Ecosystem - Unit I

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UNIT - I
Ecosystem

1. Define Ecosystem ?

A An Ecosystem is a self-regulating group of biotic communities of species interacting with one another and with their non-living environment exchanging energy and matter.

Ecosystems can be natural (forest, lakes, mountains) & artificial / human-made (agro ecosystem, urban Ecosystem) All the ecosystem on this earth put together constitute the 'biosphere'. This term has derived by Sir Arthur G. Tansley (1935)

⇒ Biotic components of an ecosystem:

1. Producers (or) Photo autotrophs:

A. They are mainly the green plants, which can synthesize their food themselves by making use of carbon-di-oxide present in the air and water in the presence of sunlight by involving chlorophyll, the green pigment present in the leaves through the process of photosynthesis. They are also known as photo autotrophs (auto = self; troph = food, photo = light).

3. Chemo auto-trophs:

A. There are some micro organisms also which can produce organic matter to some extent through oxidation of certain chemicals in the absence of sunlight. They are

known as chemosynthetic organisms or chemo-autotrophs. For instance in the ocean depths, where there is no sunlight, chem autotrophic sulphur bacteria make use of the heat generated by the decay of radio active elements present in the earth's core and released in ocean's depths. They use this heat to convert dissolved hydrogen sulphide (H_2S) and Co_2 into organic compounds.

4. Consumers:

A. All organisms which get their organic food by feeding upon other organisms are called consumers which are of

(a) Herbivores - They feed directly on producers (Primary consumers)

(b) Carnivores - They feed on the consumers. (Secondary consumers)

(c) Omnivores - They feed on both plants and animals

(d) Detrivores (Detritus feeders & Saprotrophs): They feed on the parts of dead organisms, wastes of living organisms).

5. Decomposers:

A. They derive their nutrition by breaking down the complex organic molecules to simples organic compounds and ultimately into organic nutrients. Various bacterial and fungi are decomposers.

(~~In all the ecosystems, this biotic structure~~

~~However~~, in ~~some~~, ~~it~~ is the ~~primary producers which~~)

23. Abiotic components of an ecosystem:

The physical and chemical components of an ecosystem constitute its biotic structure. Physical factors includes climatic factors, edaphic (soil) factors, geographical factors.

(a) Physical factors:

(i) Climatic factors: The sunlight and shade, intensity of solar flux, duration of sun hours, average temperature, max & min temperature, annual rainfall, wind, latitude and altitude etc.

(ii) Edaphic (soil) factors: Soil type, water availability, water currents, nutrients, pH of the soil etc.

(b) Chemical factors:

(i) Organic factors: Quantity of protein, lipids, fats, carbohydrates, etc.

(ii) Inorganic factors: include availability of major essential nutrients like carbon, nitrogen, phosphorus, potassium, hydrogen, oxygen and sulphur, level of toxic substances, salts etc.

24. Grazing food chain:

It starts with the green plants (producers) and culminates in carnivores. It extends from producers through herbivores to carnivores. Producers are autotrophic organisms

(4)

which synthesise organic food from simple inorganic raw materials through photosynthesis utilizing solar energy.

The animals that feed on other organisms are called consumers. The consumers which directly take their food from plants are called herbivores & feed 1st order consumers.
Eg: Zooplanktons, grasshopper, deer, goat etc.

The herbivores are eaten by second order consumers & primary carnivores. Eg: frog, fish, wild cat, fox etc.

The larger carnivores prey upon the primary carnivores are called third order consumers & secondary carnivores.
Eg: Snake, wolf.

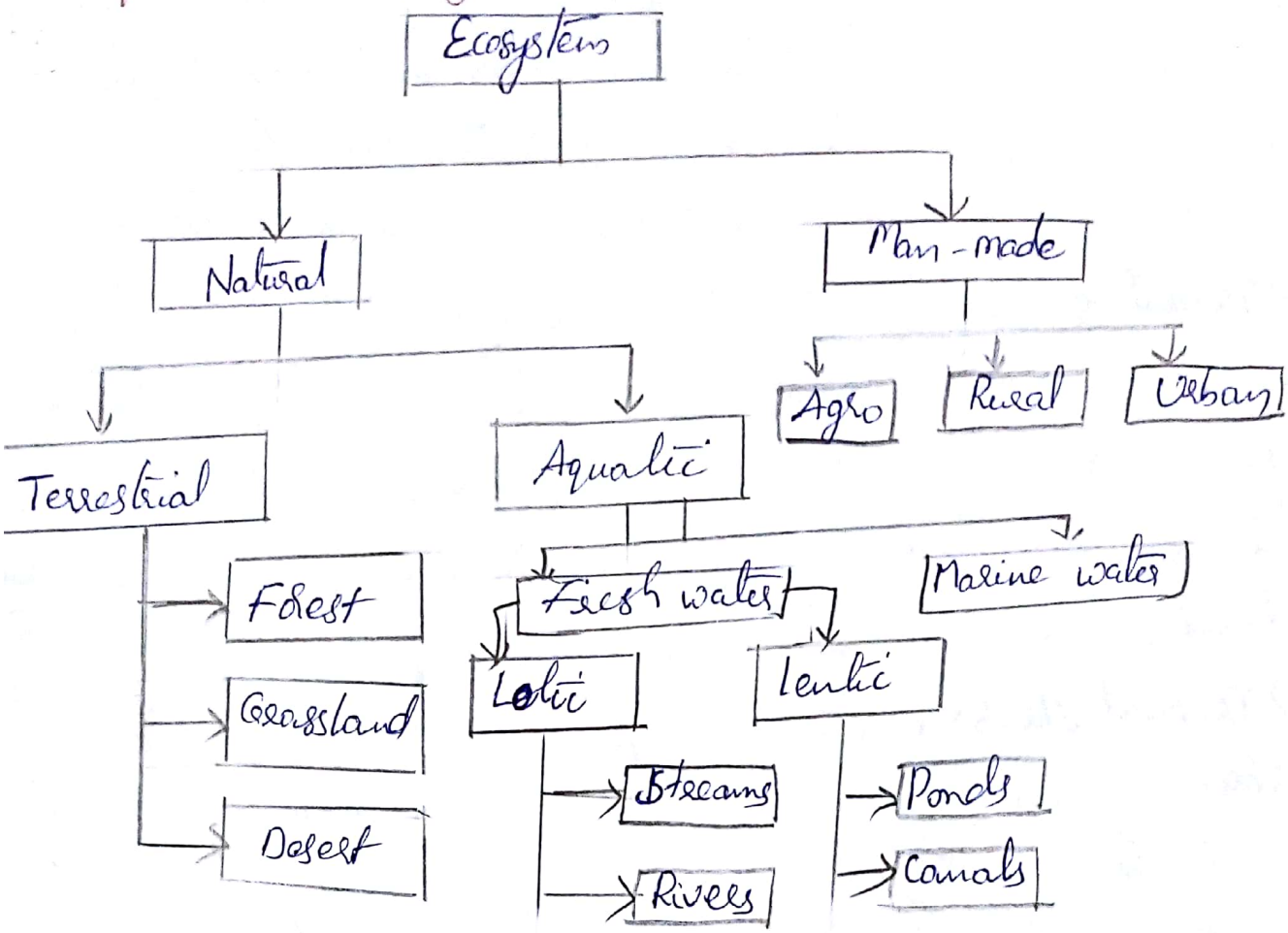
Terrestrial Grazing food chain:

Grass → Butterfly → Frog → Snake → Hawk.

Aquatic Grazing food chain:

Phytoplankton → Zooplankton → fish → Crane → Hawk.

Classification of ecosystem:



Terrestrial Ecosystem - Types:

Based on habitat ecosystems can be classified as follows:

(i) Terrestrial ecosystem that occupy land portion of the biosphere.

(ii) Aquatic ecosystem are the ecosystems present in fresh water & marine habitats.

1. Forest Ecosystem:

These ecosystems have a predominance of trees that are interspersed with a large number of species of herbs, shrubs, climbers, lichens, algae and a wide variety of wild animals and birds.

Depending upon the prevailing climatic conditions forests can be of various types:

(a) Tropical rain forests: They are evergreen broad leaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which favours the growth of trees. All through the year the climate remains more or less uniform. They are the richest in biodiversity.

(b) Tropical deciduous forests: They are found a little away from the equator and are characterized by a warm climate the year round. Rain occurs only during monsoon. A large part of the year remains dry and therefore different types of deciduous trees are found here, which lose their leaves during dry season.

(c) Tropical shrub forests: They are found the areas where the dry season is even longer. Here there are small deciduous trees and shrubs.

(d) Temperate rain forests: They are found in temperate areas with adequate rain fall. These are dominated by coniferous trees like pines, firs, red wood etc. They also consist of some evergreen broad leaf trees.

(e) Temperate deciduous forests: They are found in areas with moderate temperature. There is a marked seasonality with long summers, cold but not too severe winter and abundant rain-fall through-out the year. The major trees include broad leaf deciduous trees like oak, hickory, poplar etc.

(f) Evergreen coniferous forests (Boreal forests): They are found just south of arctic tundra. Here winters are long, cold and dry. Sunlight is available for a few hours only. In summers the temperature is mild, sunshine for long hours but the season is quite short. The major trees pines, fir, cedar

Tropical rain forests:

They are evergreen broadleaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which, favour the growth of trees. All through the year the climate remains more & less uniform. They are the richest in biodiversity. Different forms of life occupy 'specialized areas (niches) within different layers and spaces of the ecosystem depending upon their needs for food, sunlight, water, nutrients, etc.

We come across different types and layers of plants and animals in the tropical rainforests eg: emergent layer is the top-most layer of the tallest broad-leaf evergreen trees, below which lies the canopy where top branches of shorter trees form an umbrella like cover. Below this is present the understory of smaller trees. On the tree trunks some woody climbers are found to grow which are known as lianas. There are some other plants like orchids which are epiphytes i.e, they are attached to the trunks & branches of big trees and they take up water and nutrients falling from above. The orchids have special type of leaves to capture and hold the water. Some large epiphytes can hold as much as 4 liters of water, Thus these epiphytes almost act like miniponds suspended in the air, in the forest canopy. That is the reason why a large variety of birds, insects and animals like monkeys have made their natural homes (habitats) in these forests.

The understory trees usually recieve very dim sunlight. They usually develop dark green leaves with high chlorophyll contents so that they can use the diffused sunlight for photosynthesis. The shrub layer recieves even less sunlight and the ground layer

commonly known as forest floor receives almost no sunlight and is a dark layer. Most of the animals like bats, birds, insects etc occupy the bright canopy layer while monkeys, lizards, snakes, chameleons etc. keep on moving up and down in sunny and dark areas layers. Termites, fungi, mushrooms etc, grow on the ground layer. warm temperature and high availability of moisture facilitate rapid breakdown (decomposition) of the dropped leaves, twigs etc. releasing the nutrients rapidly. These nutrients are immediately taken up by the mycorrhizal roots of the trees.

Interestingly, the flowers of forest trees are very large, colourful, fragrant and attractive which helps in pollination by insects, birds, bats etc. Rafflesia arnoldii, the biggest flower (7 kg weight) is known to smell like rotten meat and attracts flies and beetles which help in its pollination.

The silent valley in Kerala is the only tropical rain forest lying in India which is the natural habitat for a wide variety of species.

2. Grassland Ecosystem :

Grasslands are dominated by grass species but sometimes also allow the growth of a few trees and shrubs. Rainfall is average but erractic. Three types of grasslands are found to occurs in different climatic regions :

(a) Tropical grasslands : They occur near the borders of tropical rainforests in regions of high average temperature and low to moderate rainfall. In Africa, these are typically known as savannas, which have tall grasses with scattered shrubs and stunted trees. The savannas, have a wide diversity of animals including zebras, giraffes, gazelle, antelopes etc. During dry season, fires are quite common.

Tropical savannas have a highly efficient system of photosynthesis. Most of the carbon assimilated by them in the form of carbohydrates is in the perennating bulbs, rhizomes, runners etc. which are present underground.

(b) Temperate grasslands : They are usually found on flat, gentle sloped hills, winters are very cold but summers are hot and dry. Intense grazing and summer fires do not allow shrubs or trees to grow. In United States and canada. These grasslands are known as Prairies, in South America as 'Pampas', In Africa as 'Velds' and in central Europe and Asia they are known as 'steppes'.

(c) Polar grasslands (Arctic tundra) : They are found in Arctic Tundras polar region where severe cold and strong, frigid winds along with ice and snow create too harsh climate

for trees to grow. In summers the sunshines almost round the clock and hence several small annual plants grow in the summer. The animals include arctic wolf, weasel, arctic fox, reindeer etc. A thick layer of ice remains frozen and the soil surface throughout the year, called permafrost. In summer, the tundra shows the appearance of shallow bog lakes, where mosquitoes, different type of insects and migratory birds appear.

3. Desert Ecosystems:

These ecosystems occur in regions where evaporation exceeds precipitation (rainfall, snow etc). The precipitation is less than 25cm/yr. About 1/3rd of our world's land area is covered by deserts. Deserts have little species diversity and consist of drought resistant or drought avoiding plants. The atmosphere is very dry and hence it is a poor insulator. That is why in deserts the soil gets cooled up quickly, making the nights cool. Based on climatic conditions, Deserts are of three major types.

(a) Tropical deserts like Sahara and Namibia in Africa and Thar deserts, Rajasthan, India are the driest of all with only a few species. wind blown sand dunes are very common.

(b) Temperate deserts like majave in Southern California where day time temperatures are very hot in summer but cool in winter.

(c) cold deserts like Gobi desert in china has cold winters and warm summers.

Many desert plants are found to have reduced, scaly leaves so as to cut down loss of water due to transpiration or have succulent leaves to store water. Desert animals like insects and reptiles have thick outer covering to minimize loss of water

Aquatic Ecosystems:

Aquatic ecosystems dealing with water bodies and the biotic communities present in them are either freshwater & marine. Freshwater ecosystems are further of standing type (lentic), like ponds and lakes & free-flowing type (lotic).

1. **Pond ecosystem**: It is a small fresh water aquatic ecosystem where water is stagnant. Ponds may be seasonal in nature ie, recieving enough water during rainy season. Ponds are usually shallow water bodies which play a very important role in the villages. They contain several types of algae, aquatic plants, insects, fish and birds.

2. **Lake ecosystem**: lakes are usually big fresh water bodies with standing water. They have a shallow water zone called 'littoral zone', an 'open-water zone' and a deep bottom area where light penetration is negligible, known as profundal zone.

The Dal lake in Srinagar (J&K), Naini lake in Nainital (Uttarakhand) and Loktak lake in Manipur are some of the famous lakes of our country.

Organisms:

(a) Planktons: that float on the surface of water Eg: Phytoplanktons like algae and zooplanktons like rotifers.

(b) Nektons: ~~that~~ swim Eg: fish

(c) Neustons: That rest & swim on the surface Eg: Insects

(d) Benthos: That are attached ~~or clinging~~ to ~~other~~ bottom Sediments Eg: Snails

(e) Periphytons: That are attached & climing to other plants & any other surface Eg: crustaceans.

3. Streams: These are freshwater aquatic ecosystems where water current is a major controlling factor, oxygen and nutrient in the water is more uniform and land-water exchange is more extensive. Although stream organisms have to face more extremes of temperature and action of currents as compared to pond & lake organisms, but they do not have to face oxygen deficiency under natural conditions. This is because the streams are shallow, have a large surface exposed to air and constant motion which churns the water and provide abundant oxygen. Their dissolved oxygen level is higher than that of ponds even though the green plants are much less in number. ~~The stream~~

4. River ecosystem: Rivers are large streams that flow downward from mountain highland and flowing through the plains fall into the sea.

The mountain highland part has cold, clear water rushing down as water falls with large amounts of dissolved oxygen. The plants are attached to rocks (Periphytons) and fishes are cold-water, high oxygen requiring fish like trouts.

In the second phase on the gentle slopes, the waters are warmer and support a luxurious growth of plants and less oxygen requiring fish.

In the third phase, the lower waters are very rich in biotic diversity. Moving down the hills, rivers shapes the land. They bring ~~them~~ with them lots of silt rich in nutrients which is deposited in the plains and in the delta before reaching the ocean.

Marine ecosystem: There are gigantic reservoirs of water covering more than 70% of our earth's surface and play a key role in the survival of about 2,50,000 marine species, serving as food for humans and other organisms, give a huge variety of sea-products and drugs. Oceans provide us iron, phosphorus, magnesium, oil, Natural gas, sand and gravel.

Oceans are the major sinks of carbon dioxide and play an important role in regulating many biogeochemical cycles and hydrological cycle, there by regulating the earth's climate.

The oceans have two major life zones:

1. Coastal zone with relatively warm, nutrient rich shallow water. Due to high nutrients and ample sunlight this is the zone of high primary productivity.
2. Open sea: It is the deeper part of the ocean, away from the continental shelf (the submerged part of the continent). It is vertically devided into three regions.
   (i) Euphotic zone which receives abundant light and shows high photosynthetic activity.
   (ii) Bathyal zone receives dim light and is usually geologically active.
   (iii) Abyssal zone is dark zone, 2000 to 5000 meters deep. The abyssal zone has no primary source of energy i.e, solar energy. It is the world's largest ecological unit but it is an incomplete ecosystem.

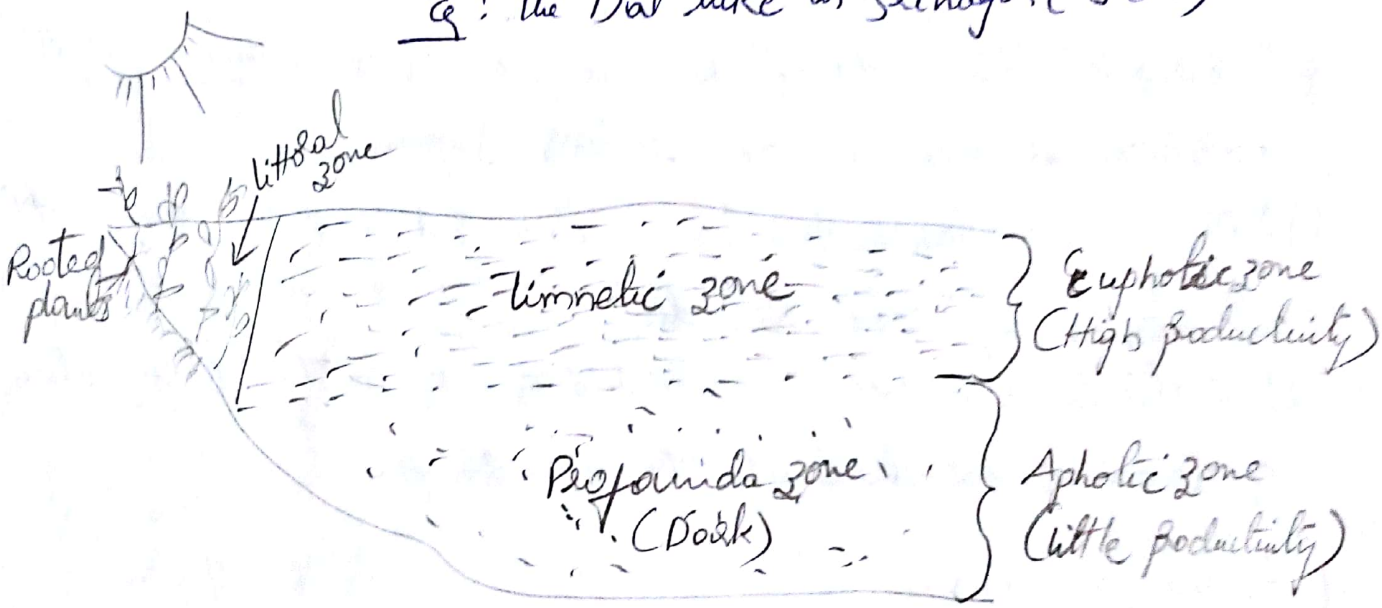
6. Estuary: An estuary is partially enclosed coastal area at the mouth of a river where fresh water and salty water meet. These are the transition zones which are strongly affected by tidal action. Constant mixing of water stirs up the silt which makes the nutrients available for the primary producers. There are wide variations in the stream flow and tidal currents at any given location diurnally, monthly and seasonally. Therefore, the organisms present in estuaries show a wide range of tolerance to temperature and salinity. Such organisms are known as 'eurythermal' and 'euryhaline'. Coastal bays and tidal marshes are common examples of estuaries.

Estuaries have a rich biodiversity and many of the species are endemic. There are many migratory species of fish like eels and salmons in which half of the life is spent in fresh water and half in salty water. For them estuaries are ideal places for resting during migration, where they also get abundant food. Estuaries are highly productive ecosystems. The river flow and tidal action provide energy subsidies for the estuary there by enhancing its productivity. Estuaries are of much to human beings due to their high food potential.

⇒ Lake ecosystem:

Lakes are usually big freshwater bodies with standing water. They have a shallow water zone called littoral zone, an open water zone where effective penetration of solar light takes place called limnetic zone, and a deep bottom area where light penetration is negligible known as profundal zone.

Eg: The Dal lake in Srinagar (J&K)



Organisms present in lake ecosystem are: Planktons i.e, phyto planktons (algae), zooplanktons (rotifers), Nektons (fish), Benthos (snails) & Periphytons (crustaceans).

⇒ Types of lakes:

(a) Oligotrophic lakes: which have low nutrient concentrations

(b) Eutrophic lakes: which are overnourished by nutrients like nitrogen & phosphorus, usually as a result of organic agricultural run-off & municipal sewage discharge. They are covered with "algal blooms". Eg: Dal lake. (15)

(c) Dystrophic lakes: that have low pH, High humic acid content and brown waters eg: bog lakes

(d) endemic lakes: that are very ancient, deep and have endemic fauna which are restricted only to that lake eg: the lake Baikal in Russia

(e) Desert salt lakes: that occur in arid regions and have developed high salt concentrations as a result of high evaporation Eg: Sambhar lake in Rajasthan

(f) volcanic lakes: that receive water from magma after volcanic eruptions eg: many lakes in Japan

(g) Meromictic lakes: that are rich in salts and are permanently stratified eg: lake Nevada.

(h) Artificial lakes: that are created due to construction of dams Eg: Govindsagar lake at Bhakra-Nangal.

⇒ Detritus food chains:

It starts with dead organic matter which the detrivores and decomposers consume. Partially decomposed dead organic matter and even the decomposers are consumed by detrivories and their predators.

Eg: Mangrove ecosystem:

Leaf litter → algae → crabs → small carnivorous fish → fish

forest ecosystem:

Dead organic matter → fungi → bacteria

Food chain

The flow of energy is mediated through a series of feeding relationships in a definite sequence or pattern which is known as "food chain".
Hence the sequence of eating and being eaten in an ecosystem is known as food chain.

- All organisms, living or dead are potential food for some other organism and thus, there is essentially no waste in the functioning of a natural ecosystem.
- A catpillar eats plant leaf, sparrow eats caterpillar, birds are eaten by cat (a) Hawk, which eventually die and then are decomposed and consumed by micro-organism like bacteria or fungi which convert complex organic substances to simpler inorganic substances that can again used by plants.

eg:
1) Grass → Grasshopper → frog → snake → Hawk (grassland ecosyst.)

2) Phytoplanktons → zooplanktons (water fleas) → small fish → Tuna (Pond ecosyst)

3) Lichens → reindeer → man (Arctic tundra)

There are Two types of food chains in the nature
1) Grazing food chain 2) Detritus food chain.

(18) (19)

1) Grazing food chain:

It starts with green plants (primary producers) and culminates in carnivores.

All the above examples are grazing food chain.

Each organism in the ecosystem is assigned a feeding level or trophic level depending on its nutritional status.

Thus in the example ② of grassland ecosystem, grasshopper occupies first trophic level, frog the IInd trophic level and snake and Hawk occupy the 3rd and 4th trophic levels respectively.

The decomposers consume the dead matter of all these trophic levels.

2) Detritus food chain:

page no. (14) (That is on pg 16)

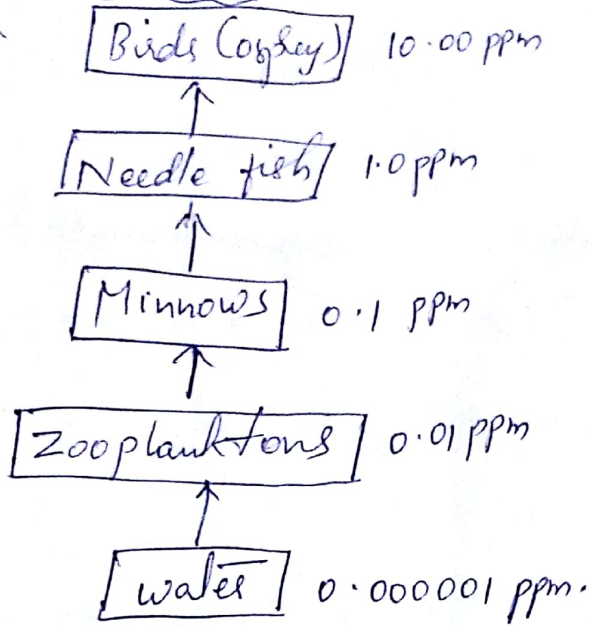
Biomagnification:

Food chains show a unique property of 'biological magnification' of some chemicals. These are several pesticides, heavy metals and other chemicals which are non-biodegradable in nature. Such chemicals are not decomposed by microorganisms and they keep on passing from one trophic level to another. And, at each successive trophic level, they keep on increasing in concentration. This phenomenon is known as biomagnification & biological magnification. Due to this property many chemicals accumulate in very toxic concentrations in organisms present high in the food chain.

Case Study 1: Biomagnification of DDT:

A striking case of biomagnification of DDT (a broad range insecticide) was observed when some birds like Osprey were found to suffer a sharp decline in their population. The young ones of these birds were found to hatch out prematue condition leading to their death. This was later found to be due to bio-magnification of DDT through the food chain, but its concentration increased along the food chain through phytoplanktons to zooplanktons and then to fish which was eaten by the birds. The concentration of DDT was magnified several thousand times in the birds which caused thining of shells in the birds' eggs, causing death of the young ones.

DDT concentration (ppm)



Case Study - 2: Minamata Disease in Japan

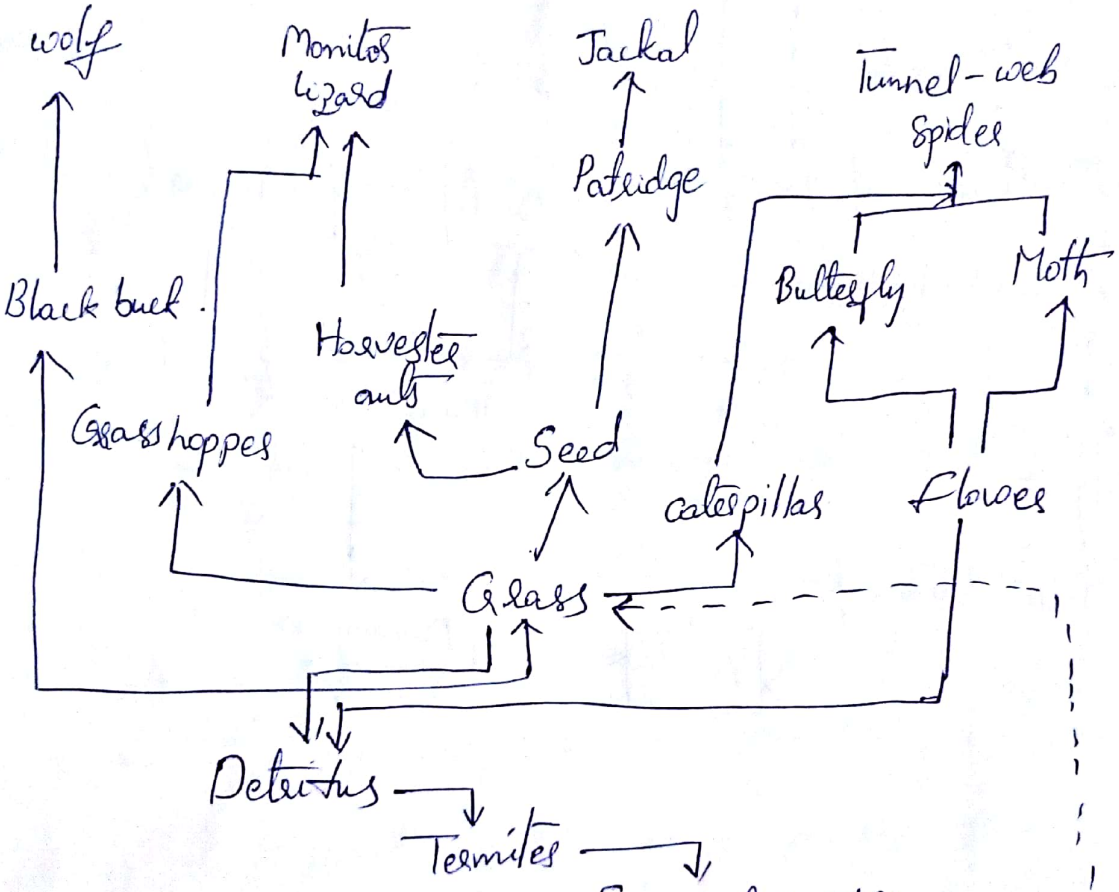
A case of human mercury poisoning which occured about forty years ago in minamata bay in Japan taught the world an important lesson about the danger of mercury poisoning. A large plastic plants located near minamata bay used a mercury containing compound in a reaction to produce vinyl chloride, a common plastic material. The left over mercury was dumped into the bay along with other waste from the plant. Though the mercury was in its less toxic inorganic state when dumped, the microorganisms at the bottom of the bay converted the mercury into its organic form (methyl mercury). This organic mercury then entered into the tissues of fish thus caused an outbreak of poisoning, killing and affecting several people. Mothers who had eaten the contaminated fish gave birth to infants who showed signs of mercury poisoning. Mercury poisoning is thus called 'minamata disease'.

It becomes very clear from the above instance that the animals occupying the higher trophic levels are at a greater risk of biomagnification of toxic chemicals.

Food web:

Food web is a network of food chains where different types of organisms are connected at different trophic levels, so that there are a number of options of eating and being eaten at each trophic level.

Grassland Ecosystem food web:



Significance of food chains & food webs:

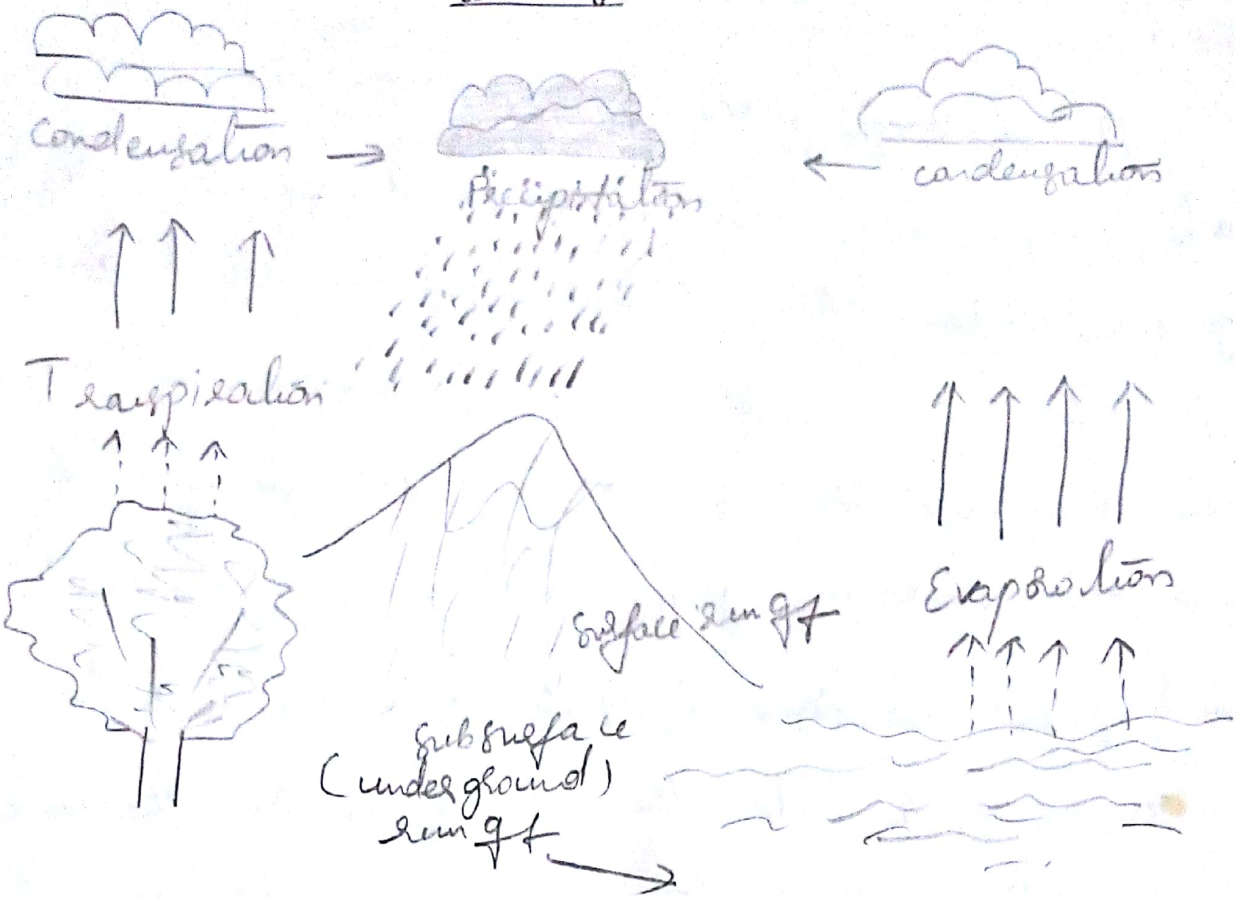
* These play a major role in the ecosystem because the two most important functions of energy flow and nutrient cycling take place through them.
* The food chains also help in maintaining and regulating the population size of different animals and thus, help maintain the ecological balance.

Hydrological cycle:

The hydrologic cycle, also known as the water cycle, collects, purifies and circulates the earth's finite water supply. When it rains, the water runs along the ground and flows into rivers or falls directly into the sea. A part of the rain water that fall on land percolates into the ground, thus recharging ground water aquifers. water is drawn up from the ground by plants along with nutrients from the soil. The water then transpires from the leaves as water vapours and returns to the atmosphere. As it is lighter than air, water vapour rises and forms clouds. The winds blow the clouds for long distances and when the clouds rise higher, the vapours condenses and changes into droplets, which fall on the land as rain. Part of this rain gets locked in glaciers. Thus the processes of evaporation from water bodies, transpiration from plant leaves, condensation of water vapours, precipitation and percolation form an endless cycle that replenishes streams, lakes and wetlands.

(diagram - PTO)

The water cycle



Bio-accumulation:

It is defined as the storage of non-degradable toxic pollutants in the tissues of living organisms. (or) accumulation of non-biodegradable toxic compounds or any pollutants in the tissues is called bio-accumulation.

Eg: * accumulation of DDT in living tissues in human beings.

* accumulation of heavy metals (mercury-Hg) in fish (causing minamata disease in human beings).

Energy flow in an Ecosystem:

Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem going. The most important feature of this energy flow is that it is unidirectional or one way flow. Unlike the nutrients, energy is not reused in the food chain. Also, the flow of energy follows the two laws of thermodynamics.

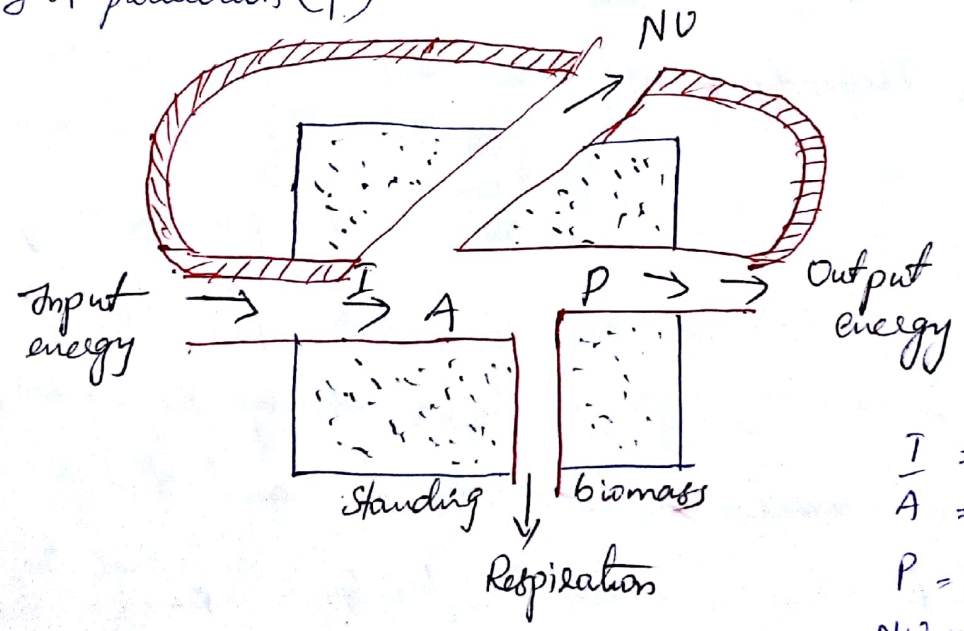
First law of Thermodynamics states that energy can neither be created nor be destroyed but it can be transformed from one form to another. The solar energy captured by the green plants (producers) gets converted into biochemical energy of plants and later into that of consumers.

Second law of Thermodynamics states that energy dissipates as it is used or in other words, it gets converted from a more concentrated to dispersed form. As the energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy takes place through respiration, loss of energy in locomation, running, hunting and other activities. At every level there is about 90% loss of energy and the energy transferred from one trophic level to the other is only about 10%.

Energy flow models:

(a) Universal energy flow model: Energy flow through an ecosystem was explained by E.P. Odum as the universal energy flow model. As the flow of energy takes place, there is a

gradual loss of energy at every level, there by resulting in less energy available at next trophic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy at every level, there by resulting in less energy available at next trophic level as indicated by narrower pipes (energy flow) and smaller boxes (stored energy in biomass). The loss of energy is mainly the energy not utilized (NU). This is the energy lost in locomotion, excretion etc. or it is the energy lost in respiration, which is for maintenance. The rest of the energy is used for production (P)

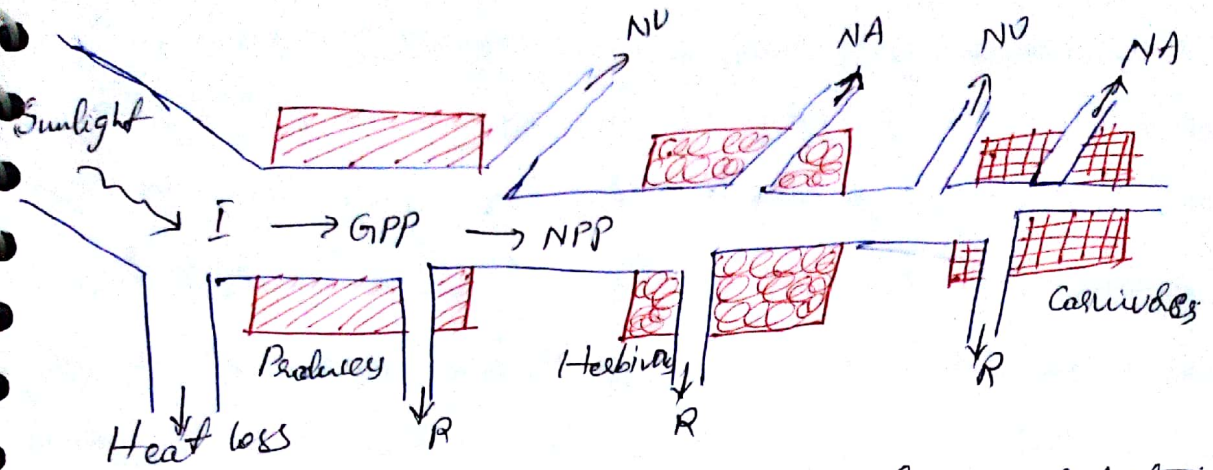


Universal energy flow model

I = Energy Input
A = Assimilated energy
P = Production
NU = Energy not used

(b) Single channel energy flow model : The flow of energy takes place in a unidirectional manner through a single channel of green plants & produces to herbivores and carnivores. In this model, the gradual decline in energy level due to loss of energy at each successive trophic level in a grazing food chain

One-way energy flow model

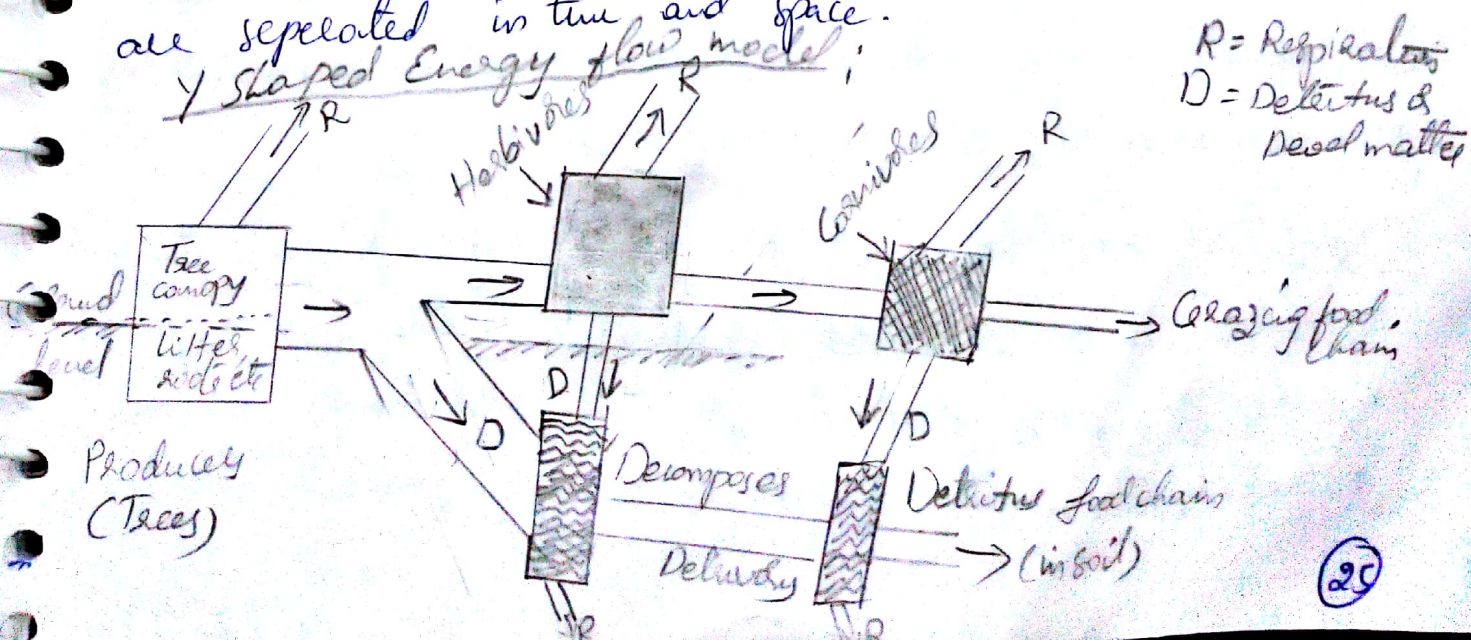


I = solar energy input, GPP - Gross primary production
NU = Energy not used NPP - Net primary production
NA : Energy not assimilated (eg: excretion : R = Respiratory loss)

(c) Double channel & Y-shaped energy flow model:

In nature, both grazing food chain and detritus food chain operate in the same ecosystem. In a forest ecosystem the huge quantity of biomass produced cannot be all consumed by herbivores. Rather, a large proportion of the live biomass enters into detritus (dead) compartment in the form of litter. Hence the detritus food chain is more important there. The two channel & Y-shaped model of energy flow shows the passage of energy through these two chains, which are seperated in time and space.

Y Shaped Energy flow model:



R = Respiration
D = Detritus & Dead matter

Ecological Pyramids:

When the ecological parameters such as number of organisms, biomass & energy at successive trophic levels are plotted, they assume a shape of pyramids. Thus, "an ecological pyramid is a graphic representation of an ecological parameter like number of individuals & amount of Biomass & amount of energy present in various trophic levels of a food chain with producers forming the base and top carnivores the tip."

Ecological pyramids were first devised by a British Ecologist Charles Elton (1927) and are, hence, also called Eltonian pyramids.

Three types of Ecological Pyramids are recognised.

(i) Pyramid of Numbers:

"A graphic representation of number of individuals per unit area of various trophic levels stepwise with producers forming the base and top carnivores the tip, is called pyramid of numbers."

Mostly the pyramid of number is straight & upright with number of individuals in successive higher trophic levels goes on decreasing from base to apex.

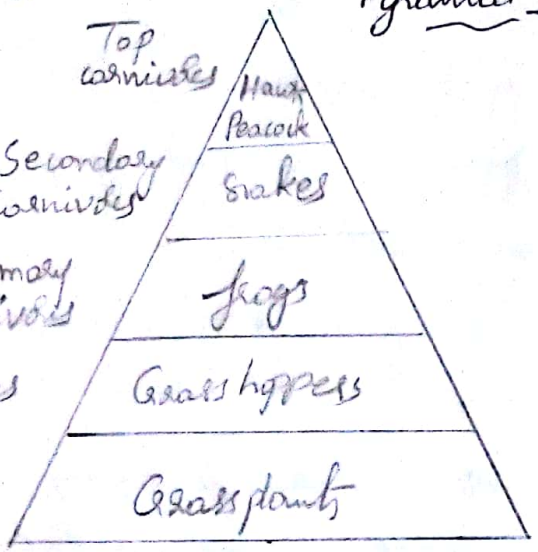
Eg: 1) In a grassland, a large number of grass & herbs support a lesser number of grasshoppers, the latter support fewer number of frogs, and the frogs to still smaller number of snakes, the latter support to very few peacocks & falcons.

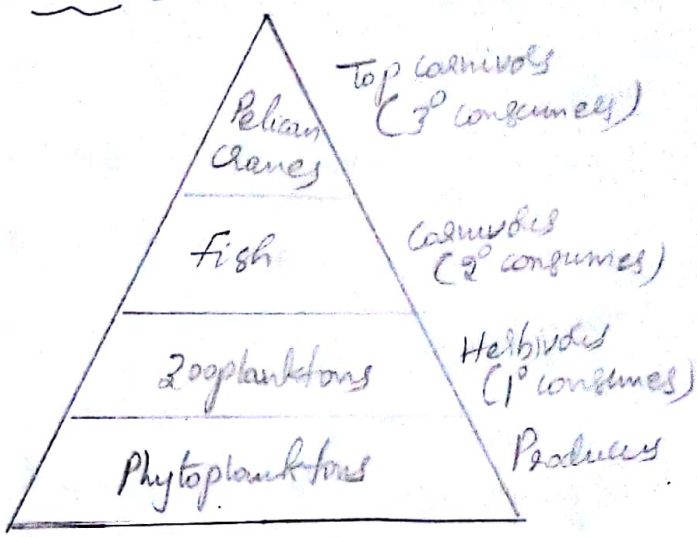
2) In a pond ecosystem, a large number of phytoplankton supports a lesser number of zooplankton followed by carnivores - fish and top carnivores like stork or king fishes.

Grassland Ecosystem

Pond Ecosystem

Pyramid of Numbers

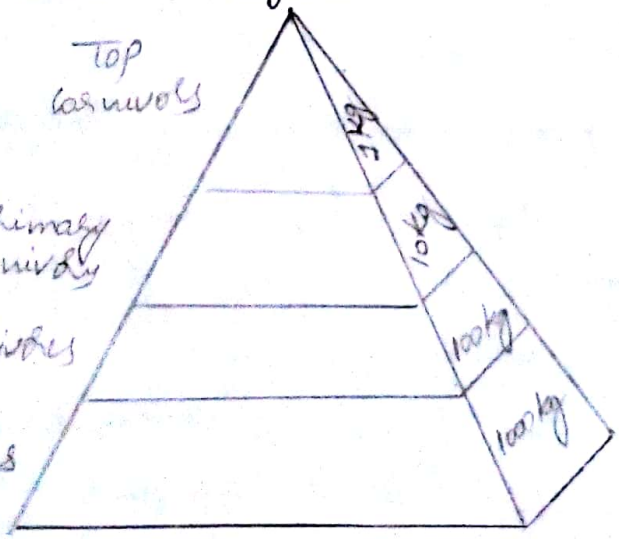


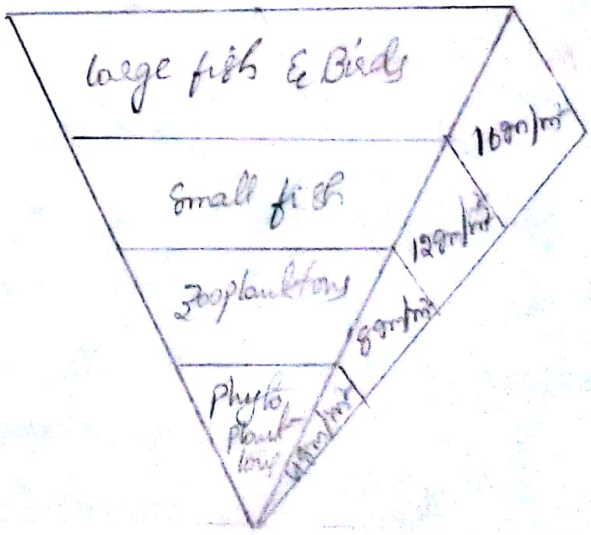


(ii) Pyramid of Biomass:

Terrestrial ecosystem

Aquatic ecosystem





The amount of living organic matter present in a particular environment is called biomass. It is measured both as fresh & dry weight.

"A graphic representation of biomass present sequentially per unit area of different trophic levels, with producers at the base and

top carnivores at the top, is called pyramid of biomass".

Eg: 1 In a terrestrial ecosystem, the maximum biomass occurs in producers and there is progressive decrease in biomass from lower to higher trophic levels. It is found that 10-20% of the biomass is transferred from one trophic level to the next in the food chain. Thus 1000kg of vegetation produces a biomass of only 100kg of herbivores, which in turn form only 10kg of biomass of first order carnivores, that give rise just 1kg of biomass of second order carnivores and so on.

Eg 2: In an aquatic habitat the pyramid of biomass is inverted or spindle-shaped, where the biomass of trophic level depends upon the reproductive potential and longevity of the members. Biomass is high only in case of long lived organisms. Thus, the biomass of phytoplanktons is less than that of zooplanktons. It is still more in the primary consumers and so on.

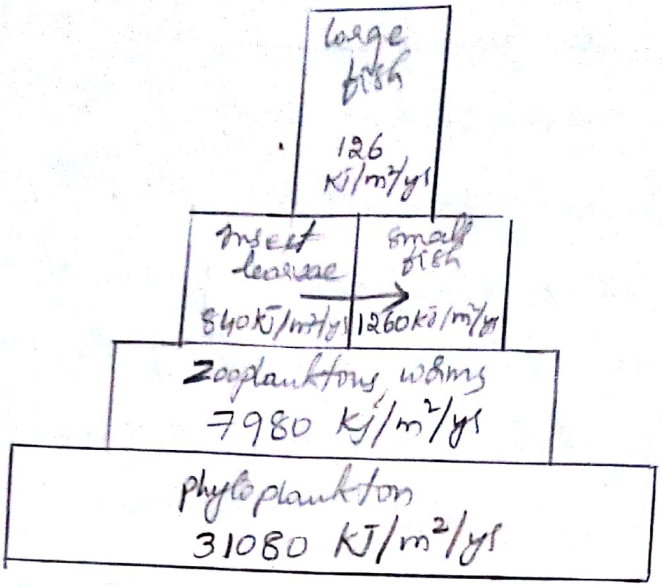
(iii) Pyramid of Energy:

"A graphic representation of the amount of energy trapped per unit time and area in different trophic levels of a food chain with producers forming the base and the top carnivores at the tip", is called pyramid of energy.

It is always upright, since it takes into consideration the total energy trapped by a trophic level in a unit area and time. The energy content is generally expressed as Kcal/m^2/ys or kj/m^2/ys. Maximum energy content is present in the producers. The energy content decreases as it passes into higher trophic levels, because of its utilization in performing life activities and dissipation of heat.

(28)

Pyramid of Energy in a food chain



According to Odum (1971), in a pond ecosystem, phytoplankton trap 31080 KJ/m²/yr of solar energy. The zooplankton and other herbivores, which feed upon the phytoplankton possess an energy content of 7980 KJ/m²/yr. They support primary carnivores (insect, larvae and small fish) with an energy content of 2100 KJ/m²/yr. The secondary carnivores (large fish) which feed upon the primary carnivores have an energy content of 126 KJ/m²/yr.

⇒ **Biogeochemical cycles:**

Earth is the source of matter for all living organisms as they require several (about 40) elements for their growth and life processes. Some elements and their compounds have an important role in the living protoplasm and are required in large amounts. These nutrients are called 'macronutrients' or 'essential nutrients' Eg: C, N, O, H, K, Ca, Mg, S, & P. Some elements are required in minute quantities and have role in the activities of the living protoplasm. These nutrients are called 'micronutrients'

of 'trace elements' Eg: Mn, ~~Ca~~, Zn, B, Mo, Va, Co, Cl & Na.

As these elements are provided by the earth and are used by the organisms for their body building and metabolism, they are called 'Biogenetic nutrients' & 'Biogeochemicals' (bio - living organisms; geo - soil, rock etc, chemicos - elements).

Def: "The movement & circulation of biogenetic nutrients through the living and non-living components of the biosphere & of any ecosystem is called biogeochemical cycling".

Types of biogeochemical cycles:

(a) Gaseous cycles like carbon (CO_2), oxygen, Nitrogen etc.

(b) Sedimentary cycles like Sulphur, phosphorus etc.

⇒ Carbon Cycle:

⇒ Ecosystem value services:

1) Performing photosynthesis by which solar energy is captured by the primary producers (green plants) and converted into chemical energy (food).
2) Absorbing CO_2 from atmosphere
3) Purifying the air by releasing oxygen
4) Absorbing toxic pollutants from environment.
5) Providing clean water, regulating water cycle.
6) Creating & conserving soil (Preventing soil erosion)
7) Maintaining nutrient cycles and sustainable growth.
8) Providing food, medicine, fuel, fodder, fertilizer, industrial raw materials
9) control of climate
10) control of population
11) control of pests.

While different types of ecosystems are known to have a wide variety of flora & fauna, they are also known to perform several important functions as discussed above.

In the recent decades, the importance of ecosystem functions is evaluated in economic terms.

Estimated annual value of ecological services: [Value ($\times 10^9$ US dollars)

1. Soil formation - 17.1
2. Recreation - 3.0
3. Nutrient cycling - 2.3
4. water regulation & supply - 2.3
5. Climate regulation - 1.8
6. Habitat for wildlife - 1.4
7. Protection from floods, storm - 1.1
8. Production of food & raw material - 0.8
9. Genetic resources - 0.8
10. Atmospheric gas balance - 0.7
11. Pollination - 0.4
12. All other services - 1.6

Total value of ecosystem services - 33.3×10^9 $

Stress condition

⇒ Secondary Production: The food synthesized by green plants through photosynthesis is the primary production which is eaten by herbivores. The plant energy is used up for producing organic matter of the herbivores with, inturn, is used up by the carnivores. The amount of organic matter stored by the herbivores & carnivores (in excess of respiratory loss) is known as secondary production. The energy stored at consumer level for use by the next trophic level is thus defined as secondary production."

~~(predominate (e.g. in forest, agroecosystems) while in other the decomposers predominate (eg. deep ocean).~~

6. Trophic structure:

A. The producers and consumers are arranged in the ecosystem in a definite matter and their interaction along with population size are expressed together as trophic structure. Each food level is known as trophic level and the amount of living matter at each trophic level at a given time is known as standing crop & standing biomass.

7. Food chains & food web:

The flow of energy is mediated through a series of feeding relationships in a definite sequence & pattern which is known as food chain. Nutrients too move along the food chain.

" The sequence of eating and being eaten in an ecosystem is known to be food chain."

Food chains are of i) Grazing food chain
ii) Detritus food chain.

8. Food web:

Food chain in ecosystems are rarely found to operate as isolated linear sequences. Rather they are found to be interconnected and usually form a complex network with

several linkages and are known as food webs. Thus, "food web is a network of food chains where different types of organisms are connected at different trophic levels, so that there are a number of options of eating and being eaten at each trophic level."

9. Biomagnification & Bioamplification & Biological magnification:

A. Food chains show a unique property of 'biological magnification' of some chemicals (several pesticides, heavy metals and other chemicals) which are non-biodegradable in nature. Such chemicals are not decomposed by micro-organisms and they keep on passing from one trophic level to another. And at each successive trophic level they keep on increasing in concentration is known as 'biomagnification'.

10. Biogeochemical cycles:

A. Nutrients like carbon, nitrogen, sulphur, oxygen, hydrogen, phosphorus etc. move in circular paths through biotic and abiotic components and are therefore known as 'biogeo chemical cycles'.

11. Primary productivity & Primary Production:

A Primary productivity of an ecosystem is defined as the rate at which radiant energy is converted into organic

substances by photosynthesis & chemosynthesis by the primary producers.

When organic matter is produced by the primary producers some of it is oxidized & burnt inside their body and converted into carbon-di oxide which is released during respiration. Now, the producers are left with a little less organic matter than that was actually produced by them. This is known as the 'net primary production' (NPP) and the respiratory loss (R) added to it gives the 'gross primary production (GPP).

Thus, $NPP = GPP - R$.

2. Carrying Capacity:

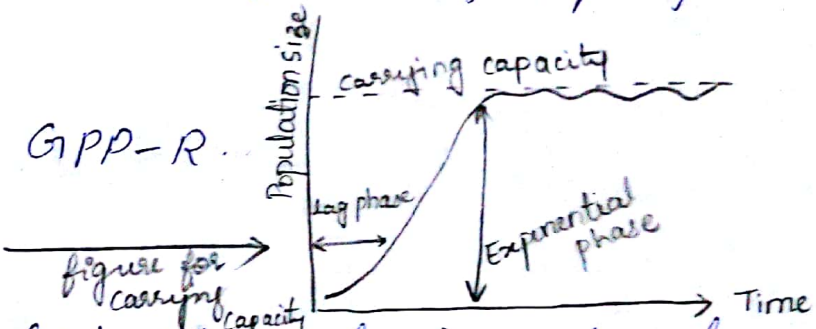


figure for carrying capacity

Populations of different species grow and increase in nubers depending upon their capacity to grow known as biotic potential. However no population can increase its size indefinately because some limiting factors & environmental resistances impose limits to their growth. These factors could be light, water, nutrients & too many predators & competitors. Consequently, the population size of any species tends to stabilize at a particular level which is known as carrying capacity.

Unit-III I (chapter-II)

Biodiversity and its Conservation

Biodiversity: It refers to the variety and variability among all groups of living organisms and the ecosystem complexes in which they live.

Levels of Biodiversity:
There are 3 levels of Biodiversity which may range from the genetic level within a species to the biota in a specific region and may extend up to the great diversity found in different biomes.

1) Genetic Diversity
2) Species Diversity
3) Ecosystem Diversity.

1) Genetic Diversity:

- It is the basic source of biodiversity.
- The genes found in organisms can form enormous number of combinations each of which gives rise to some variability.
- Genes are the basic units of Hereditary information transmitted from one generation to another.
- When the genes within the same species show different variation due to new combinations, it is called Genetic Variability.

Eg. In Oryza sativa species, there are thousands of wild and cultivated varieties of rice, which show variation at genetic level and differ in their colour, size, shape, aroma and nutrient content of the grain.

2) Species Diversity:

The Variability found within the population of a species or between different species of a community is called Species Diversity.

- It represents broadly the species richness and their abundance in a community.

- There are two popular indices of measuring species diversity known as Shannon-Wiener index and Simpson index.
- The Total no. of living species (sp) ranges from 10 million to 50 million, till now only 1.5 million and 3,00,000 fossil sps have been actually described and given scientific names.

3) Ecosystem Diversity:

This the diversity of ecological complexity showing variation in ecological niches, trophic structure, food-webs, nutrient cycling etc.

- The ecosystem also show variations with respect do physical parameters like moisture, temperature, altitude, precipitation etc.
- If we conside the forest ecosystem, mainly dominated by trees, but while considering tropical rainforest, a tropical deciduous forest, a temperate deciduous forest and a boreal forest, the variations observed are so many and they are mainly due to variations mentioned above.
- We cannot replace the biodiversity, it would disrupt the ecological balance.

For eg: coniferous trees of boreal forests cannot take up the function of the trees of tropical deciduous forest lands.

Value of Biodiversity:

The value of biodiversity in terms of its commercial utility, ecological services, social and asthetic value is enormous. The multiple uses of biodiversity or biodiversity value has been classified by Mc Neely et al in 1990, which is as follows, Indirect and Direct value.

~~2 consumptive value~~ ?

1) Direct values: Benefits derived from the biodiversity directly / indirectly from the products harvested from it.

It is divided into two types 1) Consumptive value 2) Productive value

1) Consumptive Value:
These are direct use value where the biodiversity produc
can be harvested and consumed directly.
Eg: Food, Fuel, Medicine (or) drugs, Fibre etc

1) Food Value:
- A large number of wild plants are consumed by human beings as food.
- About 80,000 edible plant species have been reported from wild.
- About 90% of present food crops have been domesticated from wild tropical plants.
- Even now our agricultural scientist make use of the existing wild species of plants that are closely related to our crop to develop new hardy strains as wild varieties are having better tolerance of hardiness.

2) Drugs and Medicines:
- About 75% of the world's population depends upon plants as plant extracts for medicines.
Eg: Penicillin from Penicillium (fungus).
Tetracyclin from bacterium
Quinine from cinchona tree used for Malaria
Digitalin from foxglove used for curing heart ailments
Vinblastin and vincristine from catharanthus plant to cure cancer, as they contain anti-cancer alkaloids.

3) Fuels:
- Our forests have been used since ages for fuelwood.
The fossil fuels coal, petroleum and natural gas are also products of fossilized biodiversity.
- Firewood used by the tribals is also considered to be a consumptive value.

II) Productive Value:

These are the commercially usable values where the products in the marketed and sold.

- These may include the animal products like tusks of elephants, musk from musk deer, silk from silk worm, wool from sheep, fur of many animals, lac from lac insect, all of which are traded in the market.
- Many industries are dependent upon the productive value of biodiversity - Eg. The paper & pulp industry, plywood industry, silk industry, textile industry, leather and pearl industry etc.

2) Indirect Values:

The benefits derived from the biodiversity which are neither harvested nor traded for.

i) Social, Religious and cultural value:

These values are associated with the social life, customs, religion & psycho-spiritual aspects of the people.

- Many of the plants are considered holy and sacred in our country like Tulsi, Neem, Mango, Bael, Peepal etc.
- The leaves, fruits or flowers of these plants are used in worship or the plant itself is worshipped.
- The Tribal people are very closely linked with the wildlife in the forests and most of their social life, songs, dances and customs are closely woven around the wildlife.
- Some animals like cow, snake, bull, peacock, owl also have significant place in our psycho-spiritual manner.

2) Ethical Value :

- Also known as existence value.
- It involves ethical issues like "all life must be preserved". It is based on the concept of "live and let live".
- If we want our human race to survive, then we must protect all biodiversity, because biodiversity is valuable.
- The ethical value means that we may or may not use a species, but knowing the very fact that this species exists in nature gives us pleasure.
- Eg: Extinct of Dodo (or) "Passenger pigeon" on the earth. We may not directly derive anything from Giraffee, Zebra or Kangaroo, but strongly feel these species should be present in nature.

3) Aesthetic Value :

- 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 called as "Eco-tourism".

4) Option Value :

- The option value is the value of knowing that there are biological resources existing on this biosphere that may one day prove to be an effective option for something important in the future.
- Thus option value of biodiversity suggests that any species may prove to be a miracle species someday.

5) Ecological Value :

- Ecosystem service value of biodiversity refers to the services provided by the ecosystem.

Like,

1) Prevention of soil erosion, soil formation
2) climate regulation, prevention from floods and droughts.
3) cycling of nutrients.
4) Waste disposal
5) cycling of water
6) Role in carbon sink,
7) pollutant absorption
8) Reduction of threat of global warming
9) natural pest control
10) pollination of plants by insects.
11) maintenance of gaseous composition of the atmosphere
12) gene flow etc.

India as a Mega-Biodiversity Nation:

- India is one of the 12 mega-diversity countries in the world.
- The ministry of Environment and Forests, Govt. of India (2009) records 47,000 sps of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

Endemism:

- Species which are restricted only to a particular area are known as endemic.
- India shows a good number of endemic species.
- About 62% of amphibians and 50% of lizards are endemic to India. Western Ghats are the site of maximum endemism.

Centre of Origin:

- A large number of species are known to have originated in India.
- Nearly 5000 species of flowering plants had their origin in India.
- From agro-diversity point of view also our country is quite rich.
- India has been the centre of origin of 166 species of crop plants and 320 species of wild relatives of cultivated crops.

Marine Diversity :

- Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exists a rich biodiversity.
- More than 340 species of corals of the world are found here.
- The Marine biodiversity is rich in molluscs, crustaceans (crabs etc.,) polychaetes & corals.
- Several spes of mangrove plants and seagrasses are also found in our country.
- India forests cover 64.01 million hectares having a rich biodiversity of plants in the Trans-Himalayan, North-west, west, central and eastern Himalayan forests, Western Ghats, coasts, deserts, Gangetic plains, deccan plateau and the Andaman, Nicobar & Lakshadweep islands.

Hot spots of Biodiversity :

Areas which exhibit high species richness as well as high species endemism are termed as hot spots of biodiversity. The term was introduced by myers (1988). Earlier 25 such hot spots of bio diversity were identified on a global level out of which two were present in India (Myer, N. et al, 2000). later additional 9 hotspots were added bringing the total to 34. The largest hot spot is existing in Brazil which occupies the 1.8% of the worlds land area.

* These hot spots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity. According to Myers et al (2000) an area is designated as a hotspot when it contains at least 0.5% or 1500 species of the plant species as endemics and have lost at least 70% of its primary vegetation.
* About 40% of terrestrial plants and 25% of vertibrate sps are endemic and found in these hot spots.
* After the tropical rain forests, the second highest number of endemic plant species are found in the Mediterranean.
* Broadly, these hot spots are in Western Amazon, Madagascar, North and East Borneo, North-Eastern Australia, West Africa and Brazilian Atlantic forests.
* These are the areas of high diversity, endemism and are also threatened by human activities. More than 1 billion people (about 1/6th of the world's population) most of whom are desperately poor people (tribes) live in these areas.
* Any measures of protecting these hot spots need to be planned keeping in view the human settlements and tribal issues.

Now three of these hot spots lie in India extending into neighbouring countries namely,

Indo-Burma region, Eastern Himalayas and Western Ghats -

1) Indo-Burma Region:

It encompasses more than 2 million km^2 of tropical Asia east of the Ganges-Brahmaputra lowlands. Earlier it included the Himalayan chain and the associated foothills in Nepal, Bhutan and India. Now it only covers the Indo-Chinese sub-region.

- The hot-spot contains the lower Mekong catchment, eastern Bangladesh, North-Eastern India, South of the Brahmaputra River, nearly all of Myanmar, part of Southern and western china. Cambodia & Vietnam the vast majority of Thailand and a small part of Peninsular Malaysia and several offshore islands.
- The Hot spot is characterised by distinct seasonal weather pattern and a wide diversity of ecosystems, including mixed wet evergreen, dry evergreen, deciduous and montane forests. These are also patches of shrublands, woodlands on limestone, low land flood plain swamps, mangroves, and seasonally inundated grasslands.
- Six large mammal species have been discovered in the last 12 years; The large-antlered Muntjac, the Annamite muntjac, the grey-shanked douc, the Annamite striped rabbit, the leaf deer and the Saola.

- This hot-spot also holds remarkable endemism in freshwater turtle species, most of which are threatened with extinction due to over-harvesting and extensive habitat loss.
- Bird life in Indo-Burma is also incredibly diverse holding almost 1,300 different bird species, including the threatened white eared night heron, the grey-crowned crocias and the orange necked partridge.

2) Western Ghats:

It extends along a 17,000 km^2 strip of forest in Maharashtra, Karnataka, Tamil Nadu & Kerala.

- It has 40% of the total endemic plant species.
- About 62% of amphibians and 50% lizards are endemic to Western Ghats.
- Forest tracts upto 500m elevation covering 20% of the forest expanse are evergreen while those in 500-1500m range are semi evergreen.
- The major centres of diversity are Agastyamalai Hills and Silent valley-the New Amambalam Reserve Basin.
- It is reported that only 6-8% of the original forests are existing while the rest has been deforested and degraded.

3. Eastern Himalayas:

- There are numerous deep and semi-isolated valley in Sikkim which are extremely rich in endemic plant sps.
- In an area of 7298 km² of Sikkim about 4250 plant species are found of which 60% are endemic.
- The forest cover of Eastern Himalayas has dwindled to about 1/3rd of its original cover.
- Certain species like 'Sapria himalayana', a parasitic angiosperm was sighted only twice in this region in the last 70 yrs.
- This hotspot is an active centre of organic evolution and is considered to the cradle of flowing plants.
- Out of the world's recorded flora 30% are endemic to India of which 35,000 are in the Himalayas.

Although the hot spots are characterized by endemism, interestingly, a few sps are common to the hot spots in India. Some common plants include japonica, Rhododendron and Hypericum, while the common fauna includes laughing thrush, fairy blue bird, lizard Hawk etc indicating their common origin long back in the geological times.

Enumerate 5 important Biosphere Reserves, National Parks, & Wild life sanctuaries of India also mention the States where they are located.

S.No	Type of In-Situ conservation	Example:
1.	Biosphere Reserve	Nanda Devi (UP) Nokrek (Meghalaya), Manas (Assam), Sudesbans (West Bengal), Nilgiri (Karnataka, Kerala & Tamil Nadu)
2.	National Parks	Kaziranga (Assam) - one-horned Rhinoceros (Imp: Wildlife) Gir (Gujarat) - Indian Lion Bandipur (Karnataka) - Elephant Corbett (Uttarakhand) - Tiger Periyar (Kerala) - Elephant, Tiger Dachigam (J&K) - Hangul
3.	Wildlife Sanctuary (WS)	- Nagarjuna Sagar - Srisailam Sanctuary (AP) Tiger, Panther - Kawal WS - AP - Tiger, Panther, Gaur, Barking deer - Pakhal Sanctuary - AP - Marsh crocodiles, spotted deer, stork - Ghana Bird Sanctuary - Rajasthan - 300 sps of birds. - Hazaribagh Sanctuary - Bihar - Tiger, leopard.

Threats to Biodiversity:

Extinction & elimination of a species is a natural process of evolution. In the geologic period the earth has experienced mass extinctions. During evolution, species have died out and have been replaced by others.

. In this century, the human impact has been so severe that thousands of species and varieties are becoming extinct annually. Ecologist, E.O. Wilson puts the figure of extinction at 10,000 species/yr (or) 27/day. If the present trend continues we would lose 1/3rd (or) 2/3rd of our current biodiversity by the middle of 21st century.

The major threats to Biodiversity are:

1. Loss of Habitat:

Destruction and loss of natural habitat is the single largest cause of biodiversity loss. Billions of hectares of forests and grasslands have been cleared over the past 10,000 yrs for conversion into agriculture lands, pastures, settlement areas or development projects. These natural forests and grasslands were the natural homes of thousands of species which perished due to loss of their natural habitat. The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today. The wetlands are destroyed due to clearing

filling and pollution there by causing huge biodiversity loss.

There has been a rapid disappearance of tropical forests in our country also, at a rate of about 0.6% per year. With the current rate of loss of forest habitat, it is estimated that 20-25% of the global flora would be lost within a few years.

Poaching: (1)

Illegal trade of wild life products by killing prohibited endangered animals i.e, poaching is another threat to wild life. Despite international ban on trade in products from endangered species, smuggling of wild life items like furs, hides, horns, tusks, live specimens and herbal products worth millions of dollars/yr.

The developing nations in Asia, latin america and Africa are the richest source of biodiversity and home enormous wealth of wild life.

The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hongkong are the major importers of the wild life products & wild life itself.

The cost of elephant tusks can go upto $100/kg, the leopard fur coat is sold at $100,000 in Japan while bird catchers can fetch upto $10,000 for a rare hyacinth macaw, a beautiful coloured bird, from Brazil, for every live animal that actually gets into the market, about 50 additional animals are caught and killed. (Conti- in 7/Pg no)

Conservation of Biodiversity:

The enormous value of biodiversity due to their genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need to conserve biodiversity.

There are two approaches of BD conservation:

(a) In situ conservation (within habitat): This is achieved by protection of wild flora and fauna in nature itself.
Eg: Biosphere reserves, National parks, Sanctuaries, Reserve forests etc.

(b) Ex-situ Conservation (outside habitats): This is done by establishment of gene banks, zoos, botanical gardens etc:

1. In-situ Conservation:

At present we have 7 major Biosphere reserves, 80 National Parks, 420 wild life sanctuaries and 120 Botanical gardens in our country covering 4% of the geoglyphic area.

Biosphere reserves: Conserve some representative ecosystems as a whole for long-term in-situ conservation. In India, we have Nanda Devi (U.P), Nokrek (Meghalaya), Manas (Assam), Sundarbans (west bengal), Gulf of manner (Tamil Nadu), Nilgiri (Karnataka) Kerala, Tamil Nadu), Great Nicobars & Simlipal (Orissa) biosphere reserves. Within the biosphere reserves we may have one & more National Parks.

A National Park is an area dedicated for the conservation of wild life along with its environment. Grazing of domestic

3. Man-wild life conflicts: (2)

Some times we come across conflicting situations when wild life starts causing immense damage and danger to man.

- In Sambalpur, Orissa 195 humans were killed in the last 5 years by elephants. In retaliation the villagers killed 98 elephants and badly injured 30 elephants.

Causes of Man-wild life conflicts:

(i) Dividing of habitats of tigers, elephants, rhinos and bears due to shrinking of forest covers compels them to move outside the forest and attack the field & sometimes even humans.

(ii) Usually the ill, weak and injured animals have the tendency to attack man.

(iii) Animals move out of the forest in search of food.

(iv) Very often the villagers put electric wiring around their ripe crops fields by that elephants get injured.

(v) Earlier there used to be wild life ~~corridors~~ corridoors through which the wild animals used to migrate seasonally in groups to other areas.

Remedial measures to curb the conflict:

1) Tiger conservation Projects (TCP)
2) Adequate crop compensation
3) Solar Powered fencing
4) Provision of wild life corridoors.

(18)

animals, all private rights and forestry activities are prohibited within a National park.

Some imp National parks in India -

- Kaziranga - Assam (one horned Rhino)
- Gir National Park - Gujarat (Indian lion)
- Dachigam (J&K) - Hangul

Wild life Sanctuaries: are also protected areas where killing, hunting, shooting & capturing of wild life is prohibited - except under the control of highest authority. However, private ownership rights are permissible and forestry operations are also permitted to an extent that they do not affect the wild life adversely.

Some important wild life sanctuaries in India:

- Ghana Bird sanctuary - Rajasthan (300 spp of Birds)
- Wild Ass Sanctuary - Gujarat (wild Ass, wolf)
- Pakhal sanctuary - AP - (Marsh crocodiles)

* Gene Sanctuaries in India:
For plants there is one gene sanctuary for Citrus (lemon family) and one for pitcher plant (an insect eating plant) in North east India. specific conservation projects for animals
For the protection and conservation of certain animals, there have been specific projects in our country eg: Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Snow leopard Project etc.

Ex-Situ Conservation of Biodiversity:

This type of Conservation is mainly done for Conservation of crop varieties, Wild Varieties and local varieties.
Main objective is for conserving the total genetic variability of the crop sps for future crop improvement (or) afforestration programs.

Following Important Gene bank/Seed bank Facilities:

1) National Bureau of Plant Genetic Resources (NBPGR):
Located in New Delhi, here agricultural and horticultural crops and their wild relatives are preserved by cryo-preservation of seed, Pollen etc, by using liquid Nitrogen at a temp. below -196°C.
eg: Varieties of rice, mustard, pearl millet, turnip, radish, tomato, onion, carrot, chilli, tobacco etc.

2) National Bureau of Animal Genetic Resources (NBAGR):
located at Karnal, Haryana.
- It preserves semen of domesticated bovine animals.

3) National Facility for Plant Tissue Culture Repository (NFPTCR): For the development of a facility of Conservation of varieties of crop plants/Trees by Tissue culture.
- This facility has been created within the NBPGR.

UNIT - II

Natural Resources

1. Natural Resources:

Life on this planet earth depends upon a variety of goods and services provided by the nature, which are known as Natural resources. "Any stock & reserve that can be drawn from nature is a natural Resource".

2. Renewable Resources:

The resources that can be replenished by the environment are called the renewable resources. These are also called the inexhaustible resources. These resources are constantly recycled in the environment like water.

3. Non Renewable Resources:

The resources that cannot be replenished by the environment are called the non-renewable resources. These are also called the exhaustible resources. These resources are formed in the environment at a very slow pace and cannot be replenished at the rate at which they are used. They include fossil fuels such as coal & petroleum and most of the minerals.

4. Floods:

Floods occur when water overflows on the bank of rivers due to heavy rains, melting of ice and snow thereby exceeding the limits of carrying capacity of rivers.

5. Aquifers and it types:

A layer of sediment & rock that is highly permeable and contains water is called an aquifer.

Aquifers are of two types:

Unconfined aquifers: which are overlaid by permeable earth materials and they are recharged by water seeping down from above in the form of rainfall and snow melt.

Confined aquifers which are sandwiched between two impermeable layers of rock or sediments and are recharged only in those areas where the aquifer intersects the land surface.

6. Subsidence:

When ground water withdrawl is more than its recharge rate, the sediments in the aquifers get compacted, a phenomenon known as ground subsidence. Huge economic losses may occur due to this phenomenon because it results in the sinking of overlying land surface.

7. Surface water:
The water coming through precipitation (rainfall, snow) when does not percolate down into the ground & does not return to the atmosphere as evaporation & transpiration loss, assumes the form of streams, lakes, ponds, wet lands & artificial reservoirs known as surface water.

8. Droughts:
When annual rainfall is below normal and less than evaporation, drought conditions are created.

9. Minerals:
Minerals are naturally occuring inorganic crystalline solids having a definite chemical composition and characteristic physical properties. Ore is naturally occuring material from which metal & valuable minerals can be extracted.

10. Occupational health hazards:
Most of the miners suffer from various respiratory and skin diseases due to constant exposure to the suspended particulate matter and toxic substances. Miners working in different types of mines suffer from asbestosis, silicosis, black lung disease etc.

11. Solar energy:
Sun is the ultimate source of energy directly & indirectly for all other forms of energy. The nuclear fusion reactions occuring inside the sun release enormous quantities

of energy in the form of heat and light. The solar energy received by the near earth space is approximately 1.4 KJ/sec/m^2 known as Solar constant.

12. Solar cells:

They are also known as Photovoltaic cells & PV cells. Solar cells are made of thin wafers of semi conductor materials like silicon and gallium. when solar radiation fall on them, a potential difference is produced which causes flow of electrons and produces electricity. Silicon can be obtained from silica & sand which is abundantly available and inexpensive. By using gallium arsenide, cadmium sulphide & boron, efficiency of the PV cells can be improved. The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4-0.5 volt and produces a current of 60 milli amperes.

13. Solar water heater:

It consists of an insulated box painted black from inside and having glass lid to receive and store solar heat. Inside the box it has black painted copper coil through which cold water is made to flow in, which gets heated and flows out into a storage tank. The hot water from the storage tank fitted on roof top is then supplied through pipes into buildings like hotels and hospitals.

14. Solar furnace:

These thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as 3000°C.

15. Solar Power plant:

Solar energy is harnessed on a large scale by using concave reflectors which cause boiling of water to produce steam. The steam turbine drives a generator to produce electricity. A solar power plant (50 K.W. capacity) has been installed at Gurgaon, Haryana.

16. Wind energy:

The high speed winds have a lot of energy in them as kinetic energy due to their motion. The driving force of the wind is the sun. The wind energy is harnessed by making use of wind mills. The blades of the wind mill keep on rotating continuously due to the striking force of the wind. The rotational motion of the blades drives a number of machines like water pumps, flour mills and electric generators. A large number of machines like water pumps wind mills are installed in clusters are called wind farms.

17. Hydro power (or) Hydel energy:

The water flowing in a river is collected by constructing a big dam where the water is stored and allowed

to fall from a height. The blades of the turbine located at the bottom of the dam move with the fast moving water which in turn rotate the generator and produces electricity.

18. Tidal Energy:

Ocean tides produced by gravitational forces of sun and moon contain enormous amounts of energy. The 'high tide' and 'low tide' refer to the rise and fall of water in the oceans. A difference of several meters is required between the height of high and low tide to spin the turbines. The tidal energy can be harnessed by constructing a tidal barrage. During high tide, the sea water flows into the reservoir of the barrage and turns the turbine, which in turn produces electricity by rotating the generator. During low tide, when the sea-level is low, the sea water stored in the barrage reservoir flows out into the sea and again turns the turbines.

19. Geothermal energy:

The energy harnessed from the hot rocks present inside the earth is called geothermal energy. High temperature and high pressure steam fields exist below the Earth's surface in many places. This heat comes from the fission of radioactive material naturally present in the rocks. In some places, the steam & the hot water comes out of the ground naturally through cracks in the form of Natural Geysers.

Biomass Energy

20. Petro - crops:

Certain latex - containing plants like Euphorbias and oil-palms are rich in hydrocarbons and can yield an oil like substance under high temperature and pressure. The oily material may be burnt in diesel engines directly & may be refined to form gasoline. These plants are popularly known as petro - crops.

21. Biogas:

-Biogas is a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide, the major constituent being methane. Biogas is produced by anaerobic degradation of animal wastes (sometimes plant wastes) in the presence of water. Anaerobic degradation means breakdown of organic matter by bacteria in the absence of oxygen.

22. Biofuels:

Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels. Ethanol can be easily produced from carbohydrate rich substances like sugar cane, corn and sorghum (Jowar).

23. Hydrogen fuel:

As hydrogen burns in air, it combines with oxygen to form water and a large amount of energy (150 K.J/gm) is released. Due to its high, rather the highest calorific value, hydrogen can serve as an excellent fuel. Production

of hydrogen is possible by thermal dissociation, photolysis & electrolysis of water.

Non-Renewable Energy Resource:

24. Geothermal Energy: Liquefied Petroleum Gas (LPG):

The main component of petroleum is butane, the other being propane and ethane (95:5). The petroleum gas is easily converted to liquid form under pressure as LPG. It is odourless, but the LPG in our domestic gas cylinders gives a foul smell. This is, in fact, due to ethyl mercaptan, a foul smelling gas, added to LPG so that any leakage of LPG from the cylinder can be detected instantaneously.

25. Natural Gas:

~~The~~ It is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. Natural gas is the cleanest fossil fuel. It can be easily transported through pipelines. It has a high calorific value of about 50 KJ/G and burns without any smoke.

26. Compressed Natural Gas (CNG):

It is used as an alternative to petrol and diesel for transport of vehicles. Delhi transport corporation has

Totally switched over to CNG where buses and auto rickshaws run on this fuel. It contains mostly methane compressed to 80 atmosphere. CNG works out cheaper (one-third) than diesel in long run because of stable price. Its carcinogenic potential is lesser, and gives higher mileage, i.e, 35-40 km/kg.

27. Synthetic Natural Gas (SNG):

It is a mixture of carbon monoxide and hydrogen. It is a connecting link between a fossil fuel and substituted natural gas. low glade coal is initially transformed into synthetic gas by gasification followed by catalytic conversion to methane.

28. Soil Erosion:

The literal meaning of 'soil erosion' is wearing away of soil. Soil erosion is defined as the movement of soil components, especially surface litter and top fertile soil from one place to another. Soil erosion results in the loss of fertility because it is the top soil layer which is fertile.

29. water logging:

In order to provide congenial moisture to the growing crops, farmers usually apply heavy irrigation to their farmland. Also, in order to leach down the salts deeper into the soil, the farmer provides more irrigation water. However, due to inadequate drainage and poor quality irrigation water

There is accumulation of water underground and gradually it forms a continuous column with the water table. We call these soils as waterlogged soils which affect crop growth due to inhibition of exchange of gases. The pore spaces between the soil particles get fully drenched with water through the roots.

30. Land Slide:

A land slide is the gravitational movement of a mass rock, earth & debris down a slope.

Landslides are usually classified on the basis of:

(a) The material involved (rock, debris, earth, mud).

(b) The type of movement (fall, topple, avalanche, slide, flow, spread).

31. Types of soil erosion:

Soil erosion is basically of two types based upon the cause of erosion:

(i) Normal erosion or geologic erosion: caused by the gradual removal of top soil by natural processes which bring an equilibrium between physical, biological and hydeological activities and maintain a natural balance between erosion and renewal.

(ii) Accelerated erosion: This is mainly caused by the gradual removal of top soil by and by anthropogenic (man-made) activities and the rate of erosion is much faster than the

rate of formation of soil. Overgrazing, deforestation and mining are some important activities causing accelerated erosion.

2. Mention the types of Agents which cause soil erosion.

There are two types of agents which cause soil erosion:

(1) Climatic agents (2) Biotic agents.

1) Climatic agents: water and wind are the climatic agents of soil erosion. Water affects soil erosion in the form of torrential rains, rapid flow of water along slopes, run-off, wave action and melting and movement of snow.

(a) water induced soil erosion:

- Sheet erosion: when there is uniform removal of a thin layer of soil from a large surface area
- Rill erosion: when there is rainfall and rapidly running water produces finger-shaped grooves & rills over the area
- Gully erosion: when the rainfall is very heavy, deeper cavities & gullies are formed which may be U & V shaped.
- Slip erosion: This occurs due to heavy rainfall on slopes of hills and mountains
- Stream bank erosion: During the rainy season, when fast running streams take a turn in some other direction they cut the soil and make caves in the banks.

(b) Wind erosion :

- Saltation : This occurs under the influence of direct pressure of stormy wind and the soil particles of 1-1.5mm diameter move up in vertical direction.
- Suspension: Here fine soil particles (< 1mm dia) which are suspended in the air are kicked up and taken away to distant places.
- Surface creep: Here larger particles (5-10mm Dia) creep over the soil surface along with wind.

2) Biotic agents:

Excessive glazing, mining and deforestation are the major biotic agents. Overglazing accounts for 35% of the world's soil erosion, deforestation 30% and un-sustainable farming techniques cause 28% of soil erosion.

33. Land slides and its ~~causes~~ Effects of land slides:

A land slide is the gravitational movement of mass of earth & debris down a slope.

Thus land slide also refers to mass movement such as rock falls, mudslide and debris flow. Land slide of different types occur frequently in geodynamically active domains in Himalaya, Northeastern India as also in Stable domains in western Ghats and Nilgiri Hills of Southern India.

* Every year land slides result in large damage to infrastructure (roads, railways, artificial reservoirs, etc) and property (building, agricultural land etc).
* Large land slides in mountainous areas can result in blocking of rivers courses.
* Land slides may adversly affect the buried pipelines of oil and gas.

4. Causes of land slides:

(a) Natural causes:

Land slides can be triggered by natural physical processes, such as heavy or prolonged rain fall, earthquakes, volcanic eruptions, rapid snow melt, slope undercutting by rivers or sea waves and permafrost thawing.

(b) Man induced land slides:

man-made factors of land slides are;

(1) Intense deforestation and soil erosion

(2) Construction of human settlement in land slide prone areas and building with weak foundations areas

(3) Roads & communication lines in mountain areas.

35. Renewable energy resources & non-conventional sources.

Renewable resources which can be generated continuously in nature and are inexhaustible.

Eg: Solar energy, wind energy, tidal energy, hydropower, biomass energy, bio-fuels, geothermal energy and hydrogen.

They are also known as non-conventional sources of energy and they can be used again and again in an endless manner.

36. Non-renewable energy sources (or) Conventional energy sources:

Non renewable resources which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted.

Eg: Coal, petroleum, Natural Gas & Nuclear fuels.

37. Coal:

Coal was formed 255-350 million years ago in the hot, damp regions of the earth during the carboniferous age. The ancient plants along the banks of rivers and swamps were buried after death into the soil and due to the heat and pressure gradually got converted into peat and coal over millions of years of time.

There are mainly three types of coal namely:

(a) anthracite (hard coal) - 90% carbon
(b) bituminous (soft coal) - 80% "
(c) lignite - 70% carbon

Anthracite coal has calorific value of 8700 K.cal/kg.

38. Petroleum:

It is the life line of the global economy. There are 13 countries in the world having 67% of the petroleum reserves which together form the OPEC (Organization of petroleum Exporting Countries). About 1/4th of the oil reserves are in Saudi Arabia.

Crude petroleum is a complex mixture of alkane hydrocarbons. Hence it is to be purified and refined by the process of 'fractional distillation' during which process different constituents seperate at different temperatures, namely Petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin wax, asphalt, plastic etc.

Petroleum is a cleaner fuel as compared to coal as it burns completely and leaves no residue.

39. Dam - Benefits:

A Dam is an artificial construction which can be constructed in between the river valleys & across the rivers to store the water for irrigation, energy production etc.

River valley projects with big dams have usually been considered to play a key role in the development process due to their multiple uses. India has the distinction of having the largest number of rivers valley projects. The tribals living in the area pin big hopes on these

projects as they aim at providing employment and raising the standard and quality of life. The dams have tremendous potential for economic upliftment and growth. They can help in checking floods and famines, generate electricity and reduce water and power shortage, provide irrigation water to lower areas, provide drinking water in remote areas and promote navigation, fishery etc.

40. Environmental Problems due to Dams :

The environmental impacts of big-dams are also too many due to which very often the big dams become a subject of controversy.

(A) The upstream problems :

(i) Displacement of tribal people
(ii) loss of forests, flora & fauna
(iii) changes in fisheries and spawning grounds.
(iv) Siltation and sedimentation of reservoirs.
(v) loss of forest (or) Agricultural (or) non forest land.
(vi) Stagnation and water logging near reservoirs.
(vii) Breeding of weeds and spread of vector borne diseases.
(viii) Reservoir induced seismicity (RIS) causing earthquakes
(ix) Growth of aquatic weeds
(x) Microclimatic changes.