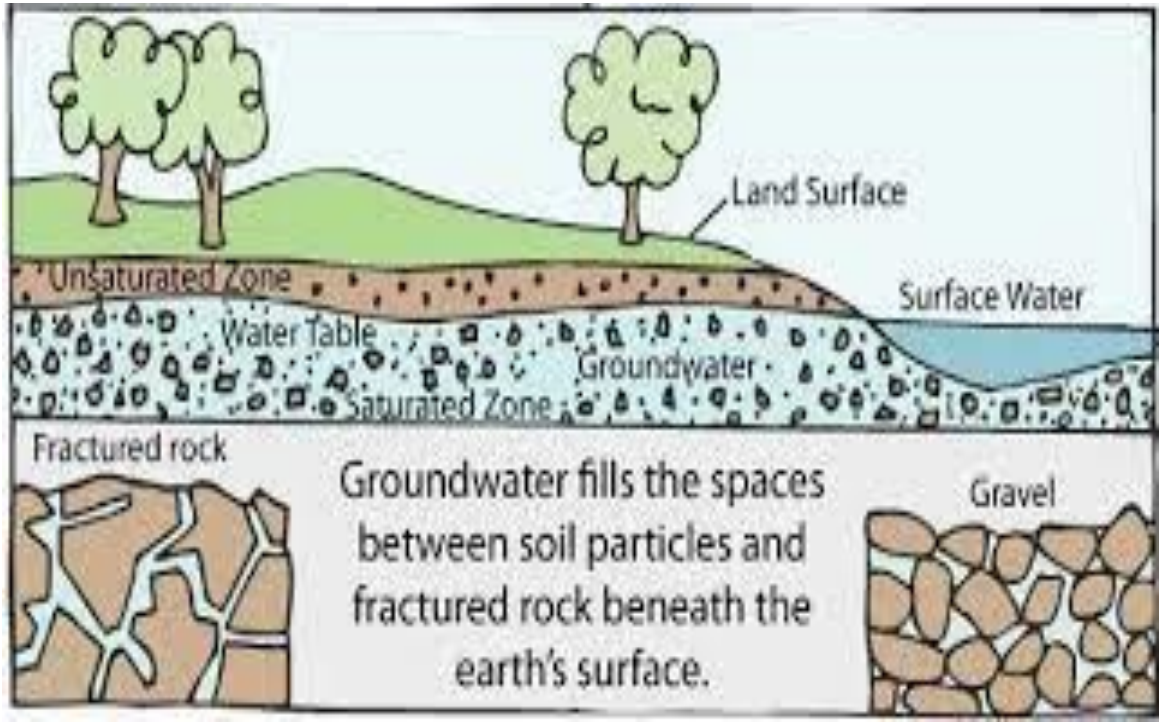
Consequences of over utilisation of surface water

- Surface water is all water above the land, including lakes, rivers, streams, ponds, floodwater, and runoff.
- When a dam is constructed over the river, valuable fresh water habitats are lost.
- When river flow is diverted towards cities, it affects aquatic organisms
- Wildlife is adversely affected
- Due to river flow diversion, estuaries are also affected because less fresh water enters, salt concentration increases, leading to disturbance in estuary ecology.

(Estuary- An estuary is an area where a freshwater river or stream meets the ocean. When freshwater and seawater combine, the water becomes brackish, or slightly salty)

Consequences of over utilisation of ground water

- Ground water is the water beneath the surface of the earth, consisting largely of surface water that has seeped down: the source of water in springs and wells.
- Water table falls
- Surface water also diminishes as streams and rivers are affected
- Land subsidence (gradual settling of the land) occurs
- Saltwater intrusion (movement of salt water into aquifiers and hence, into wells in coastal areas)



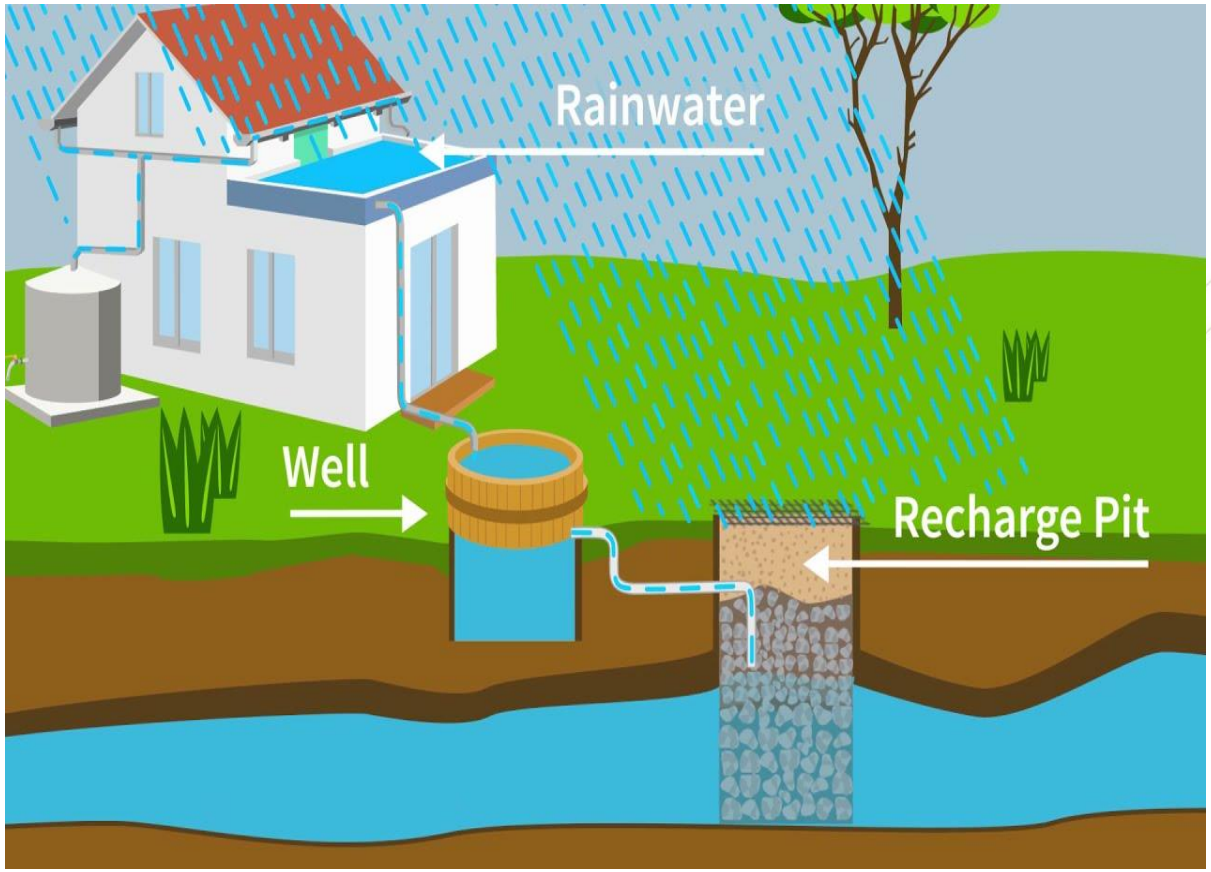
Water conservation and management

Water resources can serve more people by wise use and management:

- Avoid Polluting
  - ➢Properly dispose off oil
  - ➢Use pesticides sparingly
  - ➢Do not use excess soaps and detergents
- Dispose off wastes properly
- Have good equipment: Leak free equipment
- Reuse and renew used water
- Efficient use of water

Water Harvesting for Conservation

- In hills and mountainous regions, people build diversion channels called kuls.
- Rooftop rain water harvesting is commonly practiced in Rajasthan. Huge underground tanks are built inside the main house and are connected to slopping roofs.
- In Meghalaya, tapping stream and spring water by bamboo pipes known as bamboo drip irrigation system is prevalent.



Floods

- It is a condition of partial or complete submerge of normally dry land areas from overflow of water.
- Heavy downpour from rainfall brings down more water that can be disposed off by combined natural and man-made systems causing flooding.
- To create space, the wetlands of the flood plains which were natural flood controllers have been lost.

(Wetland → a place in which the land is covered by water—salt, fresh, or somewhere in between—either seasonally or permanently.

→ Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and flood waters)

- In India, the worst suffering states are Assam, Bihar, West Bengal, U.P.

Effect of Floods

- **Damage to buildings and other constructions:** buildings and houses get destroyed and dislocated severely that their reconstruction is not feasible. The velocity of water can erode the foundations of buildings.
- **Health effects:** floods lead to increase in mosquito population making people exposed to malaria, dengue, etc. Vehicles do not provide enough protection from flood water and can be swept away. Even shallow water can be dangerous for children.
- Many wild animals are dislocated from their natural habitats and domestic animals are also left without any home.
- Flood water can bury or move hazardous containers of chemicals from their storage places. This can led to accidents due to leakage.

- **Flood Management:**
- **Flood Forecasting**

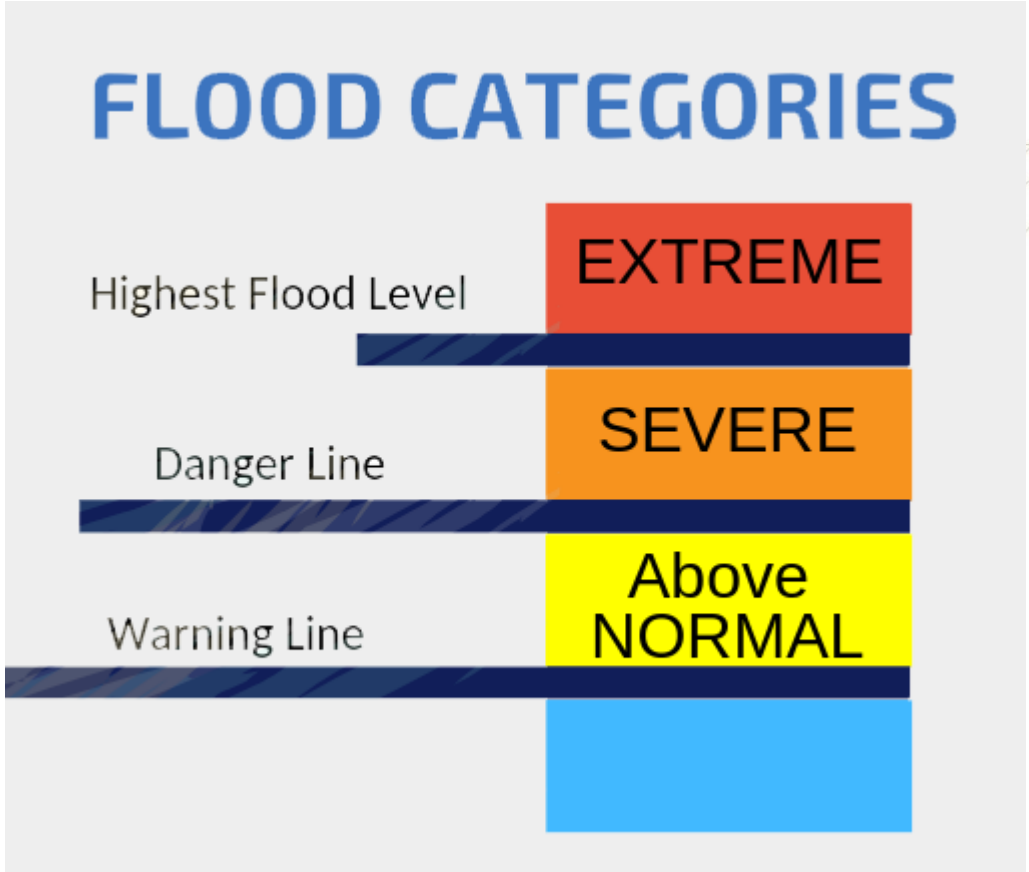
→it is one of the most important, reliable and cost effective measure.

→Central water Commission, Ministry of Water Resources has set up a network of forecasting stations covering all flood prone interstate rivers

→At present, 159 stations

→Forecasts issued by these stations are used to alert the public and to enable administrative and engineering services of the state/Uts to take measures.

FLOOD FORECAST DASHBOARD



Drought

- It is an extended period- a season, an year, or more of deficient rainfall relative to statistical multi-year average.
- When rainfall is below normal for weeks, months, or years, there is a decline in flow of rivers and streams and water level drops in wells and reservoirs.
- If dry period persists and water related problems increase, the dry period is called drought.
- During a drought, water scarcity becomes so acute that there is no water for farms, industries, households or even drinking.
- Major drought years in India- 1877, 1899, 1918, 1972, 1987, 2002.

Causes of drought:

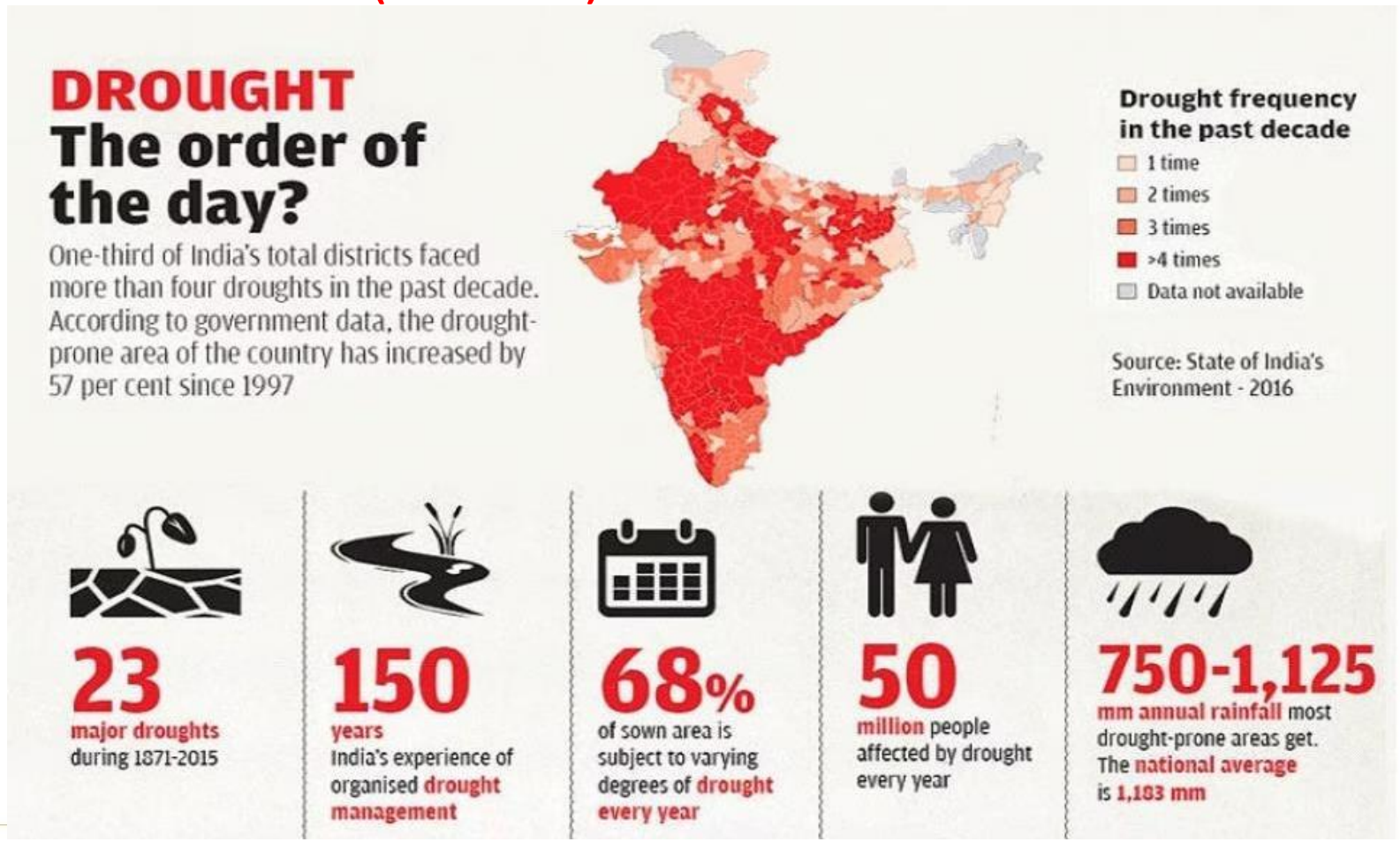
1. Erratic behaviour of the rainfall
2. Over-exploitation of surface and ground water
3. Rapid depletion of forest cover: Due to the cutting of trees in forests and hill slopes, rain water cannot percolate the subsoil and recharge the natural aquifers.

Effects of drought:

1. Surface water and ground water drops
2. Food grain production goes down

Impact of drought can be reduced by preparedness and through mitigation.

- The Drought in Numbers, 2022 report was released on May 11 at the ongoing 15th Conference of Parties (CoP15) to the United Nations Convention to Combat Desertification (UNCCD).



Conflict over river water

- As water has become scarce, national conflicts over water have risen.
- Water allocation between conflicting demands for water have led to problems of inequalities and maldistribution.
- Four categories of use on which water planning is based are:

1. Domestic 2. Agricultural 3. industrial 4. power generation

- **Major conflicts in Indian subcontinent:**

1. Indus water dispute between India and Pakistan- dispute ended in 1960 when Indus Water Agreement was signed

2. Ganga Water dispute between India and Bangladesh treaty signed in 1996

3. Yamuna water dispute between UP, Haryana and Delhi

4. Ravi-Beas dispute between Punjab and Haryana- Dispute between Punjab & Haryana, a tribunal was formed in 1986 to resolve the issue

Case Study

Kaveri river water dispute

- Kaveri river water has been cause of conflict between Tamil Nadu and Karnataka over sharing of the water
- The Cauvery Water Dispute has been a serious issue since 1974 when a 50-year-old agreement, signed in 1924 between Karnataka and Tamil Nadu State expired,
- In 1991, the Supreme Court reassigned a tribunal to settle the dispute. The tribunal gave the decision that Karnataka must release 205 TMC of water from the Cauvery reservoirs to Tamil Nadu on a monthly basis. Karnataka declined to implement the order
- Final verdict of the tribunal came on 5 Feb 2007 as-

12 km^3 of Kaveri water was allocated to Tamil Nadu annually

7.6 km^3 of Kaveri water was allocated to Karnataka annually

0.8 km^3 of Kaveri water was allocated to Kerala annually

0.2 km^3 of Kaveri water was allocated to Puducherry annually

Dams- benefits and problems

Benefits

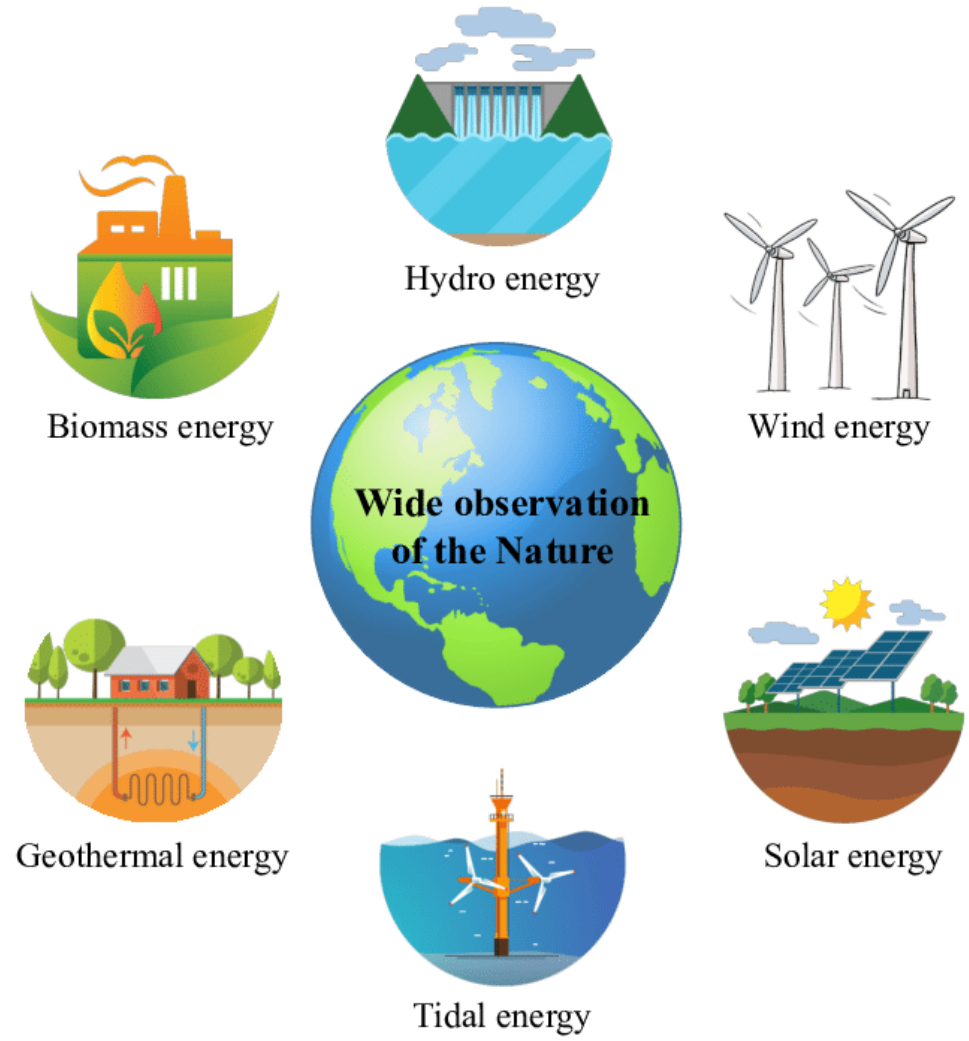
- Hydroelectricity generation
- Agriculture and Food Production
- Irrigation and Water supply
- Flood control
- Inland water Navigation

Problems

- Environmental: Destroy wildlife habitat, cause pollution
- Risk of failure: Due to landslides and earthquakes
- Displacement of tribal people
- Submergence of fertile fields and human settlements
- High cost of construction

Energy

- Energy is an indispensable requirement in modern life. It is involved in all development activities of the world.
- All the amenities of modern world which are making our lives easy and comfortable are energy driven.
- The world's energy consumption increased four-fold in the 40 years from 1950 to 1990.
- In India, as estimated in 2001, the predominant commercial energy source was coal accounting for 55 per cent, followed by oil (31 per cent), natural gas (8 per cent), hydro-energy (5 per cent) and nuclear energy (1 per cent).
- We have to harness other forms of energy such as solar, nuclear and renewable energy, enhance our energy efficiency with technological development and restrict the overuse of energy.



- **Renewable energy resources** are regenerated in natural processes and can be used indefinitely. These includes solar energy, wind energy, geothermal energy, ocean energy, etc.
- **Non Renewable energy resources:** → cannot be regenerated in a short period of time. Examples fossil fuel.

→Coal, oil, natural gas, forests and others are non-renewable and exhaustible energy resources which account for 87 per cent and 94 per cent of the energy sources of the world and India, respectively

→Rural India uses biomass, fuel wood, cow dung and so on which account for 40 per cent of the primary energy supply of India.

→ Non-renewable energy resources need to be preserved for our future generations keeping in mind the increasing population load, economic development and consumption demand.

→Renewable and non renewable energy resources can be used to produce secondary energy sources like hydrogen and electricity.

→ **Conventional Energy resource**: coal, petroleum, natural gas

Non-conventional Energy resource: solar, wind, tidal, geothermal, atomic, biogas.

RENEWABLE ENERGY RESOURCE

1. Solar energy:

- This is an enormous energy resource which is clean and pollution free.
- India receives solar energy equivalent to more than 5000 trillion KWh during a year.
- Solar energy requires to be converted into other forms of energy by suitable technologies.

There are two main ways of using solar energy to produce electricity:

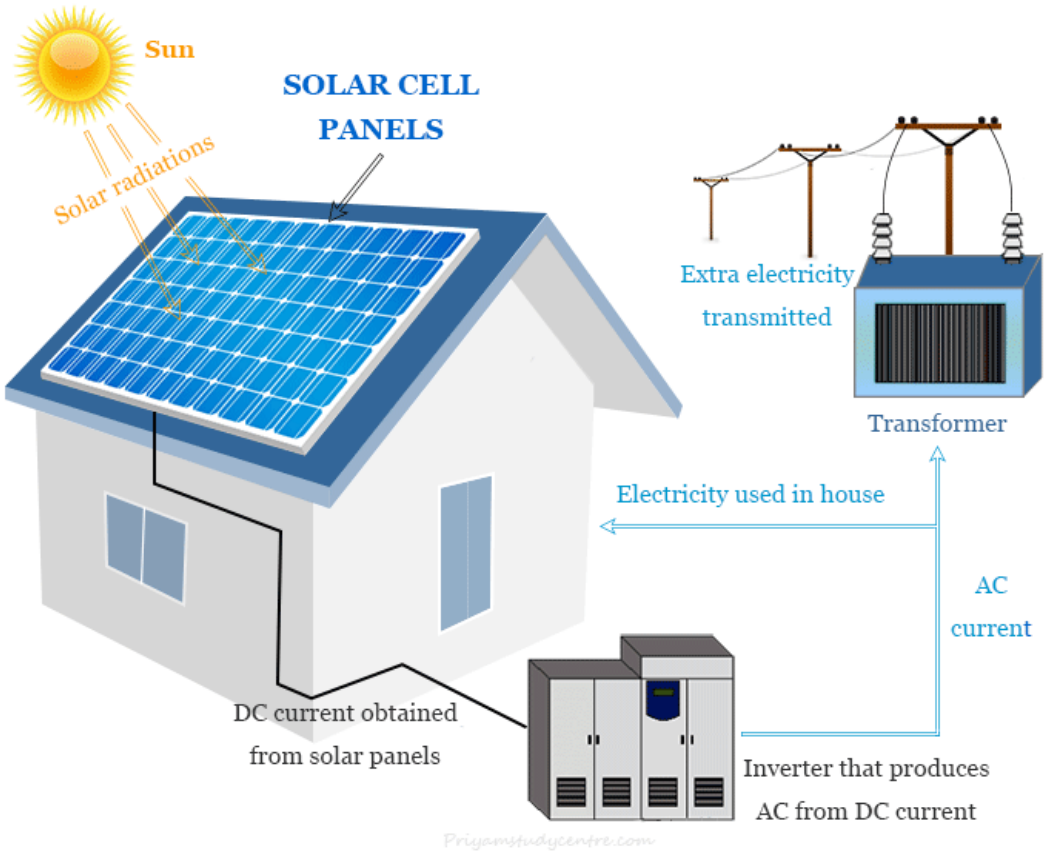
a. **Solar Cells**

b. **Solar thermal technology**

Solar Cells

- These are photovoltaic cells that can turn sunlight into electricity in an environmentally clean manner.
- This technology generates electricity directly via the photoelectric effect, in other words, as a result of the effect of solar radiation on semiconductor materials.
- Solar photo voltaic (SPV) systems have emerged as useful power sources for applications such as water pumping, telecommunications and power plants for meeting the needs of villages, hospitals, etc.
- They can be installed in remote areas in forests and deserts where installation of electric cables are cost prohibitive.
- For example, with help of Department of Non-conventional Energy Source, (DNES) solar power is being used in rural areas of West Bengal in form of lanterns, solar streetlight and solar pump (for irrigation).

- Solar powered small pumps are being used in Delhi, Haryana, Himachal Pradesh.
- Electricity in Ladakh is generated using solar panels.



Merits of solar cell panels:

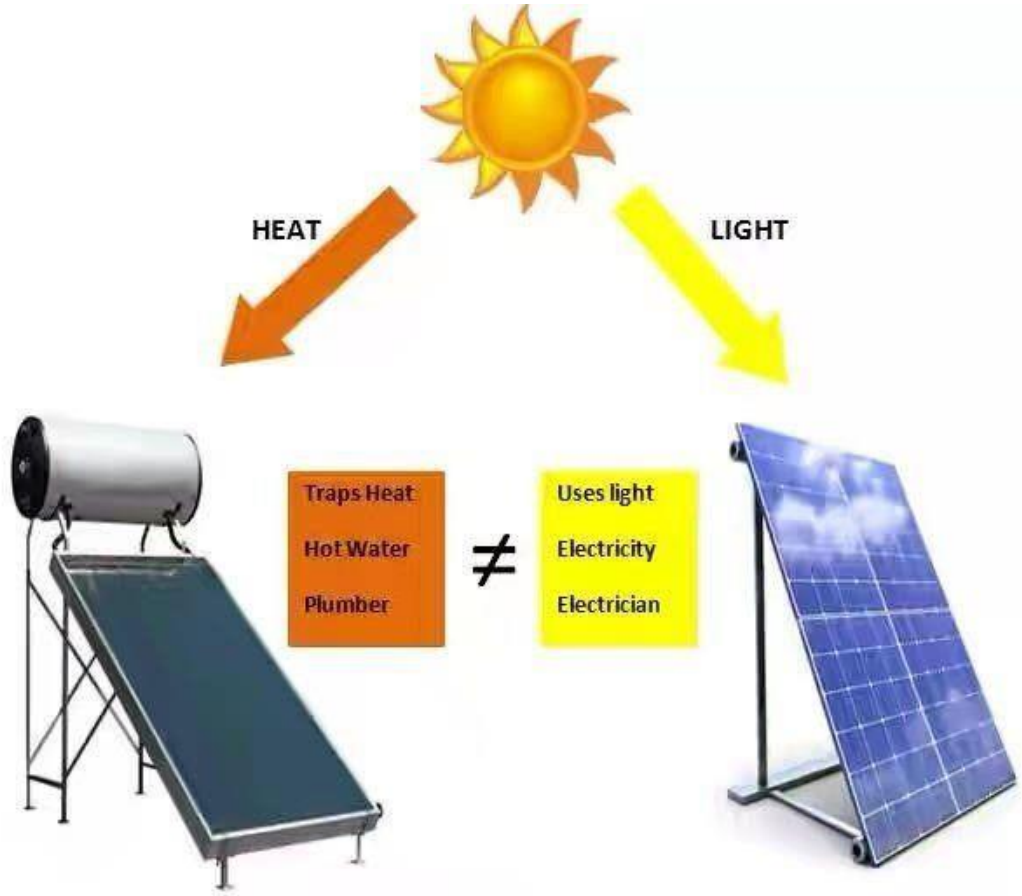
- These are useful for meeting electricity requirements of decentralised applications like water pump in a remote village
- They are easy to install and maintain
- They are noiseless, pollution free and have long life.

Limitations of solar cell panels:

- Initial cost of installing SPV system is high as silicon wafer used in making solar cells and silver used in connecting solar cells to form a solar cell panels is high.
- The DC electricity produced by solar cells is stored by charging DC batteries which is first to be converted to AC.
- The efficiency of energy is low as compared to other methods

Solar Thermal technology

- This uses heat gained directly from sunlight.
- Solar-thermal technology concentrates the sun's power to obtain thermal energy. This thermal energy is used to generate steam, which in turn operates a conventional turbine that produces electricity.



Uses:

- Solar water heating
- Solar dryer for food grains
- Solar distillation (for water purification)
- Solar cooker (for cooking)
- Solar powered devices
- Solar thermal power generation

Wind Energy

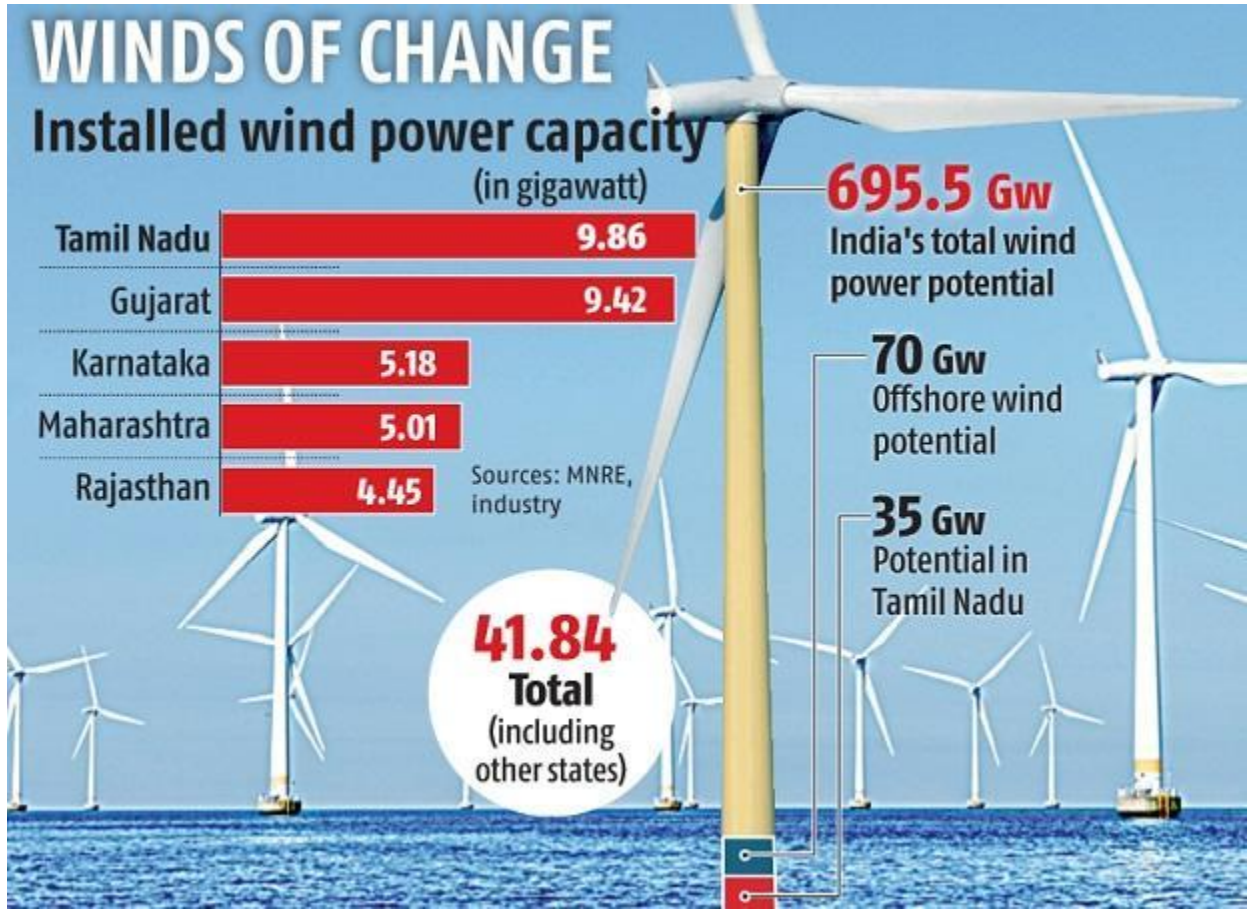
- The kinetic energy possessed by air due to its velocity is called wind energy and can be used to do work.
- To generate electricity, the rotatory motion of the windmill can be used to turn turbine of the electric generator.
- **Wind energy farm:** the output of a windmill is very small to be used commercially and therefore a large number of windmills are erected over a large area called **wind energy farm.**
- The energy output of each windmill is coupled together to get electricity on a commercial scale.

Wind power potential of India

- India is ranked fourth in world for wind resource availability.
- India's largest wind energy farm is located near Kanyakumari, Tamil Nadu.

Merits of wind Energy

- Non-polluting, environmentally friendly, sustainable source
- Low gestation period and power generation starts immediately after commissioning of windmill
- Cheaper power generation as there is no shortage of input (i.e. wind).
- Recurring expenses are almost nil

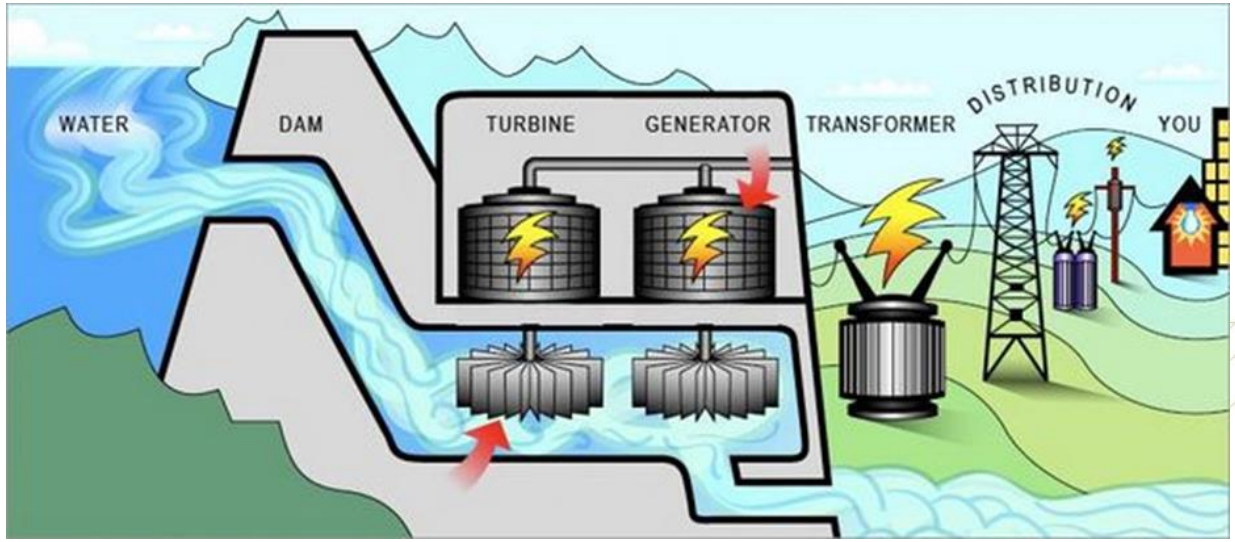


Limitations of wind energy

- Wind energy farms can be located in large vast open areas
- Cost of construction of wind energy farm is high
- Location of farms cannot be in the way of migratory birds, else it will create a havoc for them
- The tower and blades requires high maintenance cost as they are exposed to rain, sun, storm and cyclone
- Backup energy is required for the time when there is no wind

Hydroenergy

- This energy is produced from the kinetic energy of flowing water or potential energy of water at height.
- At hydro power plants, the energy of flowing water or stationary water is generated by using water turbine which generates the electricity.
- As water runs over the blades of a turbine – kind of like a giant pinwheel – they spin. This spinning turbine is connected to a shaft that spins inside a device called a generator which converts energy in the spinning shaft to electricity
- In India, hydel projects are located in Kerala, Punjab, Himachal Pradesh, Maharashtra, Karnataka, Tamil Nadu, etc.



Advantages of Hydroenergy:

- Pollution free energy
- Hydel projects have a very low generation and maintenance cost
- Generates employment as these projects are labour intensive
- Multi-purpose projects as these enable to use water for irrigation, industrial and domestic purpose, control floods, develop recreational sites, etc.

Demerits:

- High initial investment
- Cause population displacement, damage the environment as in case of Tehri Dam (on Ganga)
- Not suitable for all areas and for all rivers

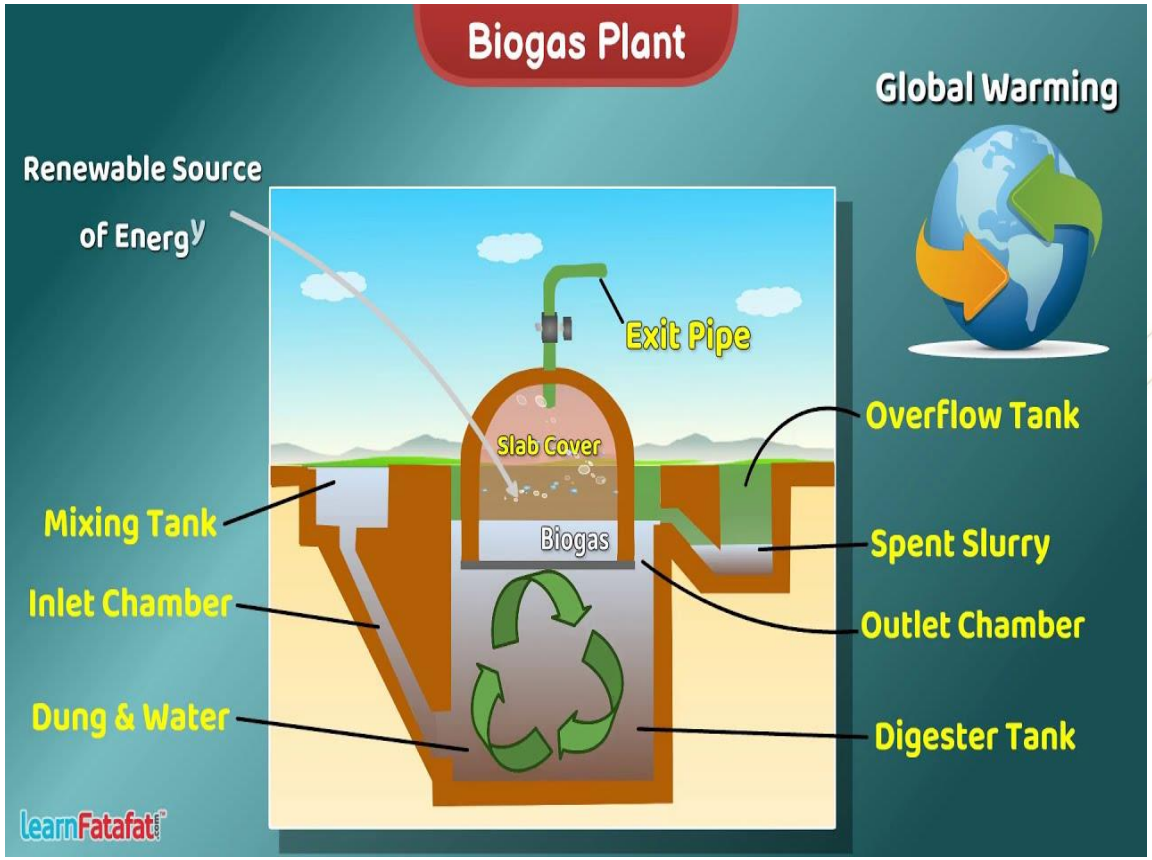
Case study

Narmada Valley Project

- The plan included construction of two dams- Sardar Sarovar and Narmada sagar and many small dams.
- Purpose was generation of electricity and irrigation of land in Gujarat, Madhya Pradesh, Rajasthan and making availability of drinking water
- But it threatened the livelihood of many people and had severe environmental impact.
- The anti-dam protest started in 1985 in Gujarat.
- In 1989, Narmada Bachao Andolan (NBA) started which resisted the construction of dam.
- In 1990, led by Medha Patkar, NBA demanded suspension of project
- Ultimately, court ordered in favour of NBA and stopped the construction of sardar sarovar dam in 1995

Biomass Energy

- Biomass is organic matter used to produce energy
- It includes fuelwood, agriculture waste, cow dung
- In India more than 70% of people in rural areas depend on biomass as a source of energy.
- dung and other materials are allowed to ferment in the absence of air in a slurry form. The produced gas, known as biogas
- Biogas, contains 55 per cent methane and 45 per cent carbon dioxide by volume.
- one cubic metre of gas produces 4,713 kcal of heat
- Biogas is used for cooking, lighting and running pump sets, engines and machines in factories and turbines to generate electricity



- **Government's initiative towards promotion of biomass:**

1. Biogas plants:

- The national project on biogas development was started in 1981/ 82
- The project aims at providing a clean and expensive energy source, producing enriched manure, improving sanitation, and elevating the status of women in rural areas
- about 2 million plants have been set up.
- A 10 MW rice straw based thermal plant has been commissioned by BHEL (Bharat Heavy Electricals Limited) at Jhalkhari in Punjab.

world's first and India's largest landfill gas-to-compressed biogas plant at the Hyderabad Integrated Municipal Solid Waste (HiMSW) site – April 2023

2. Biomass gasifiers for thermal applications

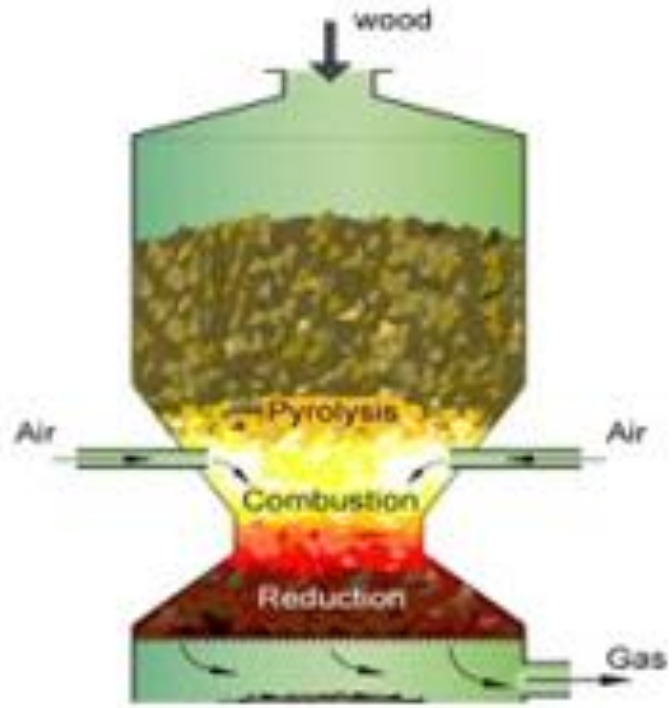
- Gasification is a process that converts organic or fossil-based carbonaceous materials at high temperatures (>700°C) with a controlled amount of oxygen and/or steam into carbon monoxide, hydrogen, and carbon dioxide.
- carbon monoxide then reacts with water to form carbon dioxide and more hydrogen via a water-gas shift reaction.

Simplified example reaction

$$C_6H_{12}O_6 + O_2 + H_2O \rightarrow CO + CO_2 + H_2 + \text{other species}$$

Water-gas shift reaction

$$CO + H_2O \rightarrow CO_2 + H_2 \text{ (+ small amount of heat)}$$



- The capacity rating of these gasifiers is up to 150 kg of biomass/hour (equivalent to 400000 kcal/ hour energy).
- The lower capacity gasifiers are used in small-scale industries like silk reeling, dyeing, and drying and in community cooking, etc. rhe bigger sized gasifiers can be used in industrial applications such as carbon dioxide manufacturing, and magnesium chloride production, etc

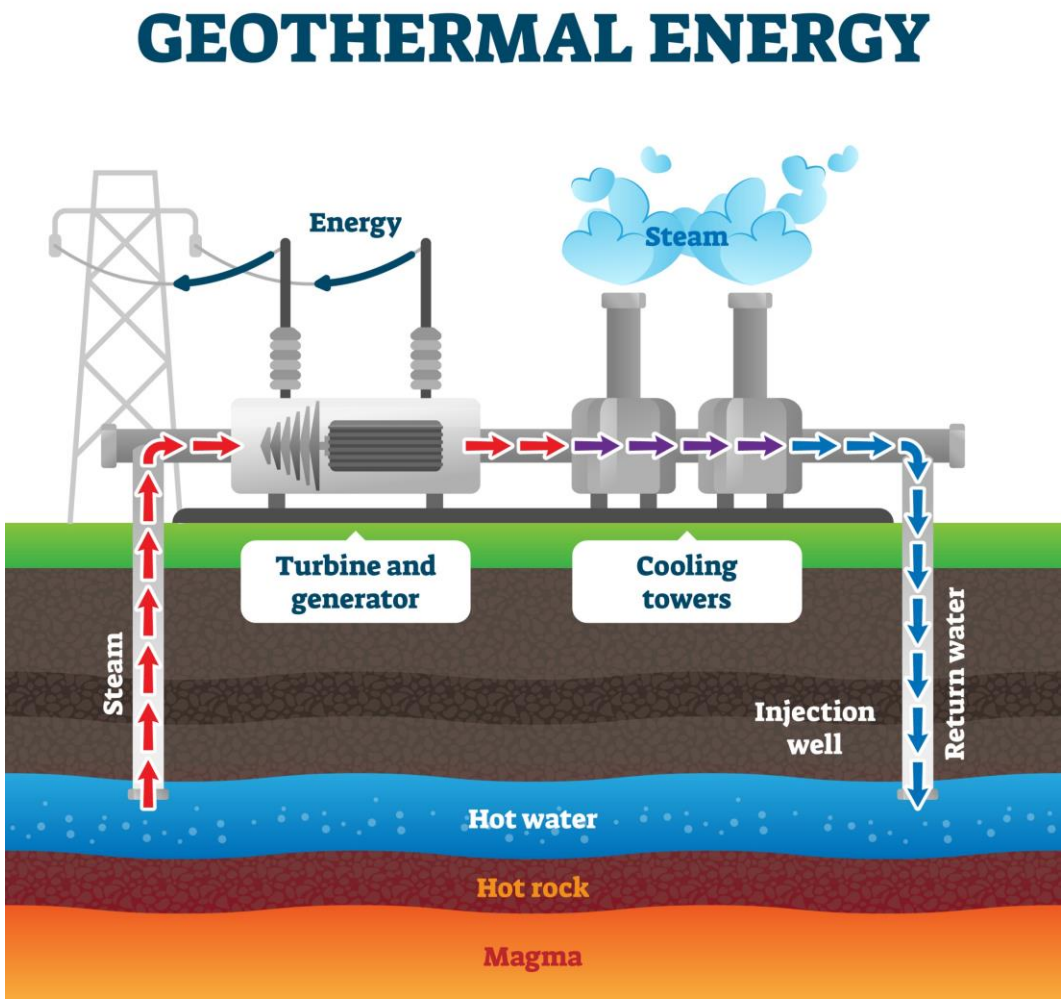
3. **Improved cookstoves**

- The National Programme on Improved cookstoves was launched in 1984/85 with the objectives of fuel conservation, reduction of smoke, conservation of forests and the environment, providing employment, elevating the status of women and children in rural areas
- Improved cookstoves have an efficiency of 20-35% as compared to traditional ones with an efficiency of 10%.
- ICs are estimated to save about 11 million tonnes of fuelwood equivalent every year.

	Envirofit	Prakti	BioLite	Vikram	Eco-chula	Philips
						
HQ, Y.o.E	US, 2006	India, 2007	US, 2009	India, 1992	India, 2008	Netherlands, 2006
No. of models	5	3	1	1	3	2
Units sold	600,000	7,000	Piloting	10,00,000	12,000	NA
Technology	Natural draft stoves	Natural draft stoves	Forced draft TE stoves	Natural draft stoves	Forced draft stoves	Natural & forced draft stoves
Primary Sales Channel	B2B	B2B	B2CP, B2B	B2G	B2B, B2G	Not in sales anymore
Sales geographies	India, Africa	India, Africa	India, Africa	India	India	Maybe restarting sales in Africa
Other products/ businesses	Charcoal stoves, solar lights	None	TE camp stove for North America	None	Contract manufacturing	Brown & white goods MNC

Geothermal Energy

- It is heat of earth and is the naturally occurring thermal energy found within rock formations and fluids held within these formations.
- Geothermal energy can be exploited in **hot spots** (volcanoes, bubbling mud holes)
- The underground hot water in contact with the hot spots changes into steam. As steam is trapped between rocks, it gets compressed at high pressure.
- At some places, hot water and steam emerges out of earth surface and form natural gysers.
- This steam under high pressure is passed through turbines to produce electricity



Merits

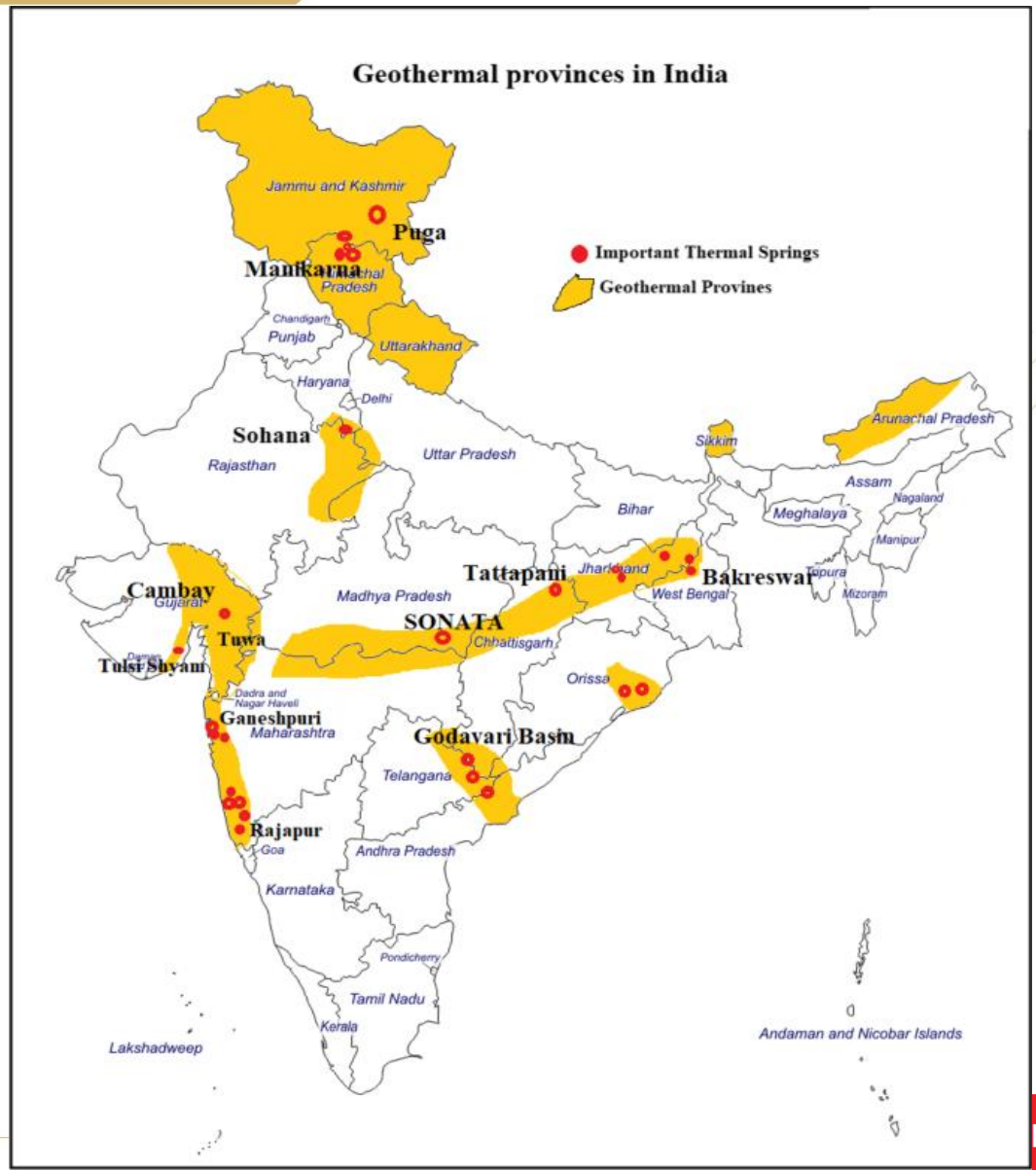
- Non polluting
- Can be harnessed for 24 hours throughout the year
- Inexpensive
- Power generation level is higher than solar and wind energy
- Can be used for power generation as well as direct heating.

Limitations

- Geothermal hot spots are scattered and distant from the areas that need energy
- Power production is less than that of fossil fuels
- Noise pollution is caused due to drilling at the geothermal site
- A single bore has life span of 10 years

Geothermal power potential of India

- Geological survey of India has discovered 350 hot water springs with temperature of 80 – 100 °C
- 5kW Pilot power plant at Manikaran in Himachal Pradesh
- Puga valley in Ladakh region has geothermal field with a potential of 4.5 MW power



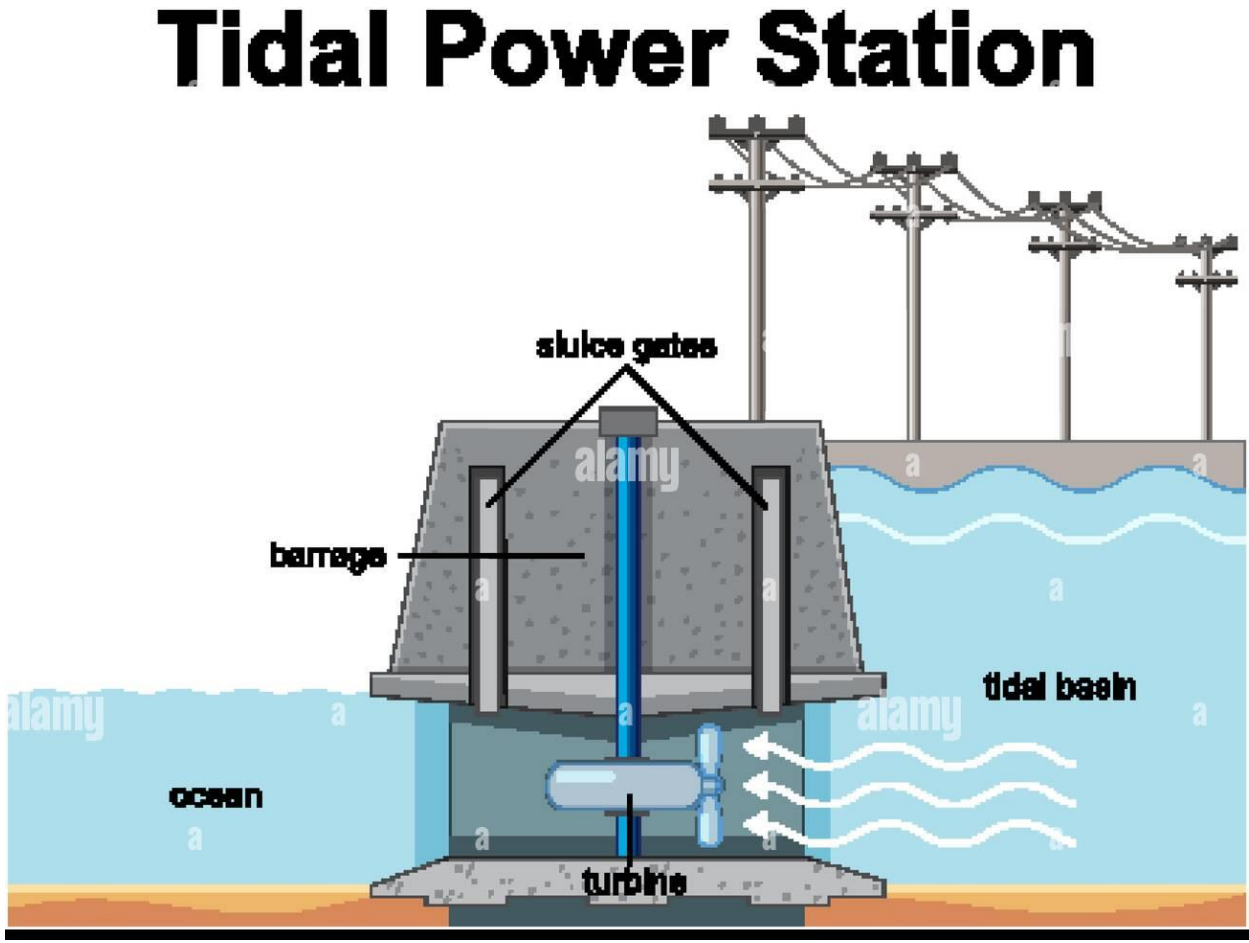
Ocean Energy

Ocean energy can be used in following ways:

1. Tidal energy
2. Wave energy
3. Ocean thermal energy

Tidal Energy:

- Movement of water level along the coasts
- tides are due to gravitational pull of moon on water in the ocean.
- Tidal energy is harnessed by constructing a dam across a narrow opening to the sea.
- A turbine fixed at the opening of the dam converts tidal energy to electricity.



Merits of tidal energy

- Inexhaustible, pollution free and renewable
- Independent of uncertainty in rainfall.
- Tidal power plant does not requires large land area as it is built on the bay.

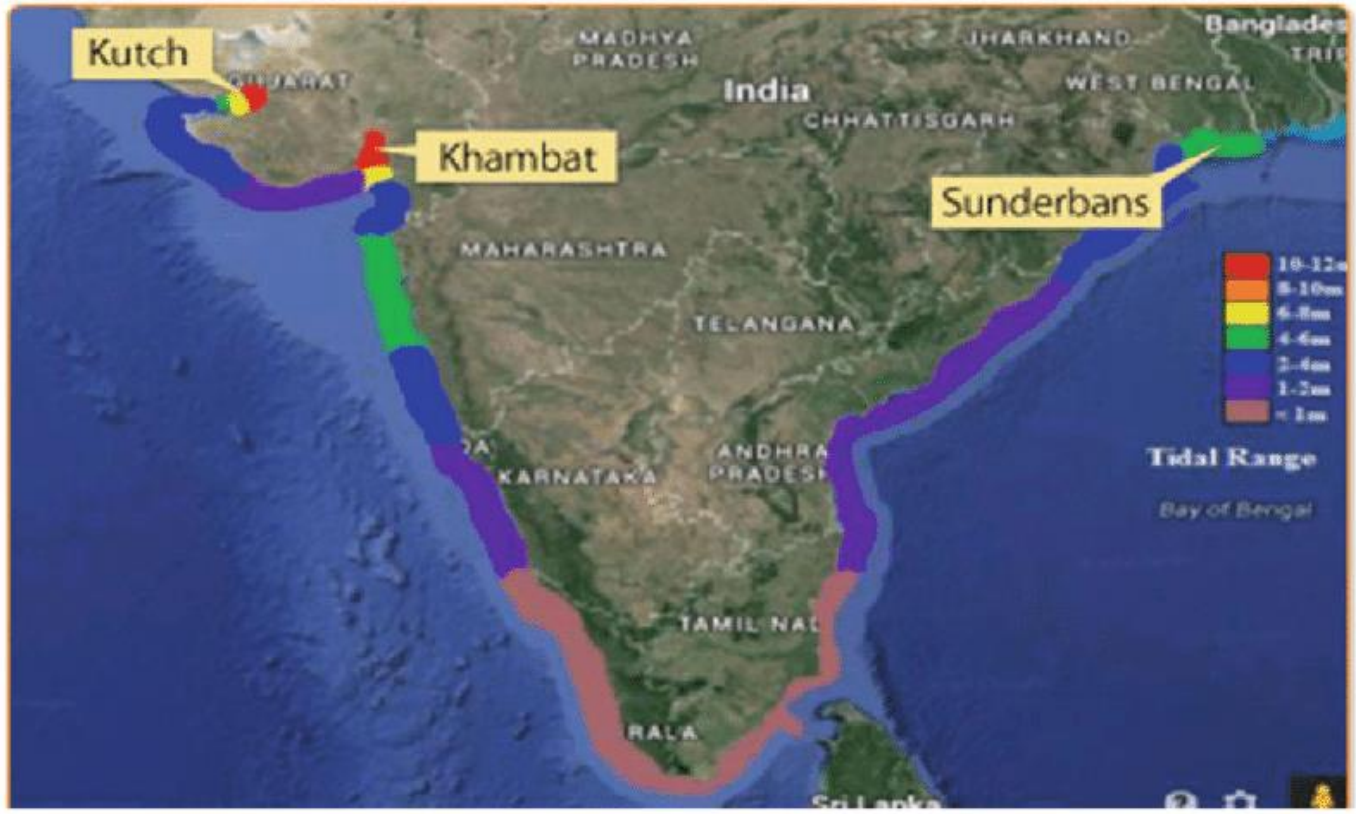
Demerits

- Due to variation in tidal range, power output is variable and power generation is intermittent and not very large
- Few suitable sites available for dam construction
- Barrier construction in areas of high tidal flow, corrosion of barrier and turbines by salt water, etc.

Tidal power generation of India:

Sites identified:

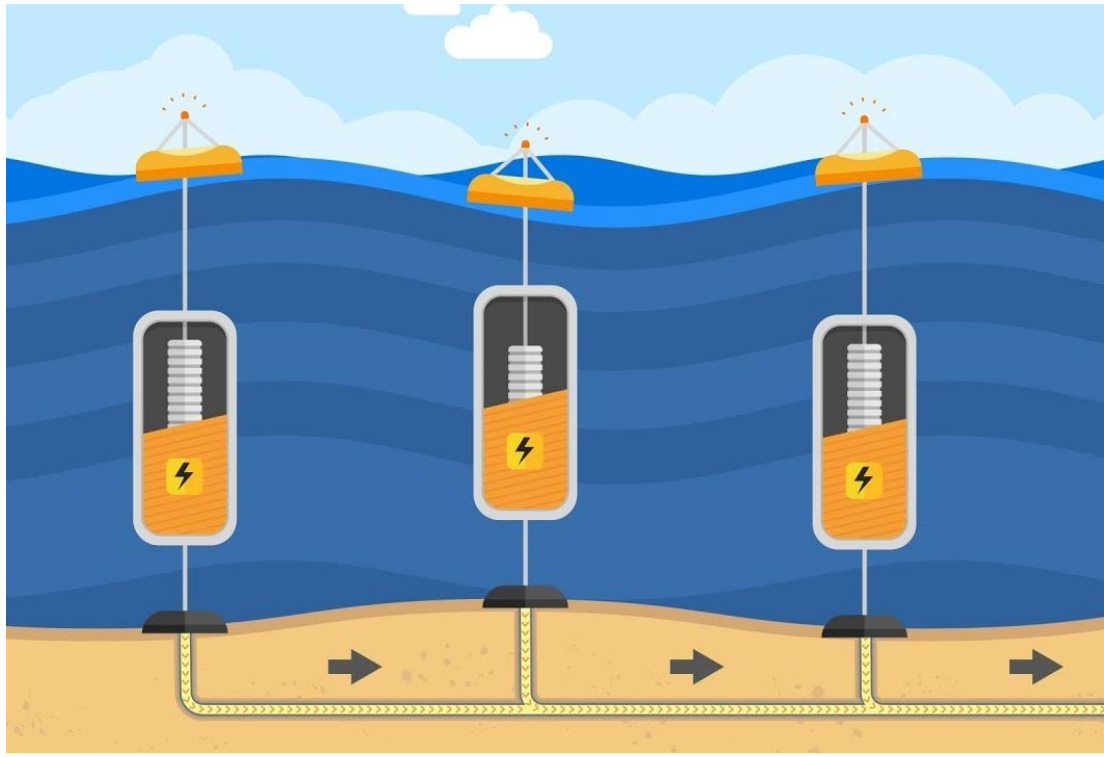
1. Gulf of Kutch
2. Sunderbans
3. Gulf of Cambay
4. Lakshadweep islands
5. Andaman & Nicobar islands
6. Coast of Orissa, Tamil Nadu, Kerala, Karnataka, Maharashtra



Gulf of Cambay/Khambat	Gulf of Kutch	Sunderbans Delta
• Maximum Tidal Range: 11m • Average Tidal Rang: 6.77 • Potential: 7000MW	• Maximum Tidal Range: 8m • Average Tidal Rang: 5.23 • Potential: 1200MW	• Maximum Tidal Range: 5m • Average Tidal Rang: 2.97 • Potential: 100MW

Wave Energy

- Due to blowing of winds on the surface of sea, fast water waves moves on its surface. The energy of moving sea water can be used to generate electricity.
- Floating generators are set up in the sea. These move up and down with the sea waves and movement drives the generator to produce electricity.



Wave power potential of India

- Wind belts in Arabian sea and Bay of Bengal are the ideal locations.
- First wave energy project with capacity of 150 MW has been set up at Vizhinjam near Trivandrum.

Merits

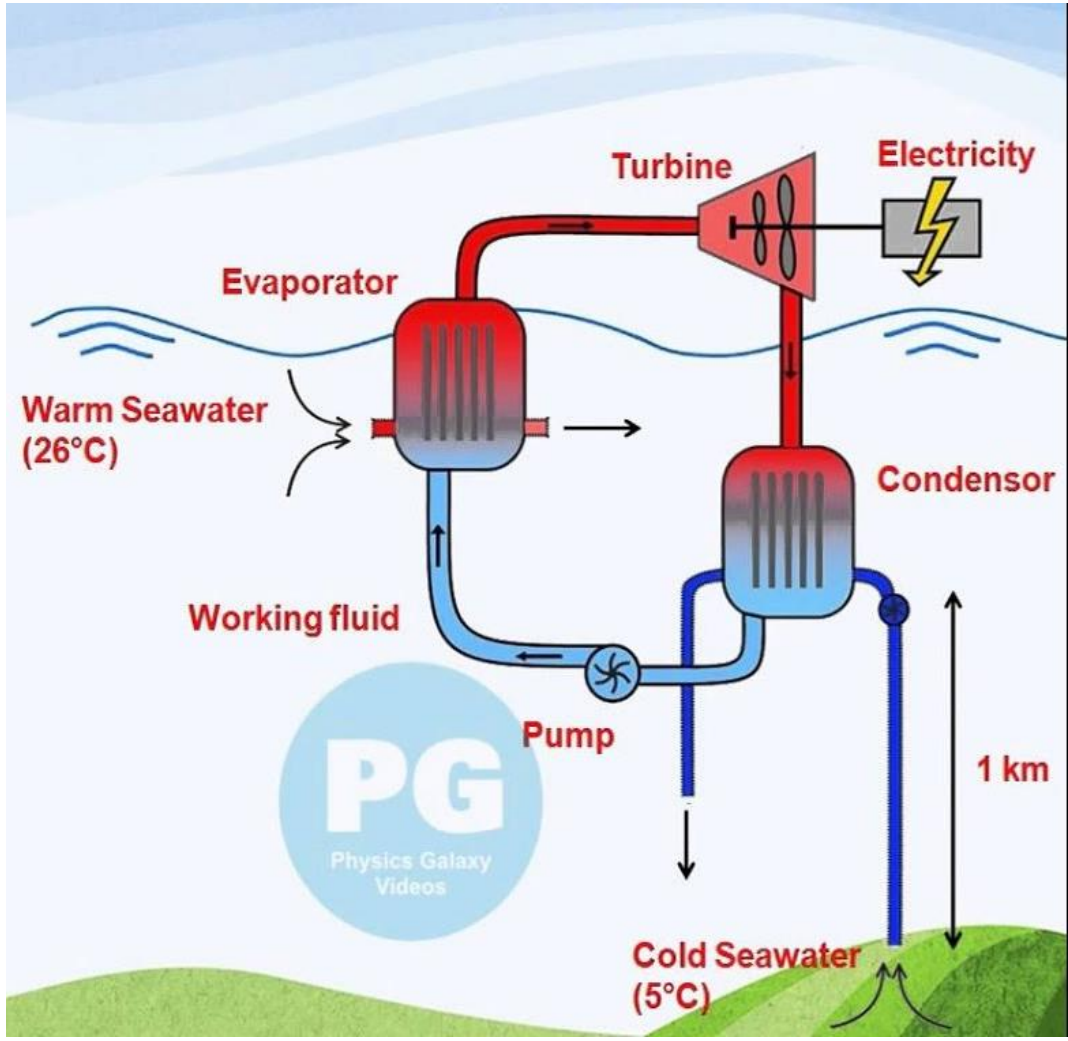
- renewable and pollution free
- Does not requires land large areas
- No specific site is required as same energy exists on every coastline

Demerits

- Output is variable
- Equipment must be able to withstand stresses in storm
- Wave power is expensive with presently available technology
- Marine animals and sea bird population could be affected due to presence of wave energy structure

Ocean Thermal Energy

- Large amount of solar energy is stored in oceans and seas.
- The sun warms the water at the surface and wave motion mixes it with water downwards.
- The mixed warms layer is separated with cold deep layer.
- It is the temperature difference (28-30°C) between these layers which is used to produce electricity.
- The process of harnessing the ocean thermal energy is known as ocean thermal energy conversion (OTEC).
- In OTEC, warm water surface is used to boil a volatile liquid like ammonia.
- The vapours of the liquid are used to run turbine of generator.



Merits

- Energy from OTEC is continuous, renewable and free
- No seasonal or daily variations in output
- Transfer nutrients from unproductive deep waters to warmer surface water, thus enriching fishing grounds

Demerits

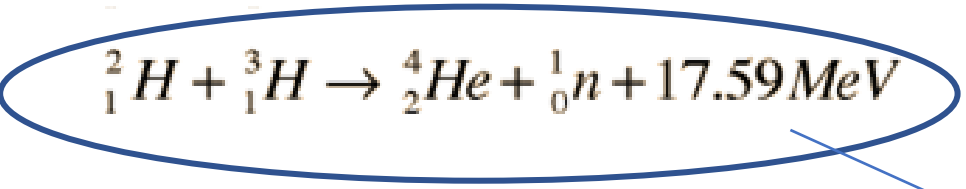
- Process requires a lot of capital investment
- Conversion efficiency is low due to small temperature difference between surface and deep water.

- **OTEC Potential of India**→ Lakshadweep, Andaman and Nicobar Islands

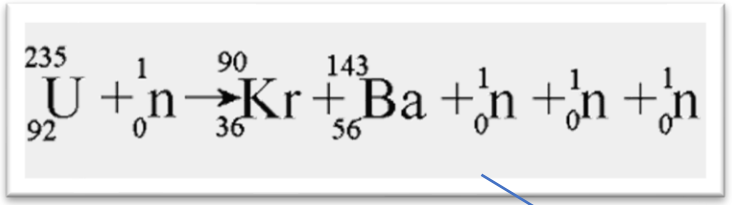
- **Nuclear energy**

When energy is released from a nucleus it is called nuclear energy. It can occur by two ways:

Nuclear fission (an atom with a heavy nucleus splits into lighter atoms) or **nuclear fusion** (two light atoms combine to form heavy atom)



Source of energy of sun (Nuclear Fusion)



Nuclear Fission

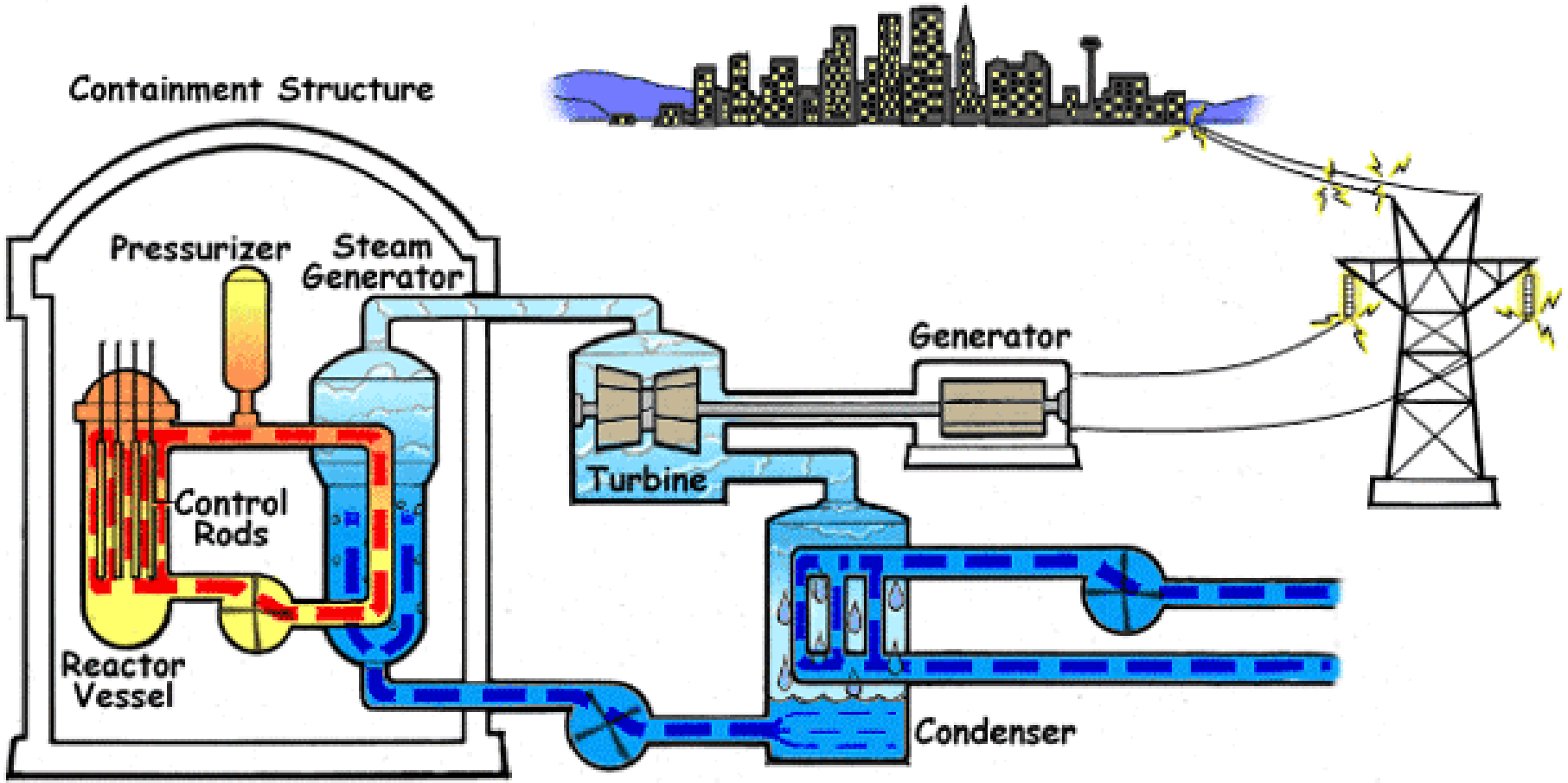
Advantages:

- large amount of energy is released
- Pollution free
- Nuclear fuel is not required again and again

Disadvantages:

- Radioactive waste is generated
- Risk of nuclear accidents leading to leakage of nuclear radiations

- **Nuclear power reactors in India:** Maharshtra, Rajasthan, Karnataka, Gujarat, Tamil Nadu



Nuclear fission occurs in this core

Non Renewable Energy Resources

Fossil Fuels

1. Coal
2. Petroleum
3. Natural gas

Mineral Resources

- A mineral is a natural substance that forms in the earth's crust over a period of millions of years. It has a definite chemical composition and identifiable physical properties
- Minerals are of the following categories:

→ metals and metallic compounds like iron, aluminum, zinc, copper, manganese, limestone, gypsum and dolomite;

→ rare earth metals such as uranium and niobium;

→ non-metals such as silica;

→ building materials such as granite, marble and mica;

→ gems such as diamonds, rubies and emeralds;

→ noble metals such as gold, silver and platinum and

→ fossil fuels such as oil, gas and coal.

Ore

→An ore is a mineral or combination of minerals from which a useful substance such as a metal can be extracted and used to manufacture a useful product.

- Examples: hematite and magnetite are ores used for steel manufacture; bauxite is an ore used for aluminum extraction and rutile is used for the manufacture of titanium.

Mining

- The process of extraction of these underground minerals is known as mining.
- Mining operations follow four phases:

(i) **Prospecting:** Searching for the mineral.

(ii) **Exploration:** Assessing the size, shape, locations, qualities and economic value of the deposits.

(iii) **Development**: Preparing for the extraction of the mineral

(iv) **Exploitation:** Extracting the mineral from the mines.

- **TYPES OF MINING**

➢**Surface Mining**

→ Mineral is above or just below the surface.

→The layers of rock and soil covering the minerals are scrapped off and then mineral are removed

Methods

1. Open pit mining

→Digging a large hole in earth to get minerals

→Large pit is called quarry

→Granite, Copper

2. Strip Mining

→Digging a long trench to get minerals

→Series of parallel strips are dug

→Soil and rock not extracted are put in previous strip

➢ Subsurface mining

→It is deep inside the earth to remove minerals such as coal, gold

→Tunnels or shafts may be used (Deep shaft mines)

→More complex and expensive than surface mining

→Risk of roof collapse, gas explosion, disturbance of underground water

Conservation of Minerals

- In the development of the nation, mineral resources are being rapidly consumed.
- The geological processes of mineral formation are so slow in comparison to the present rates of consumption.
- Improved technologies should be constantly evolved to allow use of low grade ores at low costs.
- Recycling of metal scrap like steel, copper, aluminium, zinc, lead etc. should be encouraged and facilitated by fixing appropriate standards for classification and grading of scrap
- Utilization of low grade minerals, mineral wastes and rejects should also be encouraged through appropriate incentives.

Environmental Impact of Mineral Use

- Minerals are non-renewable natural resources. Their unplanned extraction and exploitation poses a threat to raw material resources for future generations.
- Disposal of the waste which is generated during the process of mining is a problem as it causes land, soil and water pollution.
- Land erosion which is the transportation of fine soil particles carried away by water and deposited in the tailing dam causes a problem as it leads to sedimentation.
- Mining causes damage to forest cover as well as felling of trees.
- Dust generated during mining causes air pollution, which in turn causes respiratory problems and asphyxia of plants and trees.
- A large quantity of timber is used in underground mining.

- water is used in hydro-metallurgical beneficiation of minerals and the discharge of the same, contaminates water.
- Movement of heavy machinery used during mining and the process of blasting causes heavy noise pollution.
- Mining causes large disturbances to the environment adversely affecting terrestrial habitats.
- Some of the adverse social impacts of mining include:

(a) Loss of land of local people.

(b) Impact on health.

(c) Destruction of forms of community subsistence and life.

(d) Alteration of social relationships and social disintegration

Food Resources

- Food is essential for the survival of all living beings on earth.
- The three main food sources are:

→Croplands that provide 76% of total food grains

→Rangelands that provide meat and milk from grazing livestock account for 17% of total food

→Fisheries that supply remaining 7%

- An assurance of a constant food supply essential for the maintenance of peace and harmony in the society. This depends on the following factors:

(i) Availability of enough food for all (sufficient food production for the total population).

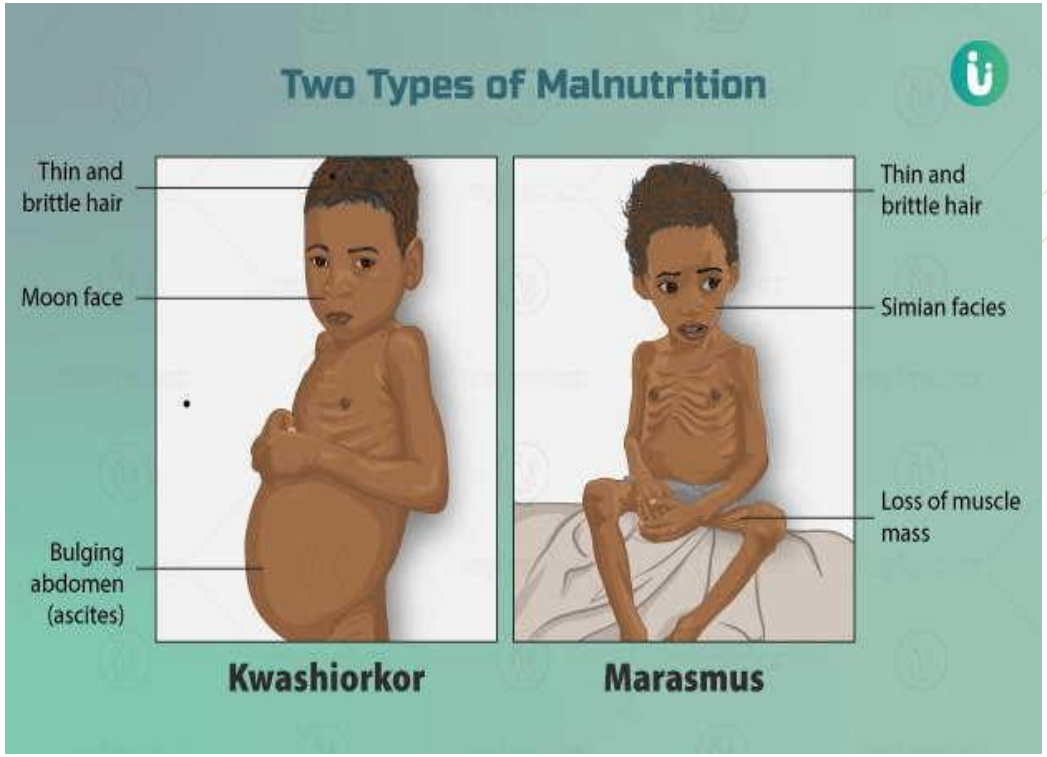
(ii) Accessibility of food for all persons (buying power and freedom for every person to purchase food).

(iii) Adequacy of food for all (food utilized by everybody should meet the nutritional requirement).

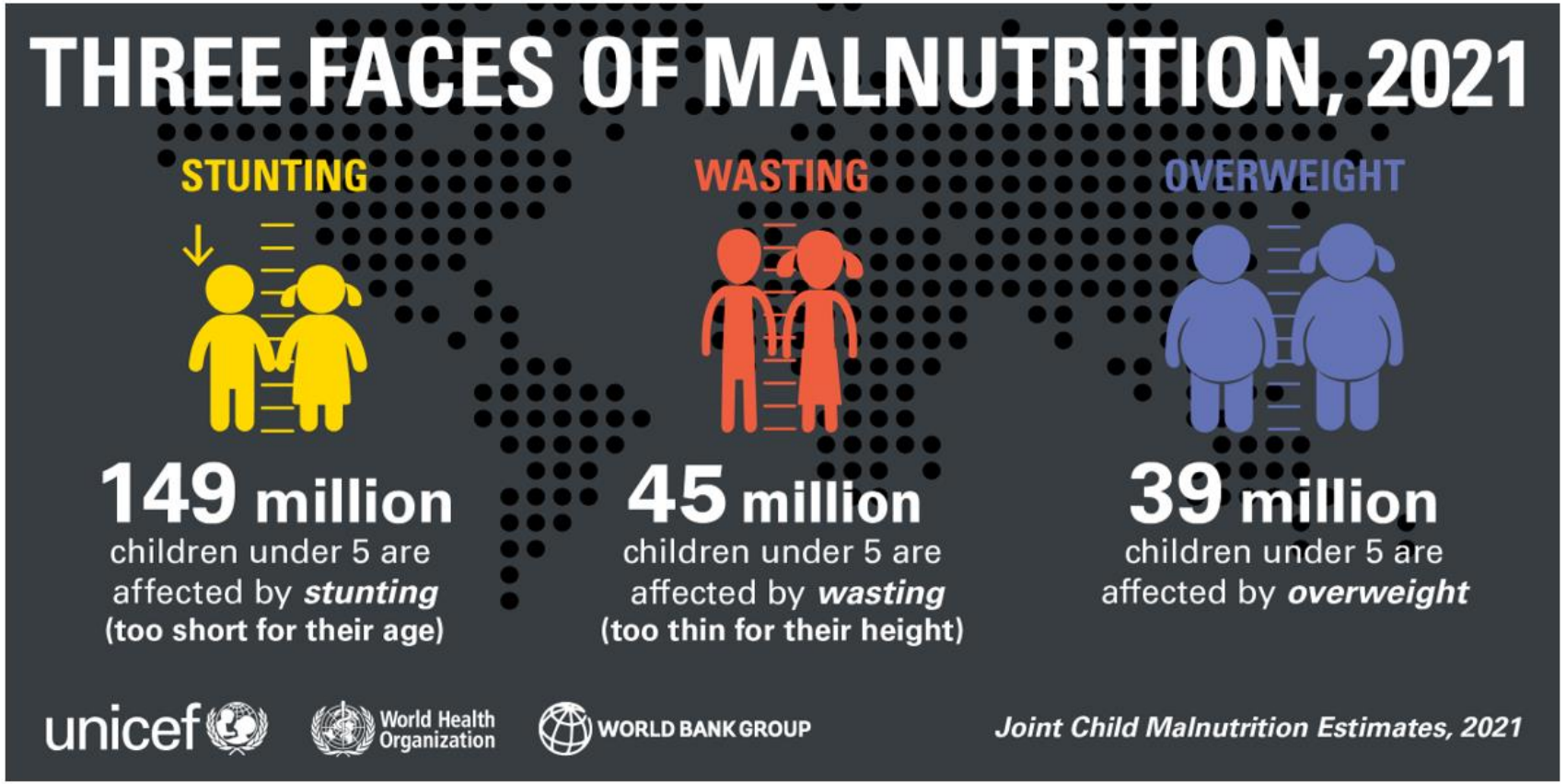
World Food Problems

- The average human must consume enough food to get approximately 2600 Kcal per day.
- People who receive fewer calories than needed are **undernourished**.
- Worldwide, one hundred and eighty two million children under the age of five suffer from undernutrition and are seriously underweight for their age, according to the World Heath Organization (WHO).
- People can receive enough calories in their diets but still be **malnourished** because they are not receiving enough of specific, essential nutrients such as proteins, vitamin A, iodine or iron.
- In addition to poor physical development and increased disease susceptibility, children who are malnourished do not grow or develop normally.

- WHO estimates that more than 3 billion people worldwide are malnourished. In addition, more than half the deaths in children less than 5 years old in developing countries are associated with malnutrition.
- The two most common diseases of malnutrition are marasmos and kwaahiorkor.
- Masrasmos is a progressive deterioration caused by diet low in total calories and proteins
- Kwaahiorkor results from protein deficiency
- a person suffering from overnutrition has a diet high saturated (animal) fats, sugar, and salt.
- **Overnutrition** results in obesity high blood pressure, and an increased likelihood of such disorders a diabetes and heart disease.



- Overnutrition is most common among people in highly developed nations, such as the United States, where the Pan American Health Organization estimates that two out of three adults are overweight, and nearly one in three is obese



Impacts caused by Agriculture

- These impacts could be classified as:
- On-site impacts
- Off-site impacts

- **Onsite Impacts**

➢**Soil Erosion:** → gradual process that occurs when the impact of water or wind detaches and removes soil particles, causing the soil to deteriorate

→Soil erosion on agricultural land takes place through three major Processes; overflow (or run off), wind and streambank erosion.

→ **Overland flows** occur when soils cannot absorb water, such as when rain or meltwater flows over saturated soils, or as a result of rain intensity that is too high for vegetation and soils to absorb

→ **Wind erosion** occurs on exposed soil if strong winds blow at times when the soil surface is relatively dry.

→**Stream bank erosion** is limited to fields that border streams

→Unskilled irrigation causes serious problems of salination and water-logging. This converts healthy land into a wet desert.

➢**Rangeland Degradation:** Range, or grazing land, provides forage for limited numbers of domestic animals.

→Overgrazing occurs when the number of animals on these lands exceeds carrying capacities

→Resulting problems of de-vegetation, erosion, and ultimately the threat of desertification.

- **Offsite Impacts**

→ The off-site impacts include water pollution from agricultural run-off, air-pollution from blowing dust or dispersal of agricultural chemicals like fertilizers and pesticides

Types of Agriculture

- **Industrialized or modern Agriculture**

➢It relies on large inputs of capital and energy, in the form of fossil fuels, to produce and run machinery, irrigate crops and produce agrochemicals such as commercial inorganic fertilizers and pesticides

➢Produces high yields which improves our affordability of food, increases the food supply, ensured the food safety, increases sustainability, and also produces more biofuels·

- **Subsistence Agriculture**

➢ Production of enough food to feed oneself and one's family with little left over to sell or reserve for hard times.

➢ Requires a large input of energy from humans and animals rather than fossil fuels

➢ **Shifting cultivation** is a form of subsistence agriculture in which short periods of cultivation are followed by longer periods of fallow (land left uncultivated) in which the land reverts to forest.

➢ **Slash-and-burn agriculture** is one of several distinct types of shifting cultivation that involves clearing small patches of tropical forests to plant crops.

➢ Tropical soils lose their productivity so farmers using slash and burn agriculture move from one area to another every three years

- **Nomadic Herding** in which livestock is supported by land too arid for successful crop growth, is another type of land-intensive subsistence agriculture.
- **Intercropping** is another form of intensive subsistence agriculture that involves growing a variety of plants simultaneously on same field.

Amazon Deforestation: Slash and Burn

Effects of Modern Agriculture

- **Soil Pollution**

→Soil pollution can be traced to wind or water erosion of exposed top soil

→compacting of soil

→Depletion of organic matter in the soil

→loss of water retention capacity

→ reduction in biological activity

→salination of soil,

→ accumulation of irrigation water in irrigated farming area due to poor absorption or poor drainage and desertification due to overgrazing.

- **Contamination of Water**

→The use of pesticides and chemical fertilizers results in water contamination.

- **Water Scarcity**

→Water is becoming increasingly scarce due to its overuse for irrigation and increase in domestic and industrial requirements.

- **Global Climate Change**

→Deforestation and loss of vegetation cover are the consequences of modern agriculture. This may cause climatic change in the area

- Modern agricultural practices have also resulted in a serious **loss of genetic variety of crops.**

- **Water Logging**

→Waterlogging occurs when the soil-surface area becomes saturated and soil pores are full of water

→Water logging could occur due to

- Periods of heavy rain.
- Poor irrigation management
- Poor drainage
- Rising water table (due to overwatering with irrigation, the unused or excess portion of water applied that recharges the ground water system causing the water table to rise)

- **Effects**

- Water-logged soil pores have no oxygen. Plants need oxygen to breathe and grow.
- Vegetation can turn yellow, growth is stunted and thin.
- Trees and plants can die and bare patches of soil appear.
- Plants species more tolerant of saturated conditions will take over (e.g. sedges, pinrushes, dock).

Prevention

- Management of drainage lines for_efficient water flow.
- Management of surface water-flow to avoid surface ponding
- Increase deep rooting vegetation for greater utilisation of water from the soil.

- **Salinity**

➢Soil salinity is also due to overirrigation. When crops are over irrigated surplus water evaporates and the dissolved salts are left behind in the soil thereby increasing the salinity of both the soil and the remaining water

➢**salinity can be prevented or checked by**

→ Improving the drainage

→ Reclamation of salinated lands by leaching with plenty of water

Sustainable Agriculture

- Farm practices that seek to balance production and preservation are known as sustainable agriculture
- Practice reduced use of farm chemicals, especially pesticides.
- The side effects of pesticides are health hazards to agricultural workers using the pesticides, health effects on the general population through contamination of food, water, air and adverse ecological effects
- The combined hazards of pesticide use are great, but so too are the benefits in terms of increased yields.
- Concern for the problems associated with massive pesticide use has prompted research on alternative methods of pest control, most importantly integrated pest management

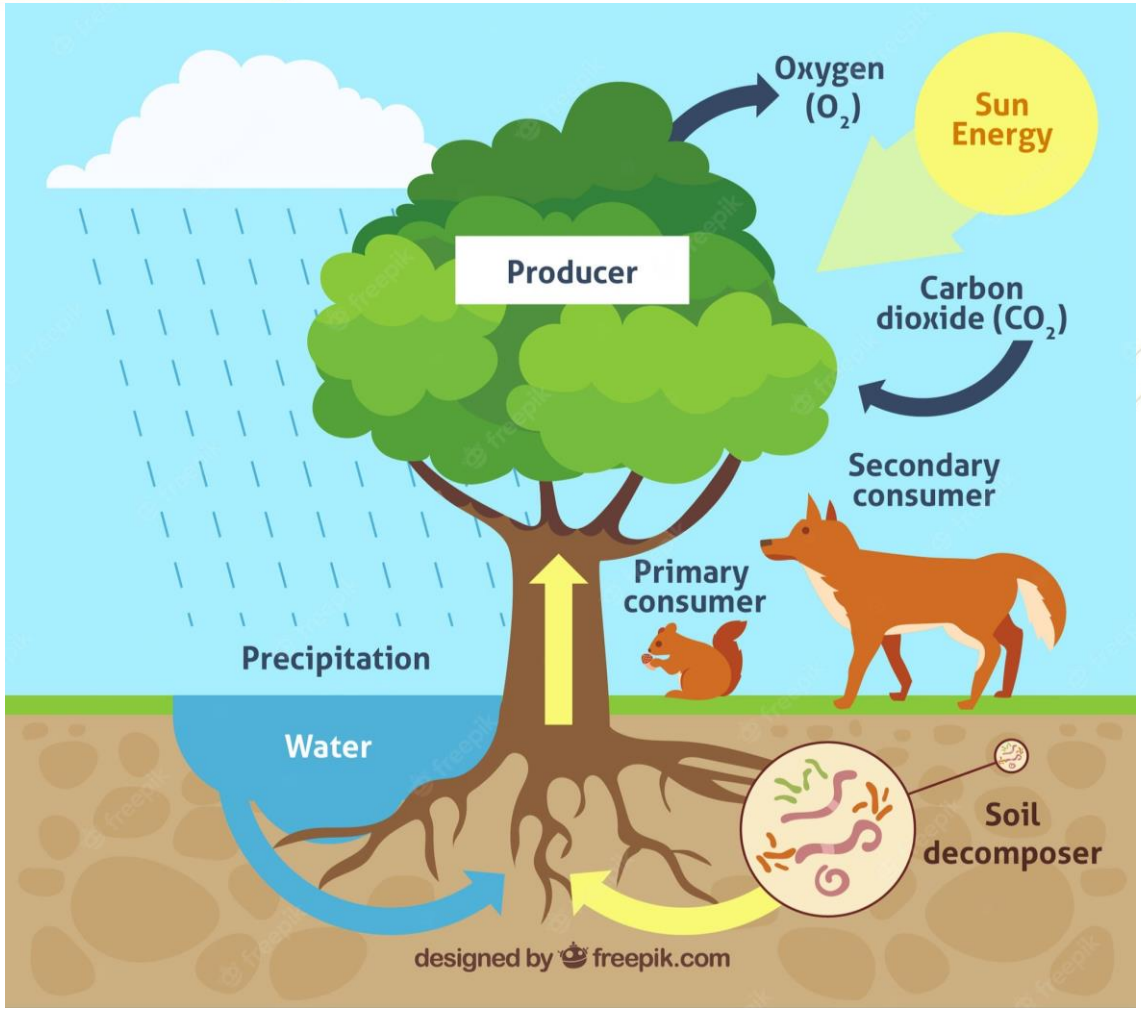

Improved food production
6
1
Improved environmental health
High production benefits and low cost production
5
Sustainable Agriculture
2
Minimization of off site environmental impacts
Optimized resource usage and conservation
4
3
Reduced environmental risk

ECOSYSTEM

- It is a community of living organisms in conjunction with physical and chemical factor (air, water, soil, etc) that occurs in some location.
- Natural ecosystems include forests, grasslands, deserts, ponds, river, etc.
- Man made/ man modified ecosystems include agricultural land, urban or industrial land use pattern.

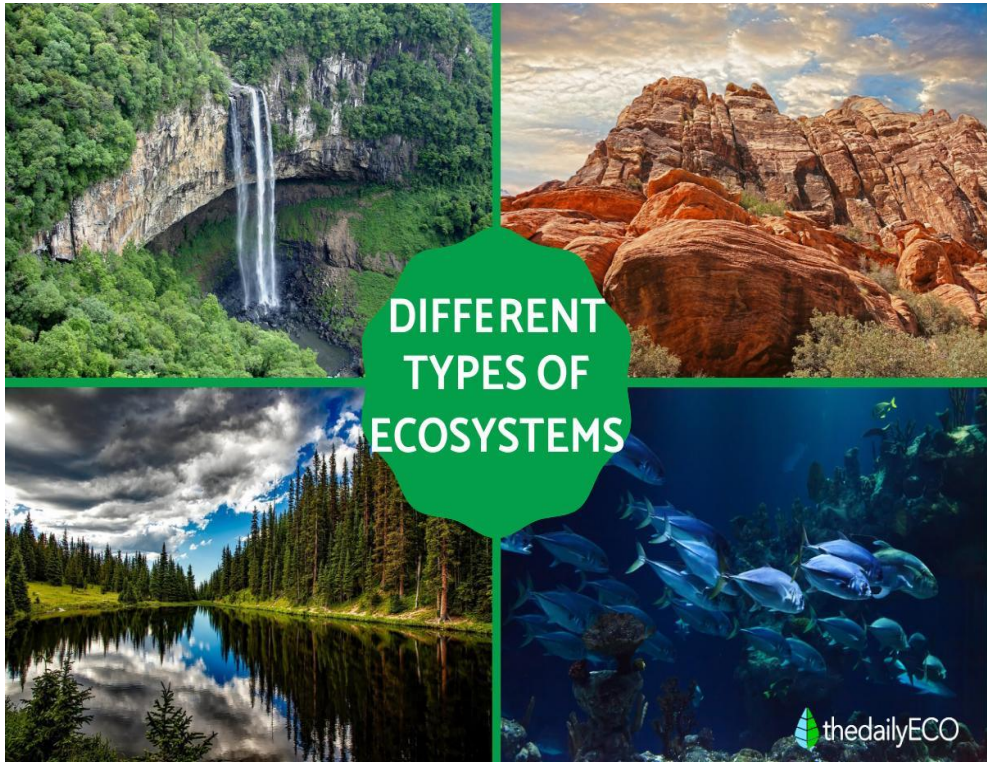
Components of ecosystem

- Biotic components
- Abiotic components



Types of Ecosystems

- **Marine ecosystem**: All the saline water reservoirs on earth such as the seas, oceans and estuaries with their characteristic biome form the marine ecosystem.
- **Freshwater ecosystem**: Ponds, streams, rivers and lakes along with their flora and fauna form the freshwater ecosystem.
- **Terrestrial ecosystem**: It includes desert ecosystem, grassland ecosystem, tree ecosystem, crop fields, forest ecosystem and so on.
- **Man-engineered ecosystem**: → Agriculture and aquaculture systems are man-engineered ecosystems.



→These ecosystems have all the essential components such as producers, consumers (both herbivores and carnivores), decomposers and abiotic materials.

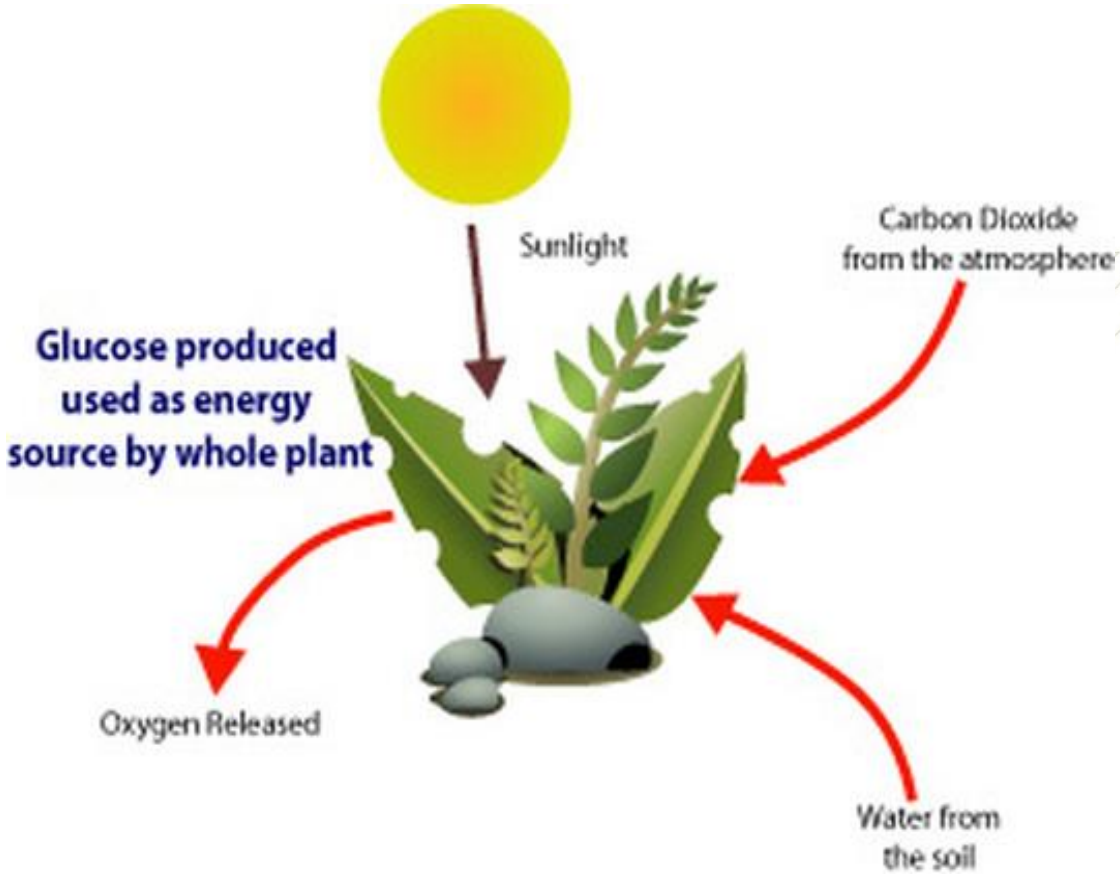
→The main purpose of these ecosystems is to produce more yields in terms of grains, milk, fish or meat.

Structure and function of ecosystem

- The two main structural features of an ecosystem are *species composition* and *stratification*
- This is also called trophic structure
- Each animal is present in different trophic level
- Plants or the producers are at first trophic level. Herbivores (primary consumers) are at second trophic level followed by secondary and tertiary consumers.
- A functional group in an ecosystem is a biological category of organisms that performs the same function. Ex- all photosynthetic plants are called producers and are in same functional group.

Producers, consumers and decomposers

- **Producers-** green plants and algae which can synthesize glucose (organic compound) from carbon dioxide and water (inorganic substance) in presence of sunlight.
- Producers convert light energy into chemical energy.



- **Consumers-** these organisms obtain energy by eating other organisms. Example- herbivores eat plants, carnivores and omnivores eat herbivores. Thus, herbivores and carnivores are consumers of the ecosystem.
- **Decomposers**- they are the final link in food web breaking down dead organic matter from producers and consumers to produce energy which is returned to atmosphere.

Energy flow through the ecosystem

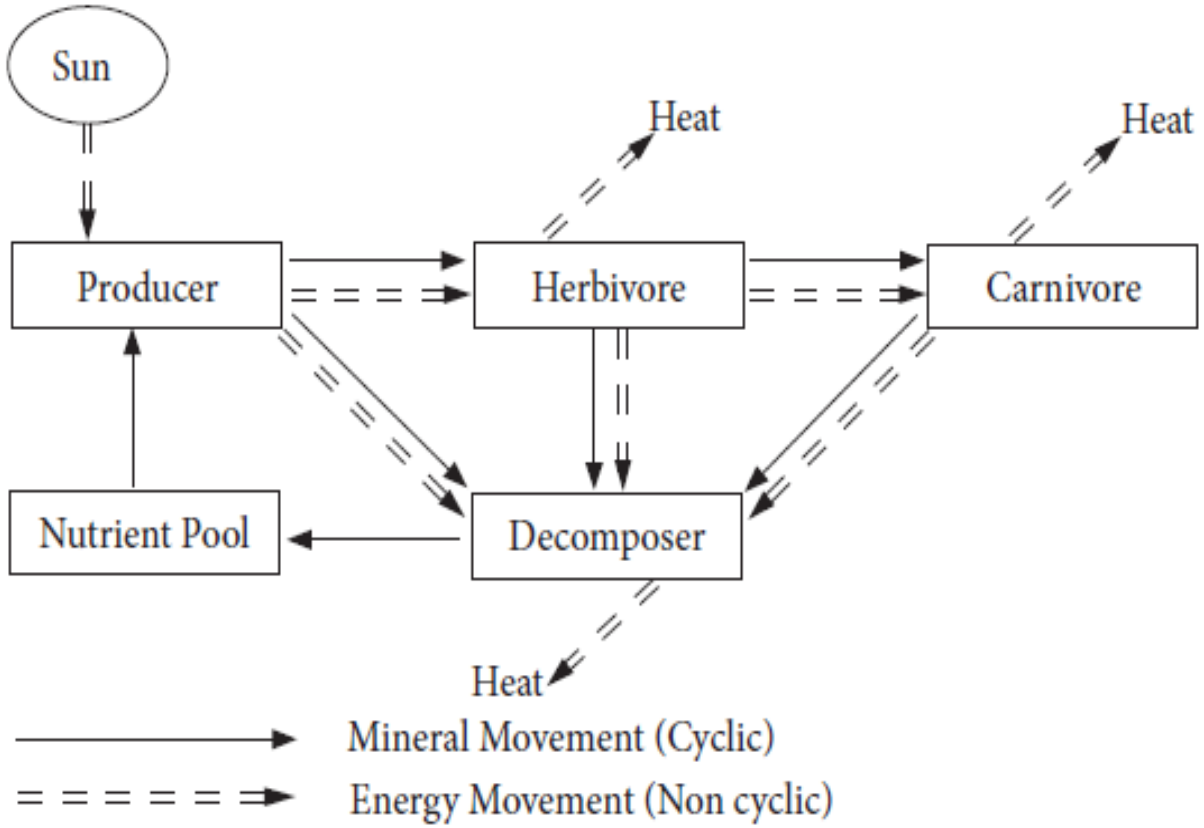
- In ecosystem, sun is largest source of energy.
- **Productivity:** The rate of food production in unit time on a unit area is known as productivity
- **Primary Productivity:** green plants can convert solar energy into chemical energy. The total amount of solar energy converted by autotrophs into chemical energy (carbohydrates) is the Gross Primary Production (GPP)
- **Secondary productivity:** net quantity of energy stored and transferred to herbivores and then to carnivores.
- In food chain energy flows from one organism to another when one organism eats the other.
- Any energy remaining in the dead organism is consumed by decomposer ((bacteria, fungi, and microbes) which break it into a simpler form which is used as nutrients by the autotrophs.
- Energy flow, or calorific flow refers to flow of energy through a food chain.

- Thus, in an ecosystem there is:

(i) Transfer of materials by cycling in a food chain without any loss of nutrients.

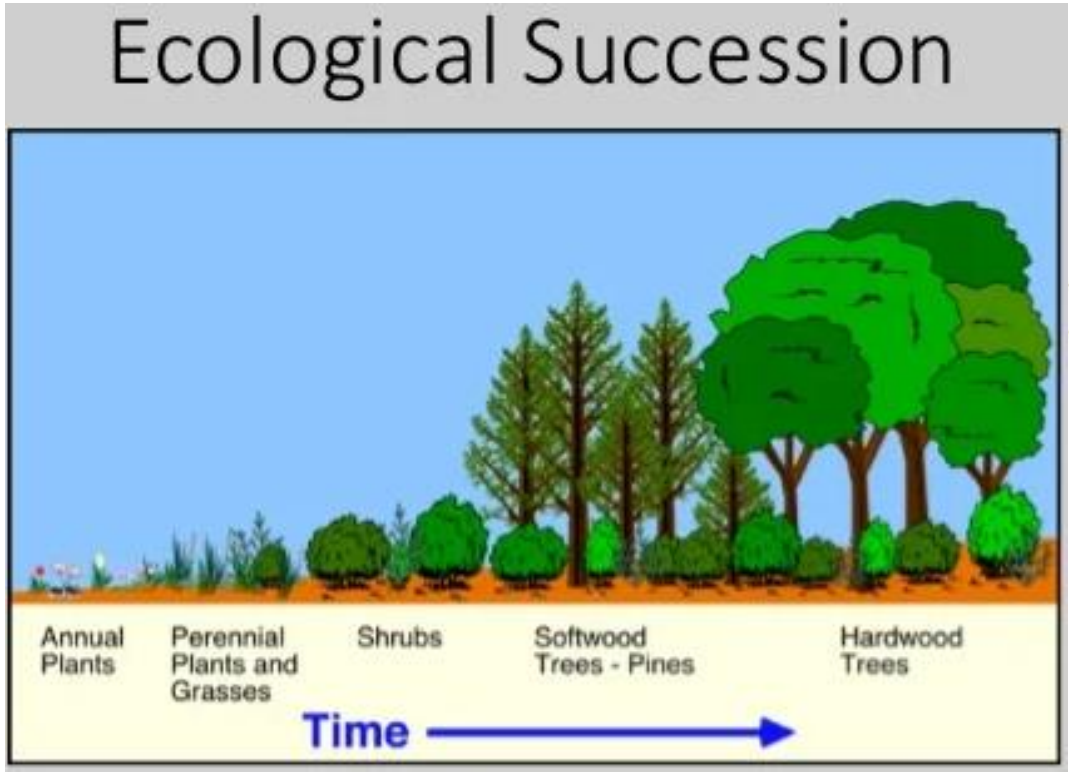
(ii) Unidirectional flow of energy with its dissipation to the surroundings.

(iii) Due to this unidirectional energy flow, the ecosystem can maintain its entity and prevent the collapse of the system



Ecological Succession

- It is the process of change in species structure of an ecological community over time.
- Ecological succession occurs because within an ecosystem an organism can have optimum growth and produce offspring till the environmental conditions remain same.
- Once, there is any change in the environmental conditions, the previously dominant species may fail and another species may become dominating.
- This gives rise to ecological succession.



- Change in plant species present in an area is one of the driving forces behind changes in animal species.
- This is because each plant species will have associated animal species which feed on it.
- The presence of the herbivore species will dictate which carnivores will be present.

Food chains and food webs

Food chains

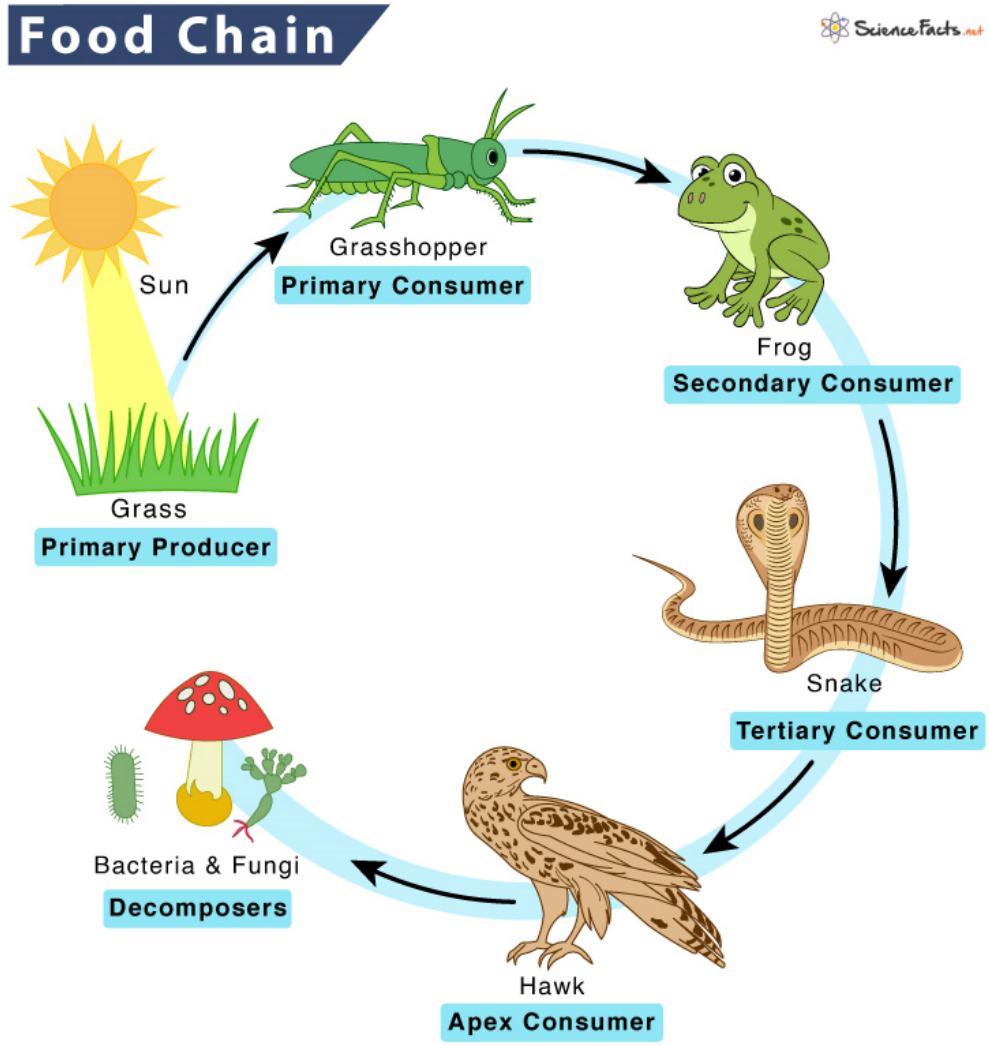
- In nature, energy must flow from one organism to another.
- Energy is transferred from plants to herbivores when these organisms eat plants.
- Similarly when carnivores eat other organisms, energy is transferred to them.
- Some organisms feed on dead matter and they form detritus food chain
- The food chain in the ecosystem helps to maintain:

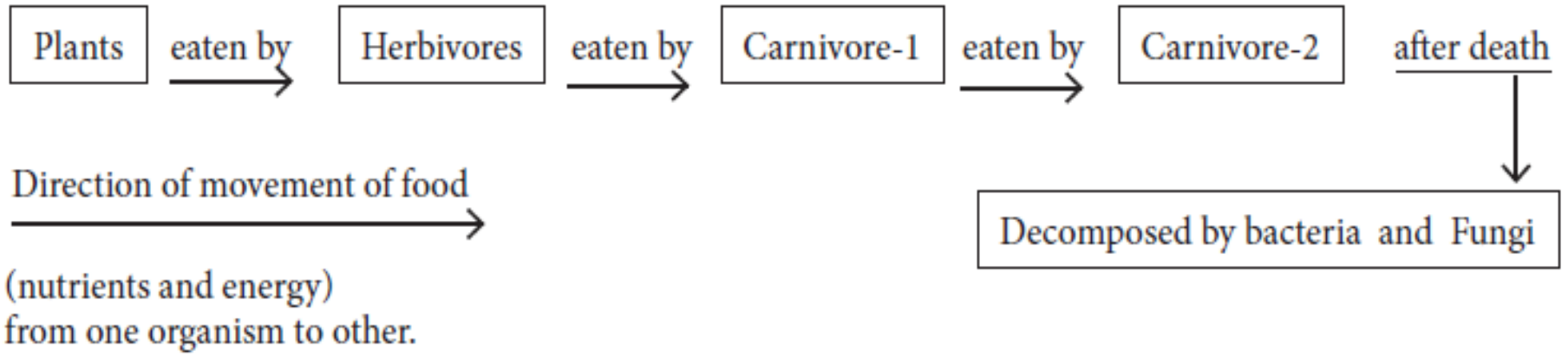
(i) The biodiversity of nature.

(ii) The feeding relationship of nature.

(iii) Flow of energy of the ecosystem.

(iv) Passage of nutrients from one organism to another.



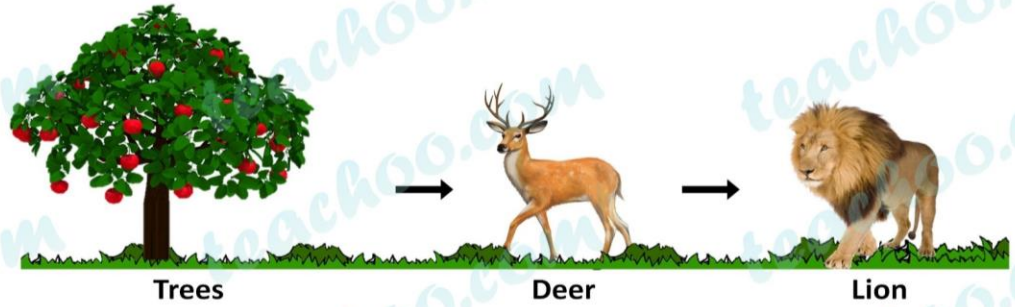


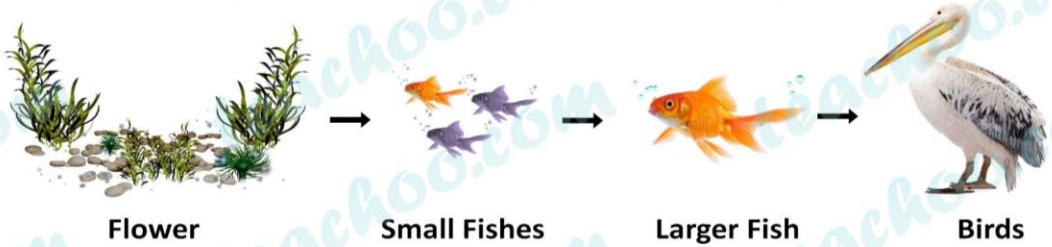
- In a food chain, the links are known as trophic levels (food level).
- The plants are producers and form trophic level-1, the herbivores are primary consumers and form trophic level-2, the small carnivores are secondary consumers and form trophic level–3 and the big carnivores are tertiary consumers and form trophic level-4.

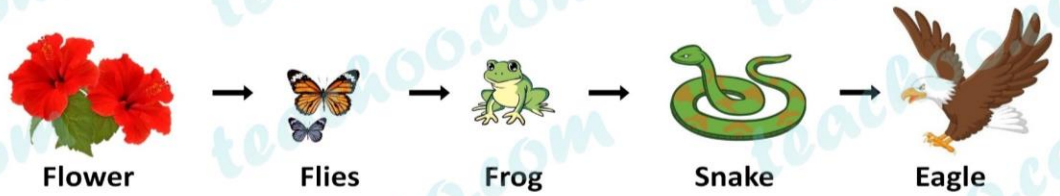
Demerit of Food Chain → **Biomagnification:** transport of toxic substance along with the nutrients in food chain from one organism to another.

Food webs: In ecosystem, a large number of interlinked chains constitute a web. If due to human activities, any link in the web is broken, then the species linked with the web may become extinct.

Food Chain







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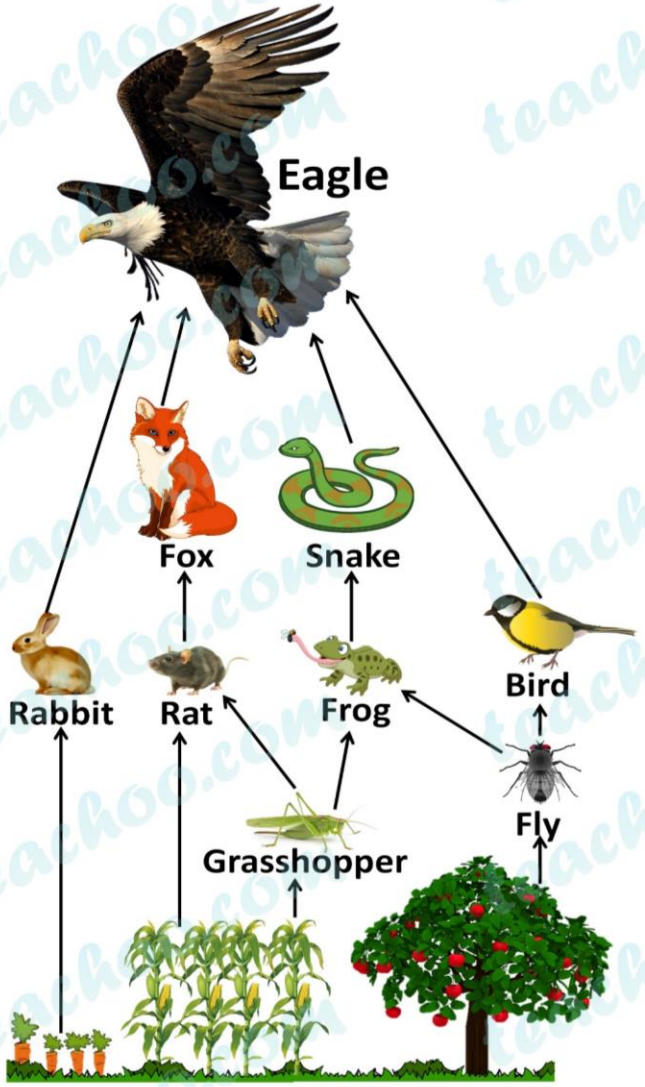
Food Web

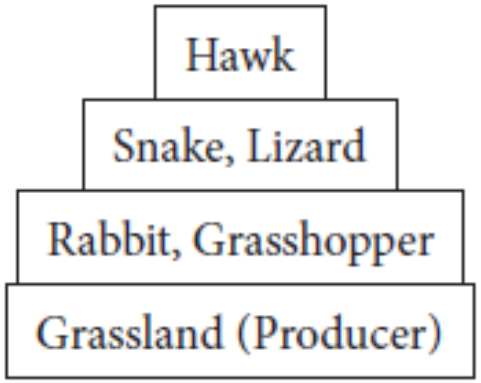


Ecological /trophic/energy pyramid:

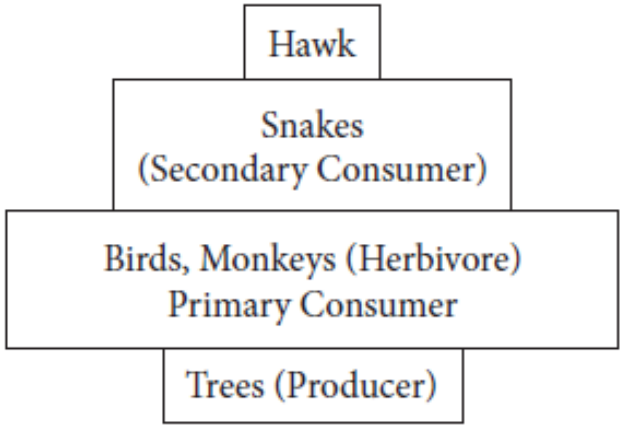
- It is a graphical representation designed to show the biomass (organic matter present in an organism) or biomass productivity (production of biomass) at each trophic level in a given ecosystem.
- An ecological pyramid is the graphical representation of the trophic structure (the position of organisms in the food chain) and function at successive trophic levels.
- Ecological pyramid begin with producers at the bottom and process through various trophic levels.
- The highest level of the food chain is at the top.
- The pyramid actually refers to the amount of biomass present in unit area (expressed in grams per m^2 or calories per m^2)
- The base of each pyramid represents producers or the first trophic level.
- The apex represents the tertiary or top level consumer.

The three ecological pyramids usually studied are:

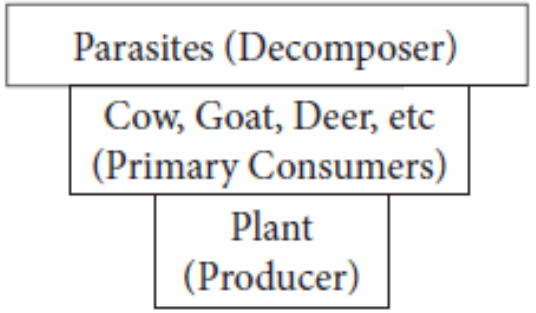
- **Pyramid of number**→ This pyramid deals with the relationship between the number of primary producers and consumers (herbivore and carnivore) of different orders.



Grassland Ecosystem

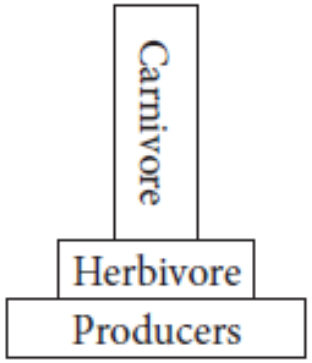


Forest Ecosystem

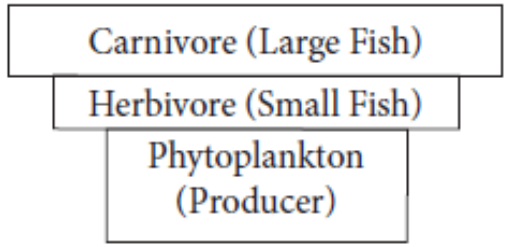


Parasitic Food Chain

- **Pyramid of Biomass**→ In a pyramid of biomass, the total weight of each trophic level (wt/unit area) is represented.



Grassland Ecosystem

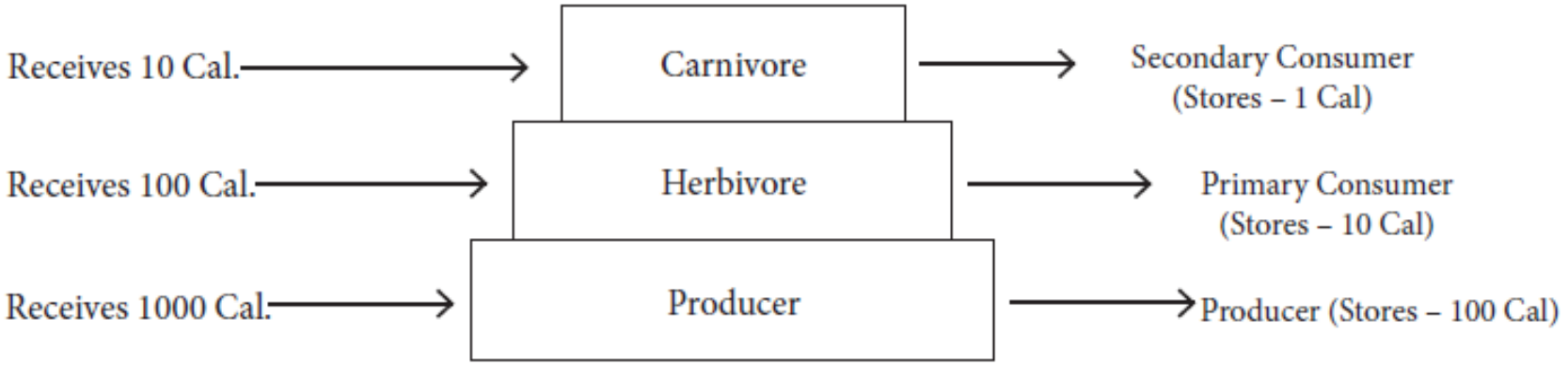


Aquatic Ecosystem
(Inverted pyramid of biomass)

- **Pyramid of Energy:** → The pyramid of energy actually depicts the rate at which the food mass is passed through the food chain.

→It is based on the actual amount of energy that individuals take in, how much is burnt up in the metabolism, how much remains in the waste products and how much they store in the body tissue

→energy pyramid gives the best picture of the overall nature of the ecosystem.



- The actual amount of energy content in successive trophic levels from the producer to various consumers decreases. Hence, the shape of energy pyramid is always upright.

Types of Ecosystem

- **Terrestrial Ecosystem-** grasslands, deserts, mountains, islands

1. **Forest Ecosystem**: it supports a lot of life forms. Each forest type forms a habitat for a specific community of animals that are adapted to live in it. Forest has vertical, horizontal and environmental structure.

Components

→**Abiotic Component**: All inorganic, organic (litters, debris) substances present in the environment and minerals present in the forest

→**Biotic Component**: The biotic component consists of all living components of the environment which constitute producers, consumers and decomposers.

- **Producers:** The vegetation of the forest is the producer. The term vegetation includes big trees, medium-sized bush and small herbaceous plants. All vegetation contains chlorophyll and performs photosynthesis
- **Consumers**

→ **Primary Consumer:** Insects like ants, beetles, flies, spiders, birds and other herbivores such as deer, squirrels, shrews, mongooses and elephants graze over the primary producer and convert it into secondary production.

→ **Secondary Consumer:** Carnivorous animals such as snakes, birds, fox and jackal which are the predators of herbivores come under this category

→ **Tertiary Consumers:** These are top carnivores, such as lions, tigers and hawks that feed on secondary consumers

- **Decomposers:** These organisms remain confined to the soil of the forest floor and have the capacity to degrade all dead plants, herbivore and carnivore tissue to release nutrients into the soil. These nutrients are again used by the producer.

Example: fungi, bacteria, mites, nematodes, protozoa and earthworms

2. **Grasslands-** Areas where vegetation is dominated by grasses. Vegetation can be both natural and cultivated. Terai Duar grassland is the most predominant grassland in India.

- **Abiotic Component**: The nutrients of the environment, such as C, H, O, N, P, S and so on are supplied by carbon dioxide, water, nitrates, phosphates and sulphates present in the air and soil of the area.
- **Biotic Component:**

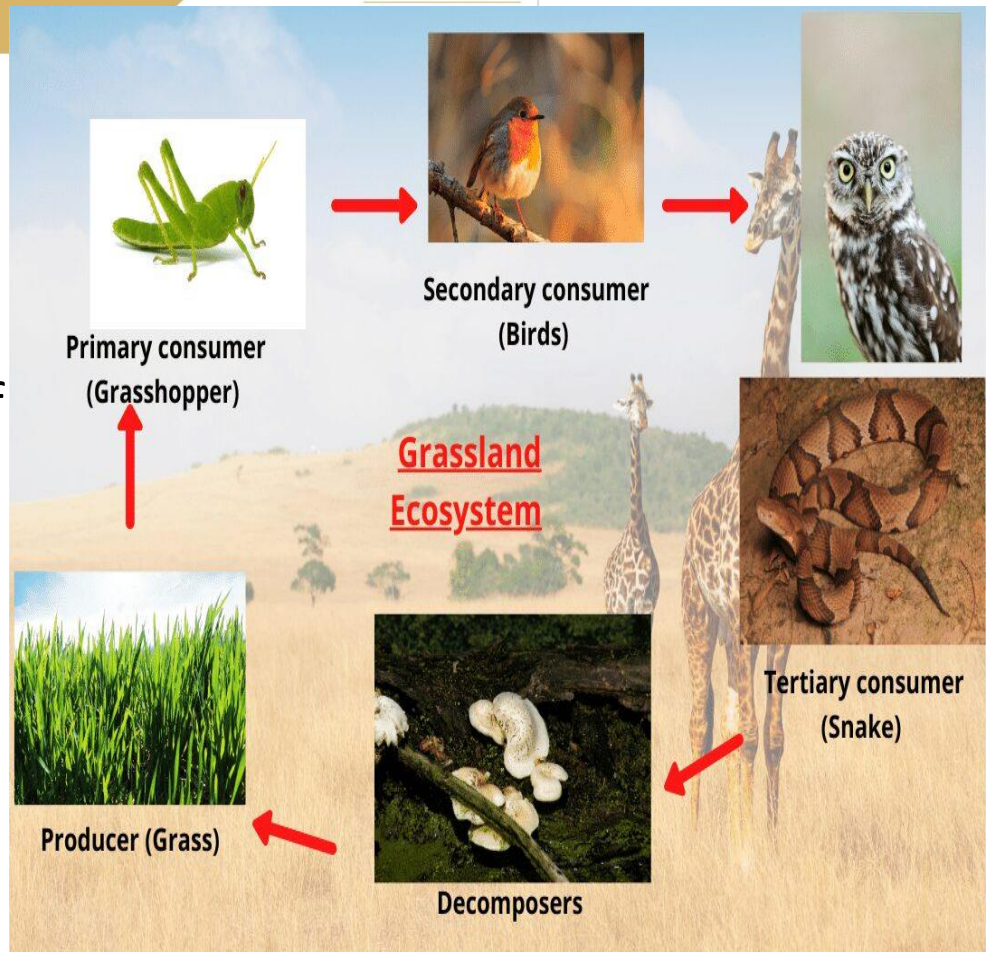
→ ***Producers:*** These are mainly grasses, a few forbs (herbaceous flowering plants) and shrubs that contribute to primary production.

→ ***Consumers:***

Primary Consumers*:* Herbivores such as bison, antelope, cattle and rodents feed on grasses and insects feed on leaves of grasses.

Secondary Consumers

Tertiary Consumer: Birds such as hawks feed on secondary consumers in a grassland ecosystem.



- **Desert Ecosystem**
- Continental interiors with very low sporadic rainfall and with low humidity are converted to deserts.
- **Biotic Components**
- ***Producers:*** Drought-resistant vegetation like euphorbias, sage bush and cacti are common here. Lower plants such as lichens and xerophytic mosses may also thrive in an oasis area.
- ***Consumers:*** A large number of nocturnal animals, mainly various reptiles and insects are seen here. Some birds and camels that feed on shoots of plant are also present here.
- ***Decomposers:*** A few fungi and thermophillic bacteria are present in this ecosystem. As the vegetation is less, the decay is also less and is managed by these decomposers.

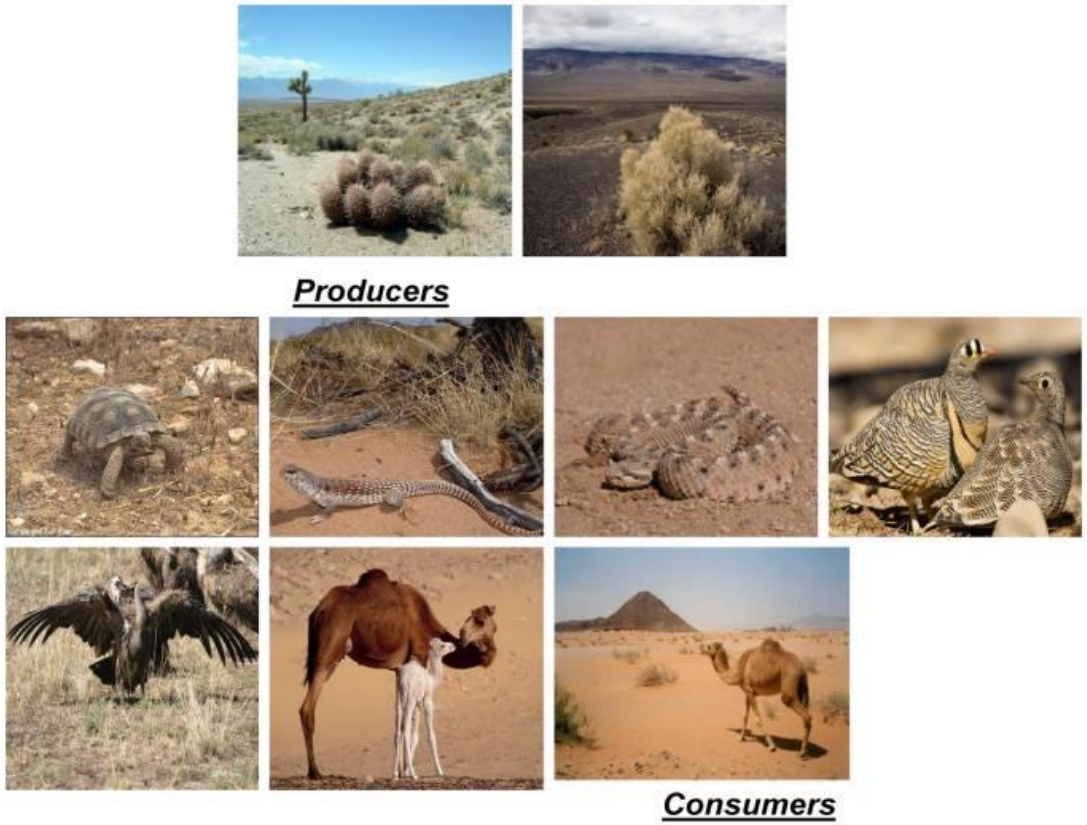


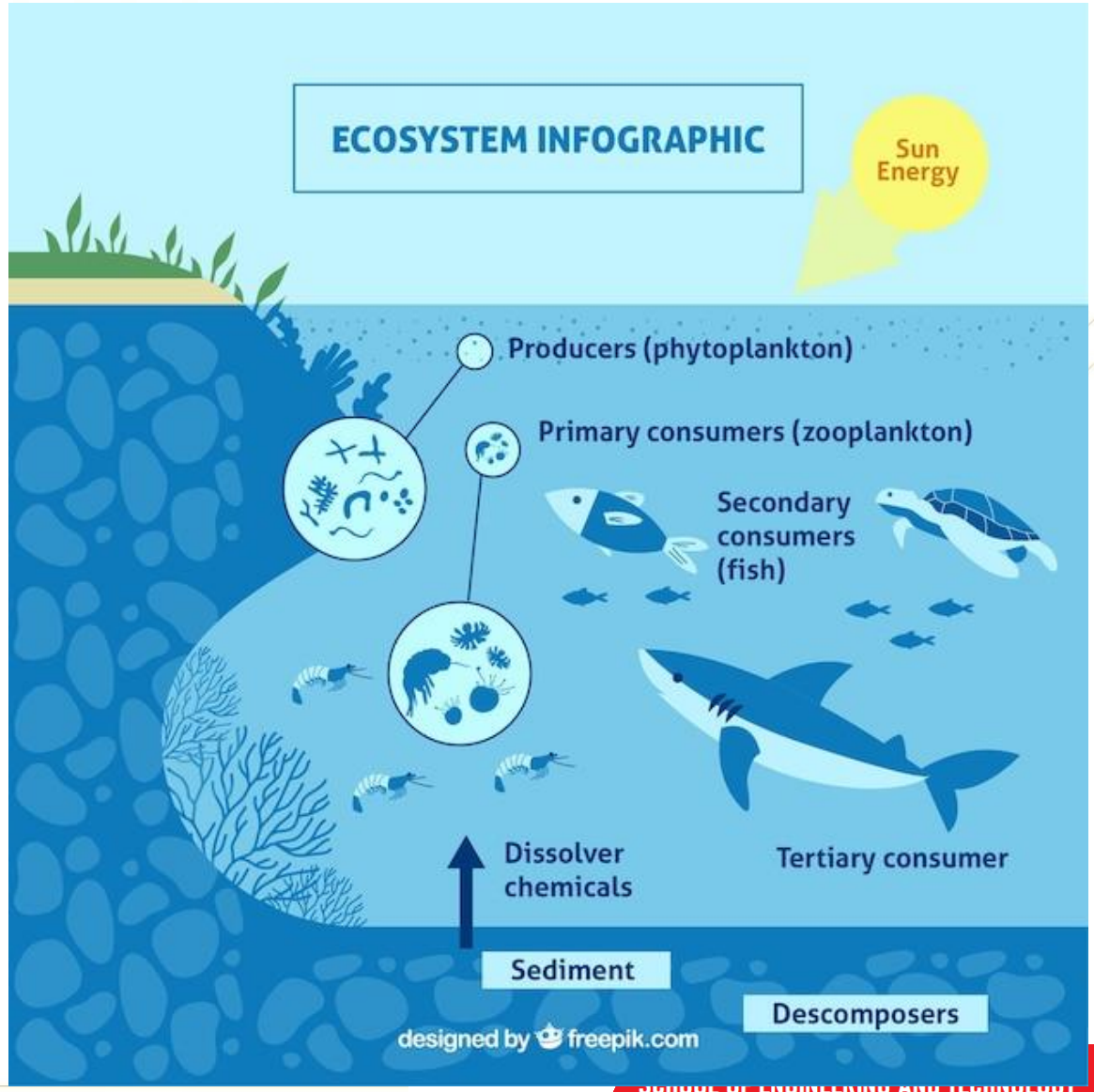
Fig. 1.6 Forest Ecosystem

Aquatic Ecosystem- An aquatic ecosystem can be freshwater, marine or estuarine ecosystem.

- **Freshwater ecosystem**: A freshwater ecosystem is of two types:
- ***Lotic:*** Having flowing water. For example, freshwater streams, springs, rivulets, brooks, rivers and so on.
- ***Lentic:*** Having stagnant or still water, for example, ponds, swamps, bogs and lakes besides others

Components of an aquatic system

- **Abiotic Component**: Abiotic components in this case are carbon dioxide, oxygen, calcium, nitrogen, phosphorous, amino acids and water.



- **Biotic Component**
- ***Producers:*** The autotrophic green plants and some photosynthetic bacteria fix the radiant energy with the help of nutrients obtained from the mud of the pond.
- ***Consumers:***

Primary Consumers: Herbivores like zoo plankton and small invertebrates such as copepods feed on the producers.

Secondary Consumers: Small carnivores like small fishes feed on primary consumers.

Tertiary Consumers: Large fishes that feed on the small fishes are the tertiary consumers.

Decomposers: Finally, bacteria and fungi present at the base of the pond decompose the organisms and help in the release and recycling of nutrients.

- **Marine Ecosystem**

→Covers approximately 71% of the earth's surface and contains 97% of planet's water

→They contain dissolved compounds, especially salts giving average salinity of 35 parts per thousand of water

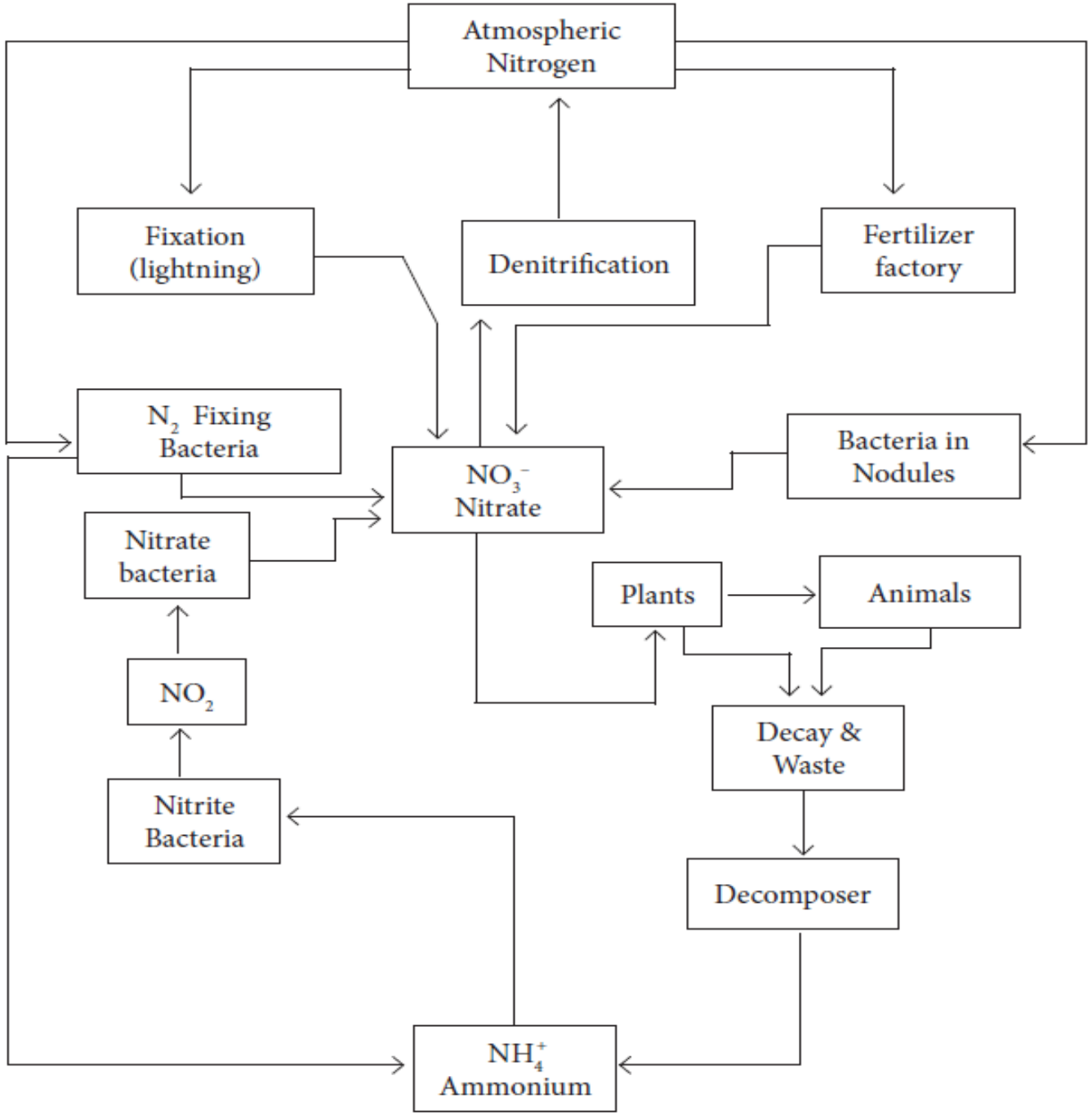
- The shoreline between the land and the open sea is termed as **littoral zone.**
- Just above the continental shelf lies **the neritic zone**. This zone is rich in nutrients (washed from land) and hence rich in species too. Sunlight also penetrates the neritic zone.
- The open sea constituting 90 per cent of the total ocean surface forms the **pelage zone.** Photosynthesis is carried out by phytoplanktons present in this zone. Zooplanktons, shrimps and jelly fish are also found here.
- The floor of the ocean constitutes the **benthic zone.** It stretches from the edge of the continental shelf to the deepest ocean trenches. Organisms present here are heterotrophic. Rooted animals such as sponges, sea lilies, sea fans and so on are present here.

- **Estuarine ecosystem:** Coastal bays, river mouths and tidal marshes form estuaries. Here,
- freshwater from the rivers mixes with the ocean water. The degree of salinity depends upon the amount of freshwater flow and tidal inflow.
- Estuaries are more productive than adjacent rivers or oceans due to the high concentration of the nutrients received from land as well as the sea.
- Organisms present in estuaries are those which are capable of tolerating fluctuation in the salinity of water.
- Some oysters, crabs and sea shrimps are found here. Estuaries contain producers, such as seaweed, marsh gases, benthic algae and phytoplanktons.

Biogeochemical cycles

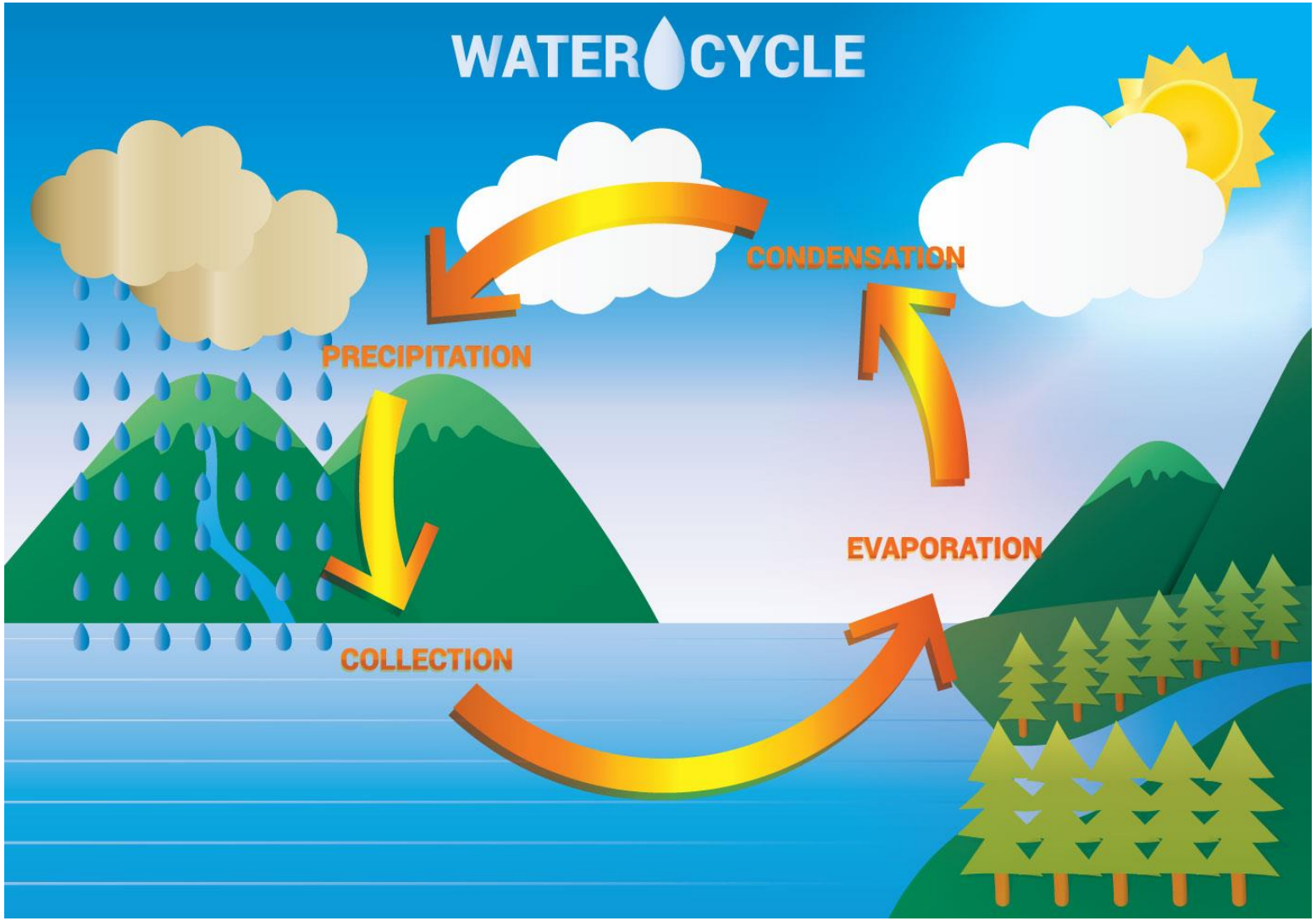
- **Nitrogen cycle**
- **Steps involved: fixation, ammonification, nitrification and denitrification**
- For the use of living organisms the elementary nitrogen has to be converted to its compound form such as ammonia, nitrates or nitrites.
- Conversion of nitrogen to its compounds is called fixation and it can be achieved by:

1. Certain free living bacteria and blue green algae
2. Industrial processes
3. Atmospheric thunder and lightning (converts gaseous nitrogen to nitrates)

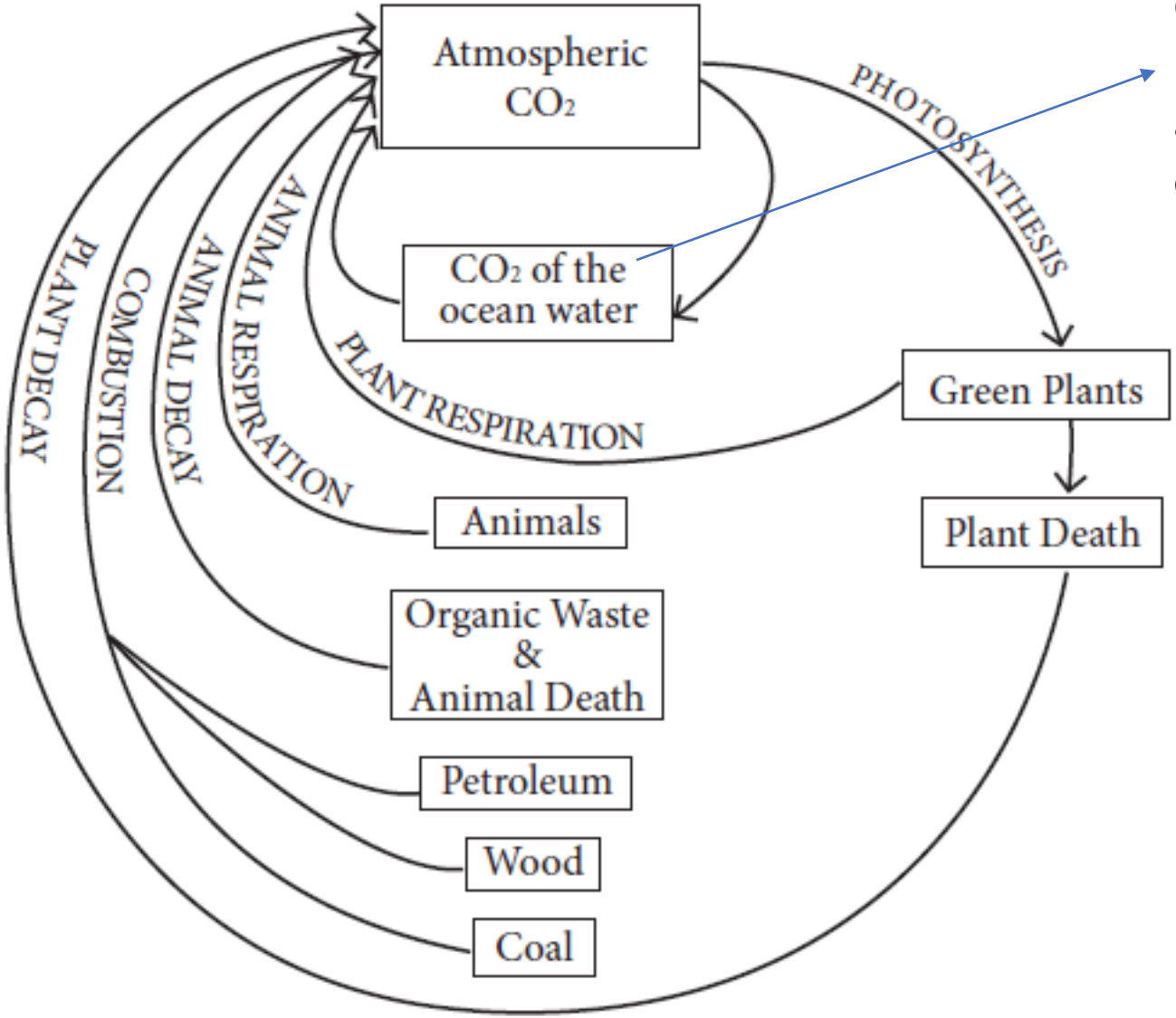

Atmospheric Nitrogen
Fixation (lightning)
Denitrification
Fertilizer factory
N_2 Fixing Bacteria
NO_3^- Nitrate
Bacteria in Nodules
Nitrate bacteria
Plants
Animals
NO_2
Decay & Waste
Nitrite Bacteria
Decomposer
NH_4^+ Ammonium

- Atmospheric thunderstorm and lightning convert gaseous nitrogen to nitrates and it reaches the soil through precipitation and is used by plants.
- Leguminous plants such as peas, beans contain nodules in their roots where symbiotic bacteria (rhizobium) can fix atmospheric nitrogen to nitrates.
- Blue green algae can fix nitrogen to ammonium ion
- Some nitrogen fixing bacteria can further oxidise ammonium to nitrates and nitrides (nitrification).
- Industrially prepared nitrogen compounds are also added to the soil.
- The death and decay of plants and animals are also sources of nitrogenous compounds.
- Some soil micro organisms break down nitrogenous compounds to N_2 in soil (DENITRIFICATION).
- in ocean and soil, denitrifying bacteria convert these nitrates and nitrites to elemental nitrogen which escapes to the atmosphere and thus completes the cycle.

- **Water cycle**


WATER CYCLE
CONDENSATION
PRECIPITATION
EVAPORATION
COLLECTION

• Carbon cycle



Oceans are the richest source of carbon where it is stored as carbonate and bicarbonate ions and an exchange with the atmosphere occurs continuously. The oceans contain 50 times more dissolved CO_2 than the atmosphere.

- Self Study : Sulfur, phosphorous and oxygen cycle

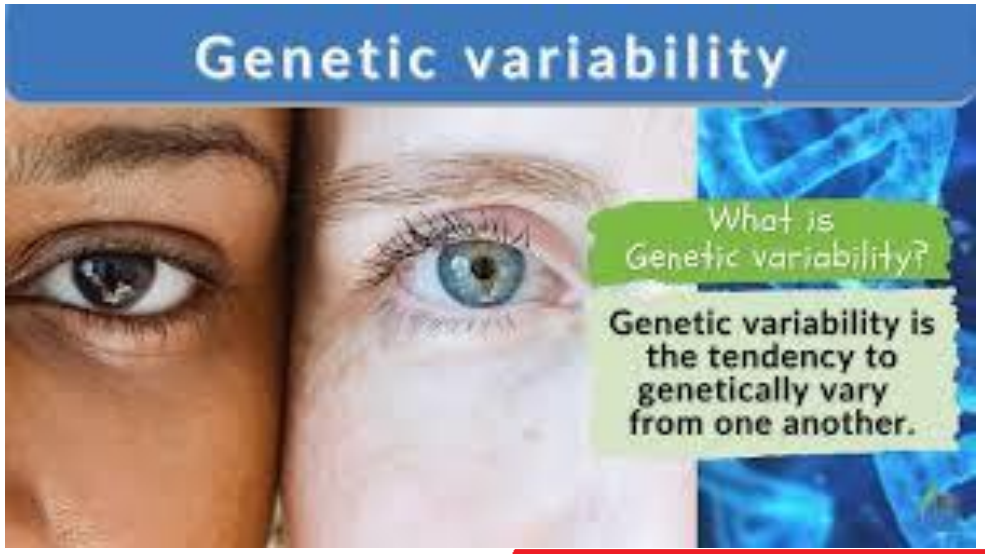
Biodiversity

- Biodiversity is the variety of life on earth. It includes all life forms – from the unicellular fungi, protozoa and bacteria to complex multicellular organisms such as plants, birds, fishes and mammals.
- It reflects the combination of genes, species and ecosystems.
- Diversity may be defined as the number of species present in a community. It is a measure termed as species richness
- The diversity can be divided into:

1. **Genetic diversity**
2. **Species diversity**
3. **Ecosystem diversity**

Genetic Diversity

- It refers to the variety present at the level of genes.
- When there is a variation of genes within the same species (single population) and also among geographically separated populations it is called genetic variation.
- Within any given species, there can be several varieties or strains which slightly differ from each other in one or more characteristics such as size, shape, etc.
- A change in external as well as internal factor is responsible for genetic variation.
- **Example-** Teak wood varieties like Indian teak, Burma teak, Malaysian teak etc. thousands of rice varieties like basmati rice, jasmine rice, etc.



Species Diversity

- A species generally consists of all the individual organisms of a natural population which are able to interbreed, generally sharing similar appearance, characteristics and genetics. A species is one of the basic units of biodiversity
- **Species Diversity** refers to the number of species and variety of species present in a particular ecosystem.
- It represents broadly the species richness and their abundance in a community. Ex- The total number of species living on earth is approximately 13.92 million

Sl. No.	Life Forms (Species)	No. Described
1	Virus	1,000
2	Bacteria	3,060
3	Cyanobacteria	1,700
4	Fungi	28,983
5	Algae	26,900
6	Lichens	18,000
7	Bryophytes	16,000
8	Pteridophytes	11,299
9	Gymnosperms	929
10	Dicotyledons	1,70, 000
11	Monocotyledons	50,000
12	Invertebrates	9,89,761
13	Mammals	4,000
14	Other vertebrates	48,853
15	Other forms	27,400
	Grand Total	13,92,485

Ecosystem Diversity

- A broader scale of biodiversity depicts the differences between different habitats, ecological processes, and the ecosystem in which the species exist.
- Based on the physical structure and species composition, the ecosystem can be divided into:

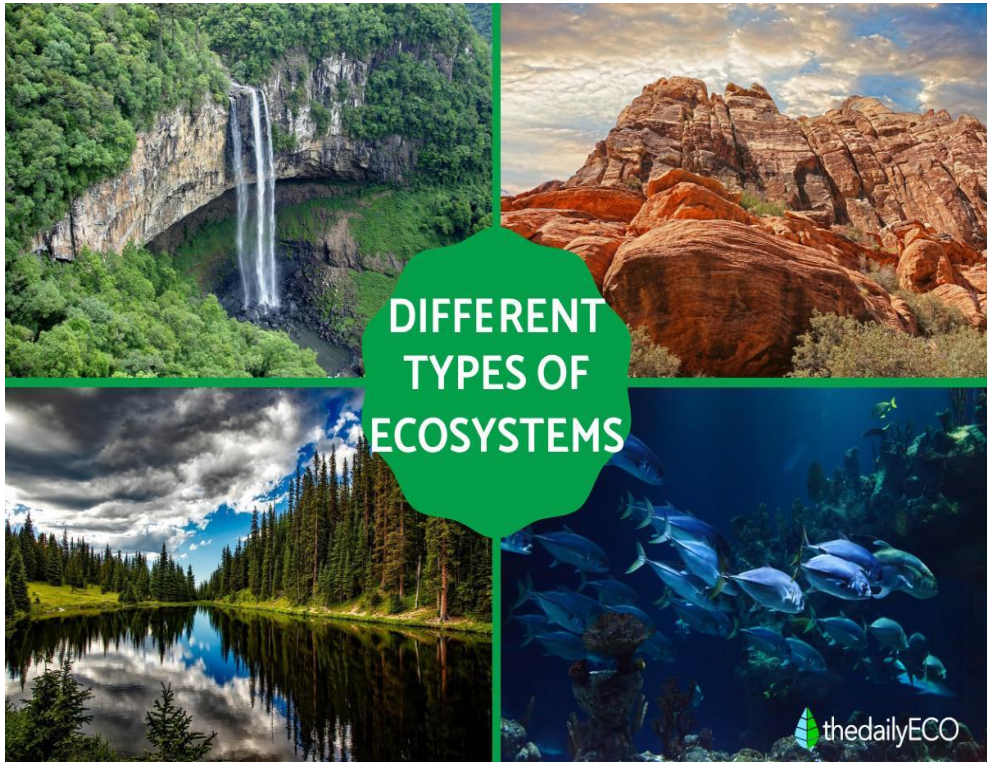
(i) **Terrestrial Ecosystems** such as forests, grasslands, deserts and so on.

(ii) **Aquatic Ecosystems**: These are of two types:

(a) **Freshwater,** consisting of lotic and lentic.

(b) **Marine,** consisting of oceans and estuaries.

(iii) **Artificial or Man-made Ecosystem** consisting of lakes, croplands and so on.



Functions of biodiversity

- Two main **functions of biodiversity** are

1. It is the source on which the entire human species depends on for food, fiber, shelter, fuel and medicine.

2. It depends on biosphere which in turn leads to stability in climate, water, soil, air and overall health of biosphere

Values of biodiversity:

For conservation of biological resources an economic evaluation of biodiversity is essential.

The **value of biodiversity can be categorized as:**

1. Direct use value
2. Indirect use value
3. Social value
4. Aesthetic value
5. Existence (ethical) value

- **Direct use** is of two types

1. The **consumptive use** value is the value placed on nature's products that are consumed directly, without passing through a market. Some of them are firewood, fossil fuels, etc. These are consumed locally and not sold in market.

- When direct consumption includes recreation, as in sport fishing and game viewing, the consumptive value is the whole recreational experience.

2. **Productive use value** refers to products that are commercially harvested (sold in a market). Its value is estimated at the production end rather than retail end by adding an inflated cost to the finished product. Ex- many raw materials for drug manufacturing are plant or animal based.

- Productive use value is often the only value of biological resource reflected in national income accounts and may have a major impact on the national economy.

- **Indirect values:** provide economic benefits without being harvested and do not appear in GDP.
- However, they are crucial to other natural products which influence the GDP. These values involve functions performed by biodiversity which are not of any use. Ex: ecological processes etc.
- **Examples:** soil formation and protection,
- watershed protection,
- waste disposal,
- pollination, nutrient cycle, oxygen production, carbon sequestration,
- control of floods, climate regulations,
- recreation and eco-tourism,
- educational and scientific value and environmental monitoring.

- **Aesthetic Value**: Great aesthetic value is attached to biodiversity. We will not like to visit vast barren lands with no signs of visible life
- People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is now known as ecotourism.
- The aesthetic value of our ecosystem contributes to the emotional and spiritual wellbeing of a highly urbanized population.

- **Social Values: S**ocial values are ideals and beliefs which people preach and uphold in order to structure the traditions, institutions and laws of the society they live in.
- Social movements along with the efforts of non-governmental organizations at the national and international levels, play an important role in the conservation of nature

- **Ethical value:** These values are related to conservation of biodiversity because all life forms must be preserved.
- The ethical obligations for protecting biodiversity are:

(i) Protect other species from extinction.

(ii) Do not waste resources.

(iii) Remember that all species are interdependent and have a right to exist.

(iv) People must take responsibility for their actions.

(v) People must feel responsible towards their future generations.

(vi) Remember that nature has spiritual and aesthetic values that can be transformed into economic values.

(vii) Keep in mind that nature matters to us and so our actions must not harm it.

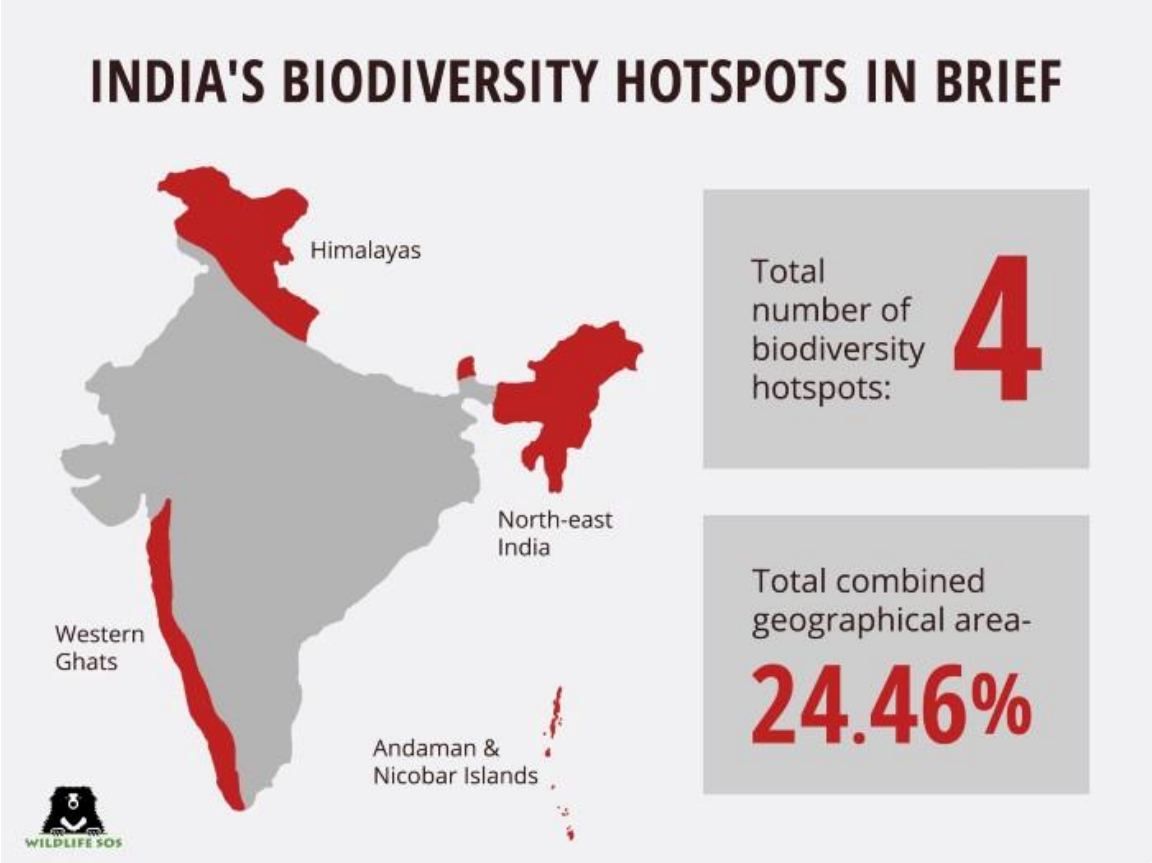
Hotspots in Diversity

- Biodiversity hotspots are environmental emergency rooms (store houses) of the earth
- Hotspots are defined as localised concentration of biodiversity and are in need of sincere conservation action.
- Terrestrial biodiversity hotspot is based on plant diversity that has:

(i) At least 0.5 per cent or 1,500 of the world's 3, 00,000 species of green plants

(ii) Has lost 70 per cent of its primary vegetation.

- There are 25 terrestrial hotspots around the world.



INDIA A MEGADIVERSITY NATION

India has a rich heritage of biodiversity, a wide spectrum of habitats from tropical rainforests to alpine vegetation, and from temperate forests to coastal wetlands .

- India occupies 2.4% of the total land area of the world, but India contributes 8.22% of the known global biodiversity.
- India is one of the 12 mega-diversity nations of the world
- India is in the 10th position in the world and 4th in the Asia in terms of plant diversity
- India ranks 10th in the world in terms of number of mammalian species

- India ranks 11th in the world in terms of endemic species of higher vertebrates
- India has three biomes, namely the tropical humid forests, the tropical dry deciduous forests and the warm desert/semi- deserts
- India can be divided into ten biogeographic zones and 26 biotic provinces which represent the major ecosystems of the world

Biomes: A biome is an area classified according to the species that live in that location

Endangered Species

- An endangered species is a population of organisms which is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters.
- In India, nearly 450 plant species have been identified in the categories of endangered, threatened or rare.
- However, a few species of endangered reptiles, birds, mammals and plants are given below: green sea turtle, tortoise, python

Birds: Great Indian bustard, Pelican, Siberian White Crane

Carnivorous: Indian wolf, Mammals tiger, leopard, striped hyena, Indian lion

Endemic species

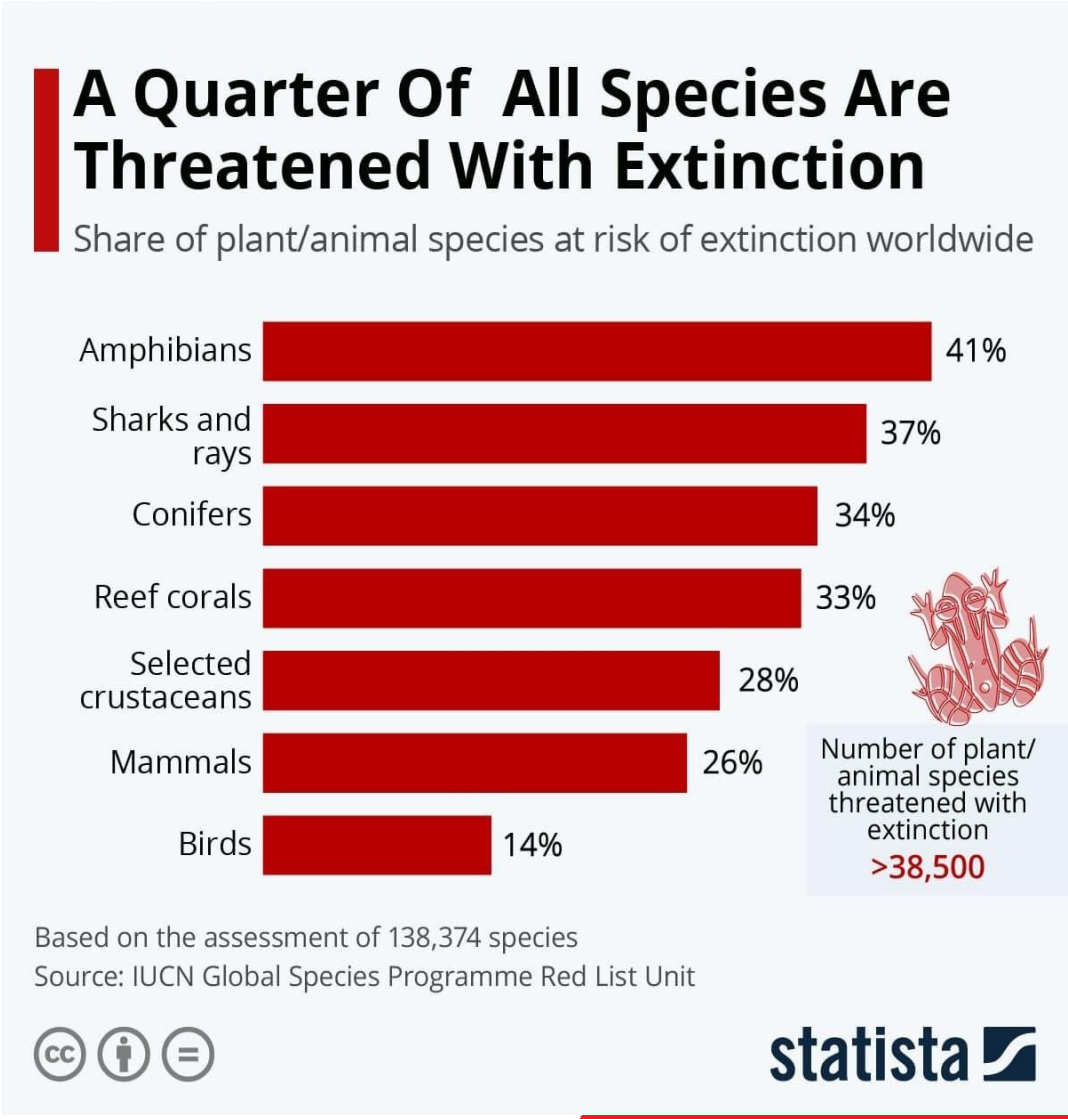
- These are species that are found only in some particular areas, usually isolated by natural or even geographical barriers. They have a value in their uniqueness. Areas of endemism containing several endemic species.
- Out of about 47,000 species of plants in our country 7000 are endemic. Thus, Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, Khasi Hills and Western Ghats.
- A large number out of a total of 81,000 species of animals in our country is endemic.
- The Western Ghats are particularly rich in amphibians (frogs, toads etc.) and reptiles (lizards, crocodiles etc.). About 62% amphibians and 50% lizards are endemic to Western Ghats. Some of the rarest animals found in India are: Asiatic cheetah, Asiatic Lion, Asiatic Wild Ass, Bengal Fox, Gaur, Indian Elephant, Indian Rhinoceros, Marbled Cat

Extinction of Species

- Extinction, the elimination of a species is a normal process in nature. Hundreds of species, sub-species and varieties to become extinct every year.
- The **causes of extinction** are:

Population Risk: Uneven change in population rates (i.e. birth rates and death rates) can cause a species in low abundance to become extinct. e.g. blue whales.

Environmental Risk: Environmental risk means variation in the physical or biological environment, including variations in predator, prey, symbiotic or competitor species. In case of species that are sufficiently rare and isolated, such normal environmental variations can lead to their extinction.



- **Natural calamities**: A natural catastrophe is a sudden change in the environment .It includes fires, storms, floods, earthquakes, volcanic eruptions etc. Such a natural phenomenon may cause the extinction of most forms of life there.

- **Genetic Risk**: Change in genetic characteristics in a small population of a species, due to reduced genetic variation, genetic drift or mutation, genetic assimilation [cross-breeding] makes the species more vulnerable to extinction.

- **Human Actions**: Human activities like hunting , development of agriculture, rise of civilization, rapid deforestation and introduction of industrial chemicals and emissions, pesticides and pollution are also leads to extinction of species.

- **Habitat Loss and Degradation**: Habitat loss and degradation are the major proximate causes of species extinction. The main causes of habitat loss are agricultural activities, harvesting or extraction (including mining, fishing, logging, etc.) and development of human settlements, industry and associated infrastructure.

- **Diseases**: Pathogens, or disease organisms, may cause extinction. Animals in sanctuaries and reserves are more prone to infection when they are under stress

Threats to Biodiversity

(i) loss/degradation of habitat: → caused by natural disasters like flood, fire, hurricanes and erosion.

→The human need for wood, minerals and water (dams) and agricultural practices

→Changes in forest composition, quality and habitat-type, lead to a decline in primary food species for wildlife and eventually to loss of habitat.

(ii) **overexploitation of resources:** → Unlimited extraction (through mining, fishing, logging, harvesting and poaching) and development work (human settlement, industry and associated infrastructure) are the major factors that contribute to the overexploitation of resources.

→As a result of this overexploitation, tigers, giant pandas, black rhinoceros, musk deer, cod and several whale species are on the verge of extinction.

(iii) **pollution:** → the nonbiodegradable or less biodegradable waste remains in the environment and enters our food chain. This waste travels through the food webs, gets biomagnified and reaches the tissues of all living species.

→ Organic pesticide DDT which affects all types of birds (peacocks, hawks, kites, and so on).

(iv) **Extinction of Species due to Aggressive Non-native Species:** When two or more species are inter-dependent or a particular species has strong links with another, the Domino Effect takes place causing extinction of the weaker species.

(v) **Global Environmental Change:** Global warming is a result of the accumulation of Greenhouse gases. It causes the global environment to change and leads to the extinction of many species which fail to adapt and acclimatize to the changing environmental conditions.

(vi) **Poaching and international trade of wild species and products,**

(vii) **Economic and social causes** such as poverty, government policies, environmental laws and enforcement, population pressure and unsustainable development projects and

(viii) **Deforestation** due to the collection of fuel wood, fodder, overgrazing and agriculture.

Poaching of wildlife

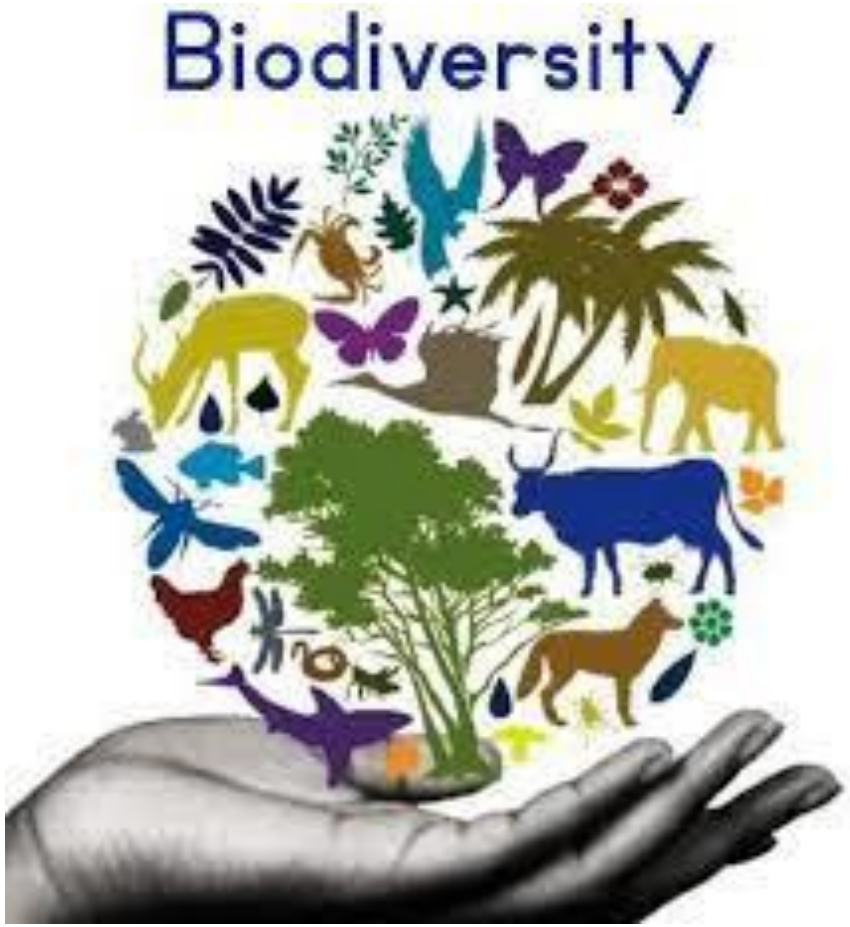
- **Poaching** refers to killing animals or commercial hunting. It contributes to loss of biodiversity.
- The animals are killed not only for their meat but also for their hides, and different parts of their body that are used as clothing, for food, to make folk medicine, or jewellery or as trophies
- **Poaching can be of two types listed below**:

1. **Subsistence poaching:** This refers to killing animals for survival.

2. **Commercial poaching:** This refers to hunting animals in order to sell their products

Conservation of biodiversity

- The act or process of conserving. The protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water.
- **Objectives:**
- Protection of all critically endangered, endangered, vulnerable, rare and other species of life present in the ecosystem.
- Preservation of all varieties of old and new flora, fauna and microbes.
- Protection and preservation of critical habitats, unique ecosystems.
- Regulation of international trade in wildlife.
- Reduction of pollution.
- Increase in public awareness



- **There are two approaches of biodiversity conservation**:

(a) In situ conservation (within habitat):

→In this type of conservation, the natural process and its interaction with the habitat as well as with all the elements of biodiversity are conserved.

→The establishment of protected areas such as national parks, sanctuaries and biosphere reserves is an example of in-situ conservation.

(b) Ex situ conservation (outside habitats):

→In case of complete degradation of a habitat, in-situ conservation is not possible, as the endangered species need special care. In such cases, the endangered species is removed from the area and kept under total human supervision

→This is done by establishment of gene banks, seed banks, zoo, botanical gardens, culture collections etc.

- **Bioprospecting** is the collecting, cribbling of biological samples (of plants, animals and micro-organisms) and gathering indigenous knowledge to help in discovering genetic or biochemical resources.
- The main objective of bioprospecting is the development of new life-saving drugs, crops that provide better economical benefits or industrial products.
- Bioprospecting must also obey the national laws and respect the rules of international treaties like:

(i) **Informed consent:** The source country must know, what will be done, which benefits will be shared and must give permission for collection.

(ii) **Fair agreement on benefits of sharing:** Benefits may include support for conservation, research, equipment, technologies, knowledge, transfer, development and royalties.

Biopiracy

- Biopiracy is defined as, "the illegal appropriation of life – micro-organisms, plants and animals (including humans) and the traditional knowledge that accompanies it"
- Multinational corporations (MNCs) have been searching for rich natural resources everywhere to make out a product along with the traditional knowledge prevailing there, then patent it and mint money out of it.