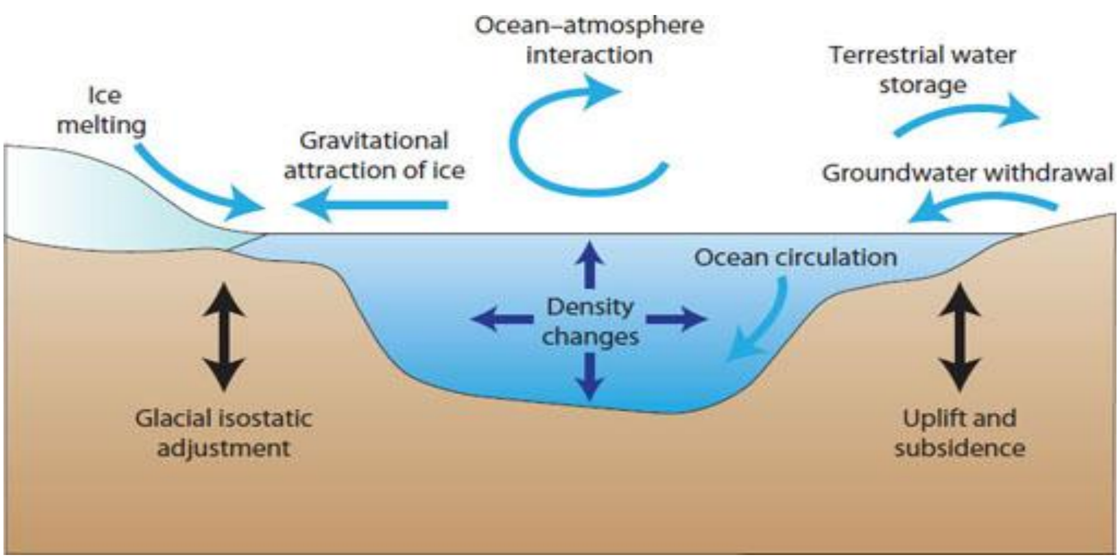
Que. 1 (a) Write note on causes of sea level changes.

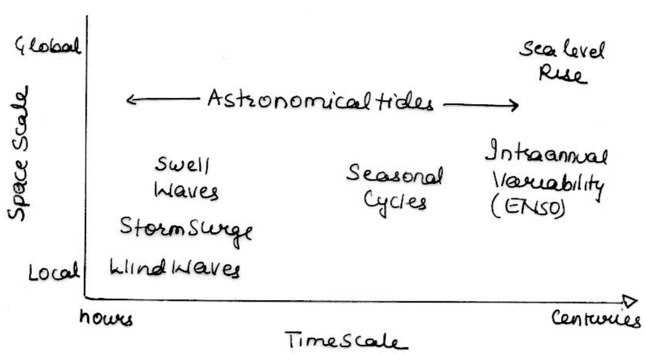
Ans. 1 (a) The sea level has and continues to fluctuate greatly throughout time. On a day to day basis, the sea level changes according to the tide but the sea level also changes on a much grander time scale too. These changes in sea level are normally caused by ice ages or other major global events. Sea level rise is caused primarily by **two factors** related to global warming: the added water from melting ice sheets and glaciers, and the expansion of seawater as it warms

Sea level rise at specific locations may be more or less than the global average due to many local factors: subsidence, upstream flood control, erosion, regional ocean currents, variations in land height, and whether the land is still rebounding from the compressive weight of Ice Age glaciers.



Global warming is causing global mean sea level to rise in two ways.

- First, glaciers and ice sheets worldwide are melting and adding water to the ocean.
- Second, the volume of the ocean is expanding as the water warms.



- A third, much smaller contributor to sea level rise is a decline in the amount of liquid water on land—aquifers, lakes and reservoirs, rivers, soil moisture.

The **sea level changes for a variety of natural reasons**. These reasons can be put into two categories; **eustatic and isostatic change,** depending on if they have a global effect on sea level or a local effect on the sea level.

Eustatic change is when the sea level changes due to an alteration in the volume of water in the oceans or, alternatively, a change in the shape of an ocean basin and hence a change in the amount of water the sea can hold. Eustatic change is always a global effect.

Isostatic sea level change is the result of an increase or decrease in the height of the land. When the height of the land increases, the sea level falls and when the height of the land decreases the sea level rises. Isostatic change is a local sea level change whereas eustatic change is a global sea level change.

Isostatic sea level change can also be caused by **tectonic uplift or depression.** As this only takes place along plate boundaries, this sort of isostatic change only takes place in certain areas of the world

The pace of global sea level rise more than doubled from 1.4 mm per year throughout most of the twentieth century to 3.6 mm per year.

The **effects of sea level rise** are already being felt, and the forecasts are not very hopeful.

First, **water is increasingly invading coastal areas**, causing soil erosion and threatening farmland, housing or recreation areas. The flooding of wetlands and pollution of aquifers also occur, affecting the flora and fauna of each place, causing the loss of habitat for fish, birds, plants and many other species.

On the other hand, a higher sea level causes heavy rains and strong winds, unleashes severe storms and **other big atmospheric phenomena** that can be a real threat to places that might be on its way.

On the **social aspect**, the constant threat of sea level rise menaces hundreds of millions of people living in coastal communities. If water continues to rise, they will be forced to abandon their homes and move to another area, with the corresponding demographic problem. This is known as forced migration resulting from climate change.

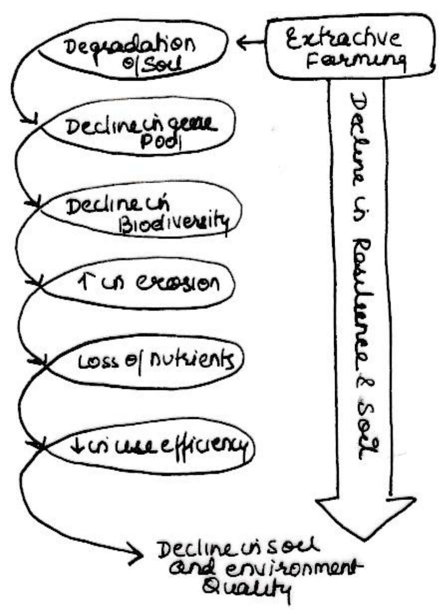
Finally, low-lying islands would be swallowed by the oceans, leading to the disappearance of large land areas and even some countries.

Que. 1 (b) Avail brief details of challenges faced by soil.

Ans. 1(b) Soil degradation implies a decline in soil quality with an attendant reduction in ecosystem functions and services. Conceptually, there are **four types of soil degradation**:

(i) physical; (ii) chemical; (iii) biological; and (iv) ecological

Soil physical degradation generally results in a reduction in structural attributes including pore geometry and continuity, thus aggravating a soil's susceptibility to crusting, compaction, reduced water infiltration, increased surface runoff, wind and water erosion, greater soil temperature fluctuations, and an increased propensity for desertification. Soil chemical degradation is characterized by acidification, salinization, nutrient depletion, reduced cat ion exchange capacity (CEC), increased Al or Mn toxicities, Ca or Mg deficiencies, leaching of NO3-N or other essential plant nutrients, or contamination by industrial wastes or by-products. Soil biological degradation reflects depletion of the soil organic carbon (SOC) pool, loss in soil biodiversity, a reduction in soil C sink capacity, and increased greenhouse gas (GHG) emissions from soil into the atmosphere. One of the most severe consequences of



soil biological degradation is that soil becomes a net source of GHG emissions (i.e., CO_2 and CH_4) rather than a sink. Ecological degradation reflects a combination of other three, and leads to disruption in ecosystem functions such as elemental cycling, water infiltration and purification, perturbations of the hydrological cycle, and a decline in net biome productivity. The overall decline in soil quality, both by natural and anthropogenic factors, has strong positive feedbacks leading to a decline in ecosystem services and reduction in nature conservancy. Once the process of soil degradation is set-in-motion, often by land misuse and soil mismanagement along with the extractive farming, it feeds on itself in an ever-increasing downward spiral

Soil and Ecosystem Services

Soil, the most basic of all resources, is the essence of all terrestrial life and a cultural heritage. Yet, soil is finite in extent, prone to degradation by natural and anthropogenic factors, and is non-renewable over the human timescale (decades). Soil quality also has strong implications to human health

Soil organisms are sensitive to changes in land use, climate, and natural disturbance. Human soil disturbances like mining, road and building construction, tillage for agriculture, erosion, and land degradation are major threats to soil biodiversity, particularly impacting fungi and soil invertebrates. In many cases, these changes lead in irrevocable changes in soil biodiversity and soil functioning. In addition, invasive species, including invasive soil organisms, can decrease biodiversity and alter decomposition and nutrient cycling rates. Increased wildfire intensity can directly impact soil organisms, alter plant inputs, and change water infiltration capacity. Climate change may shift soil communities, and also changes how quickly soil communities decompose plant material and soil organic matter. People rely on soil for food, clean water, flood and drought mediation, and climate regulation. As we recognize both our reliance on ecosystems and our ability to alter them, it is important to understand how we negatively impact soil organisms that support us, and how we can change behavior to protect soil biodiversity and sustain our future.

Soil Organic Carbon and Its Impact on Soil Quality

The SOC pool, including its quantity and quality, is the defining constituent of soil . Indeed, SOC pool is the most reliable indicator of monitoring soil degradation, especially that caused by accelerated erosion . Soil degradation depletes the SOC pool, along with it, plant available N and other essential nutrients such as P and S. Furthermore, as identified repeatedly in this special issue of Sustainability, depletion of SOC pool is a global issue and a principal cause of soil degradation, especially in the European semi-arid Mediterranean regions

Soil Quality Index

The SOC pool is a key indicator of soil quality, and an important driver of agricultural sustainability. In addition to its amount, other parameters of SOC include its depth distribution, quality or attributes (physical, chemical, biological)

Conservation Agriculture and Soil Quality

Four basic principles of CA are : (i) retention of crop residue mulch; (ii) incorporation of a cover crop in the rotation cycle; (iii) use of combination of chemical and bio fertilizers; and (iv) elimination of soil mechanical disturbances. Properly implemented on suitable soil types, CA has numerous co-benefits including reduced fuel consumption and increased soil C sequestration. Mechanical tillage is an energy-intensive process and its reduction or elimination can decrease consumption of fossil fuels.

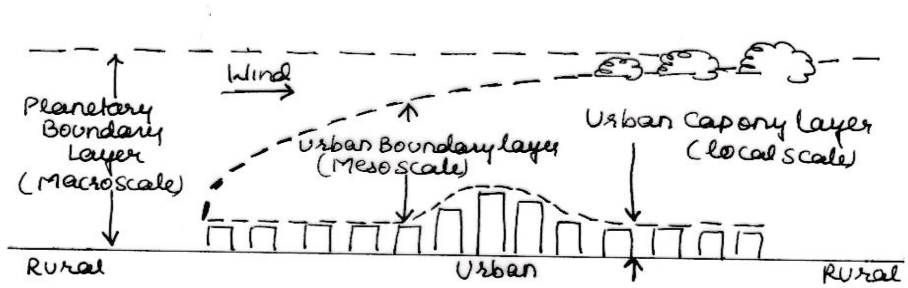
Que. 1(c) What is canopy heat trap?

Ans. 1 (c) The elevated temperature in urban areas as compared to rural, less developed areas is referred to as the urban heat island effect. As cities grow and develop, more buildings and people are added. The process of urban development leads to this phenomenon.

Although we tend to think of heat islands as a modern ecological problem, scientists first noted this issue as early as the 1800s. Any area (rural, urban, or otherwise) can experience the heat island effect, but urban areas are typically of more concern since they represent a more serious threat to local climate warming.

For smaller cities, heat islands are less noticeable. For a large city of one million people, the average temperature can be anywhere from around 1°C to 12°C warmer than the surrounding area. Cities such as Toronto experience a cumulative heat island effect. Since the late 1800s, Toronto has experienced an average temperature increase of 2.7°C This may not seem significant at first, but over time, these increases can cause major problems.

When urban and suburban areas lose land surface and naturally occurring vegetation, heat can no longer easily escape. Tall buildings, concrete, and asphalt trap heat and contribute to the warming effect. Waste heat from energy use is another source of additional heat. Other contributing factors include local weather, seasonal changes, time of day, and geographic location.



There are three basic types of heat islands: ***canopy layer, boundary layer, and surface. Both canopy layer and boundary layer heat islands*** refer to atmospheric heating (warmer air temperatures). Surface heat islands refer to the actual temperature of surfaces in a specific heat island. Although the timing and intensity of these types may vary, they can all be harmful to urban and suburban environments.

Heat island:

The presence of any area warmer than its surrounding landscape. They can be developed on urban or rural areas. As it would be expected, there is a relatively minor knowledge about on-urban heat islands, since they usually do not represent a risk for the human being or the environment. Meanwhile, urban heat islands have been profusely addressed during decades in urban areas with a wide range of climates and landscapes.

Urban heat island effect: The well-known phenomenon allusive to the atmospheric temperature rise experienced by any urbanized area. The heat island phenomenon has been commonly associated to cities, because their surfaces are characterized by low albedo, high impermeability and favorable thermal properties for the energy storage and heat release. Besides, many cities present narrow urban canyons with reduced sky view factors that tend to absorb and reemit the radiated energy from their surfaces. These factors contribute to urbanized areas increasing their temperatures in relation to their rural peripheries that are usually more vegetated, and therefore moderate the temperatures mainly through the evapotranspiration process, shades production and solar radiation interception.

Surface urban heat island: The remotely sensed urban heat island. It is observed by using thermal infrared data that allow to retrieve land surface temperatures. Usually, close relationships between the near surface air temperatures and land surface temperatures have been found.

Therefore, the surface urban heat island is a reliable indicator of the atmospheric urban heat island.

Micro urban heat islands: They refer to urban hot spots as poorly vegetated parking lots, non-reflective roofs and asphalt roads. Micro urban heat islands are strongly affected by micro climate factors, therefore remotely sensed data are more suitable than atmospheric data for identifying heat spots.

Urban heat sink: Also called negative heat island. It is the expression of a city colder than their country sides. There are few references about this phenomenon. Heat sinks have been observed in cities with temperate, tropical, semi-arid and arid climates, and mainly during the mornings.

Que.1 (d) Explain impact of biotechnology on Gene Pool.

Ans. 1 (d) Biotechnology is defined as 'any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use' in the Convention on Biological Diversity, which has been developed to ensure fair and equitable sharing of the benefits arising from the use of biological diversity elements, which constitutes the main guarantee of sustainable development

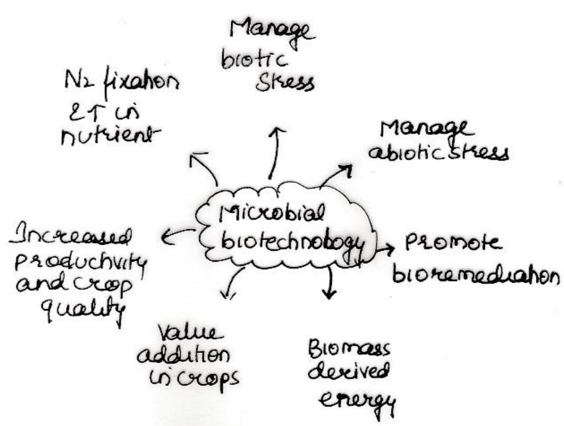
As highlighted, biotechnology refers to any kind of technological application adopted in the process of changing the genetic structure of living organisms to produce desired genotypes.

The gene pool of a biological species is the largest and most inclusive. Members of groupings above the level of biological species cannot share a common gene pool because they are reproductively isolated from each other. Humans can artificially cause species to overcome reproductive barriers and achieve gene flow between species or even genera. This is a common situation in plant breeding where artificial introgression is often accomplished from the gene pool of a wild relative of a crop to the gene pool of the crop. To reflect this reality, Jack R. Harlan and J. M. J. de Wet expanded the concept of gene pool beyond its original definition. They called the gene pool of a crop and its wild ancestor, which, together, usually satisfy the conditions of a biological species, the primary gene pool. They proposed to characterize supra specific groupings of a crop species and related species as secondary or even tertiary gene pools, depending on the difficulty of achieving artificial introgression within them. These terms refer to artificial situations of domesticated plants and are inconsistent with the original definition of gene pool for natural populations.

Transgenic crops have their bad effects. Among them is that it disturbs the ecological balance and natural interaction of organisms. As some parties naively claim that transgenic organisms add to the world's diversity by producing new species, the real fact is that it actually threatens.

Bio diversity on a wider level. For example, transgenic crops can be made to be resistant to herbicides. This application would mean that farmers could use herbicides on their fields without damaging their product. This is great for a farmer's productivity, but bad for biodiversity. Wiping out the weeds would have an impact on the populations of insects who feed on the weeds, and so on up the food chain. If insect resistance and herbicide tolerance are combined in the same crop variety, there may be few insects capable of feeding on the crops and few invertebrates and birds would be able to exploit the weed-free fields. In Europe there is already a massive decline in farmland birds, with several previously common species are now close to extinction.

Transgenic organisms also raise the issue of **"Genetic Pollution".** This is a major concern to environmental scientists, conservation biologists and evolutionary geneticists alike, as it leads to a loss of pure scientific recourses. Genetic pollution is basically an uncontrollable and undesirable gene flow into wild populations. Scientists are very keen in the genetics of native populations. The idea of destroying natural gene pools by adding genes to and from organisms is unacceptable and is seen as sabotaging the billions of year's worth of natural selection.



Similarly, introducing **foreign genes** into a species can also lead to an unwanted spread to non-target plants. The genes inserted in transgenic crops are often derived from other species, giving traits that are not present in wild populations. If introduced accidently, it may give an impact to the fitness and population dynamics of hybrids between the native plants.

The **implementation of transgenic crops** is also leading to the practice of monoculture. Monoculture is a method used in industrialized agriculture where it favours genetic uniformity. This is where vast fields are planted with a single high yielding variety, using expensive inputs such as hi-tech irrigation systems, fertilizer and pesticides to maximize production. Genetic uniformity invites disaster because it makes crops vulnerable to attacks, a pest or disease that strike one plant quickly spreads throughout the crop.

As an impact from **monoculture,** the demand on genetically uniformed plants can lead to genetic erosion. Genetic erosion is a process whereby an already limited gene pool of an endangered species diminishes even more. In terms of transgenic plantations, even though on one hand uniformed transgenic plants are potentially high yielding under certain conditions, its uniformity in genetic material is actually destroying biodiversity even faster. This is because farmers now concentrate on a limited number of plant varieties with special genetic characteristics. As they plant the new transgenic seeds, natural seeds are eaten. In fact, genetic erosion of worldwide crops is increasing at a current annual rate of 1 to 2%. Since the middle of the century, a large proportion of the genetic diversity of the world's top food crops has disappeared from the farmers worldwide.

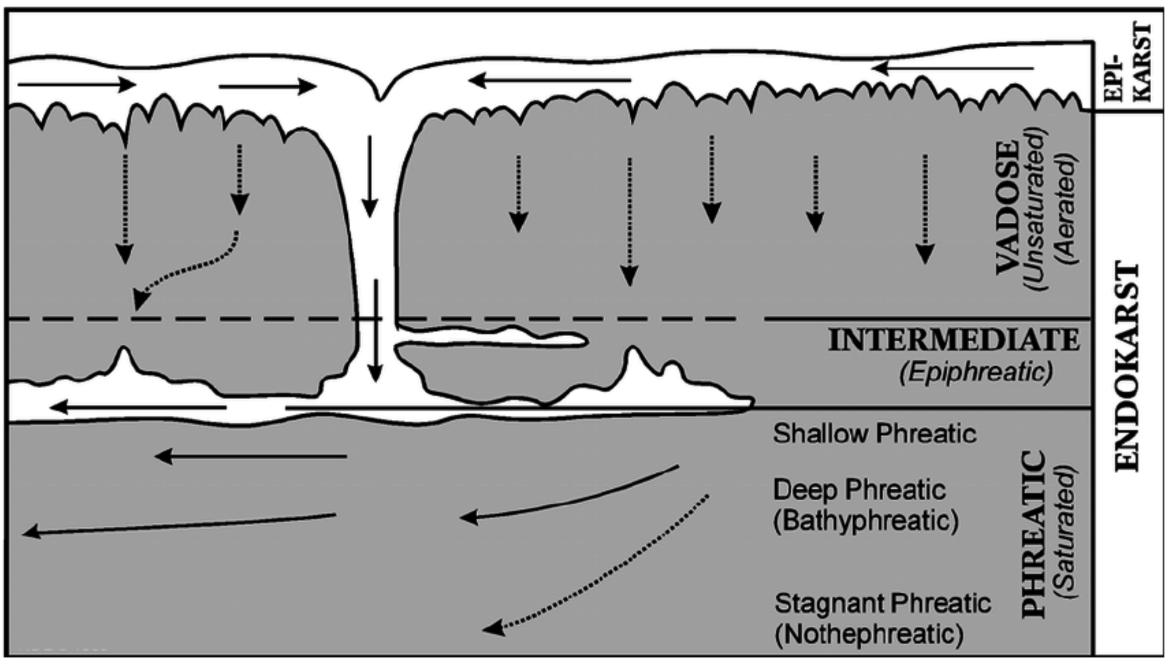
In conclusion, despite the benefits and dreams of feeding the world through plant biotechnology, genetic engineered crops are in reality threatening biodiversity as it controls the genes according to what is needed only, rendering natural genetic construct as well as disturbing the natural ecological balance. Human beings should think twice before meddling with the building blocks of nature as it deeply disturbs the unique biodiversity we have today.

Que. 1(e) Discuss vadose and phreatic zones in water resource planning.

Ans. 1 (e) The water table defines the highest level of the saturated, or phreatic, zone in a sediment or surficial rock unit. Above this is the **zone of aeration, or vadose zone**,in which waters circulate freely under the influence of gravity and in relation to the combination of porosity (the ratio of voids to total volume of the material) and permeability (continuity among the voids). Thus, when surface water, rain or snow melt infiltrates into the ground, it permeates down to the water table and eventually recharges the phreatic zone. Vadose seepage permeates in a diffuse manner, while vadose flow moves along integrated conduits under gravitational influence.

Saturated zone

The saturated zone encompasses the area below ground in which all interconnected openings within the geologic medium are completely filled with water . Many hydrogeologists separate this zone into two subzones: the phreatic zone and the capillary fringe.



The **phreatic zone** is the area in which the interstitial water will freely flow from pores in the geologic material. Water in the pores of the phreatic zone is at a pressure greater than atmospheric pressure . Lying above, and separated from the phreatic zone by the water table , is the capillary fringe. Capillary action within the voids of the geologic medium causes water to be drawn upward from the top of the phreatic zone or captured as it percolates downward from the

overlying unsaturated zone . Unlike the phreatic zone, however, the capillary action causes the water in the pores to have a pressure that is lower than atmospheric pressure. While the pores of both subzones are saturated, the different pressures in each cause the water to behave differently.

Water within the phreatic zone will readily flow out of the pores while the negative pressures within the capillary fringe tightly hold the water in place. It is water from the phreatic zone that is collected and pumped from wells and flows into streams and springs .

Water within the phreatic portion of the saturated zone moves through the interconnected pores of the geologic material in response to the influences of gravity and pressure from overlying water. Rates of groundwater movement within the saturated zone ranges from a few feet per year to several feet per day depending upon local conditions. Only in larger fractures or karst systems do velocities approach those seen in surface flows.

The saturated zone extends downward from the capillary fringe to the depth where rock densities increase to the point that migration of fluids is impossible. In deep sedimentary basins, this may occur at depths of approximately 50,000 feet. At these extreme depths, the voids are no longer inter-connected or not present.

Localized saturated zones can occur within the unsaturated zone when heterogeneities within the geologic medium cause differential downward percolation of water. Specifically, layers or lenses of low permeability, such as clay or shale, can retard the movement of water in the unsaturated zone and cause it to pool above the layer. This forms a perched zone of saturation.

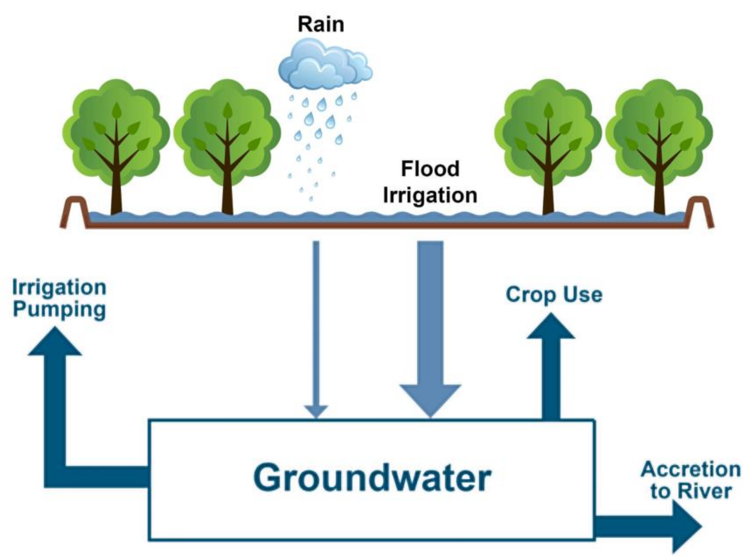
Groundwater is the largest source of freshwater for mankind. Isotope techniques are used to determine the origin and replenishment rates of groundwater, obtained through the use of stable and radioisotopes naturally present in groundwater.

Groundwater constitutes 30 per cent of the world's available freshwater. A further 69 per cent is locked up in polar icecaps, while rivers and lakes only represent one per cent. Groundwater is often hidden deep in aquifers, permeable rocks and sediments and is extracted using pumping wells. Often, aquifers can be renewable water resources, slowly replenished by rainfall infiltration over hundreds up to many thousands of years.

A growing global population, coupled with more intensive agriculture and increasing industrial use, have led to an ever-rising demand for groundwater. Water managers in many regions have had to deal with an over-exploitation of accessible aquifers and are often forced to rely on deep ancient groundwater sources for reliable freshwater supplies. Added to this are threats emanating from the spill of contaminants and toxins into the groundwater, for instance from agriculture, industry or urban activities.

A scientific assessment of the origin and replenishment rate of aquifers is critical in fulfilling their function as reliable long-term water supplies. Stable and radioisotopes naturally present in groundwater can be used to learn more about the origin and replenishment rates of groundwater.

Dealing with pollution in groundwater is more complex as aquifer contamination is extremely difficult to remediate. Stable and radioisotope tracers (nitrogen-15, carbon-13 and tritium) are used to help fingerprint the sources of contaminants and to quantify the transformations and biodegradation of pollutants in aquifer systems.



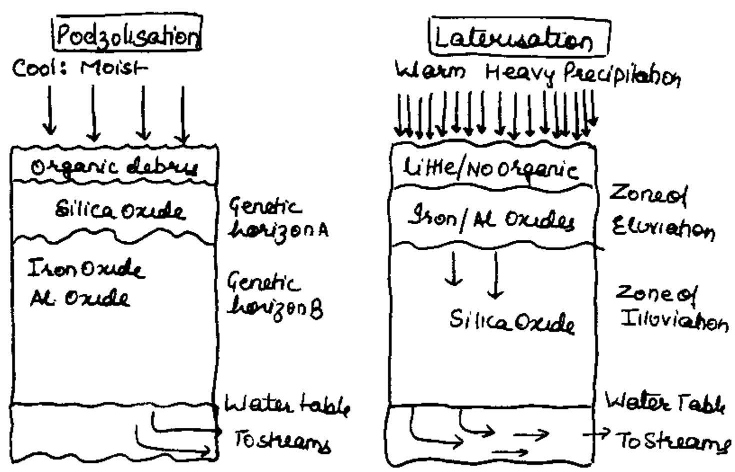
Growers utilizing flood irrigation contribute to the replenishment of the groundwater supply by allowing water to soak into the ground where a portion of it eventually reaches the underground aquifer. In normal and wetter years, surface water makes up the bulk of the supply with groundwater being drawn upon to a lesser extent. In those years, growers using flood irrigation are net groundwater rechargers, providing more water to the aquifer than is pumped out. In dry years, this stored groundwater can be utilized to help meet irrigation demand that cannot be supplied by surface water alone. This practice of utilizing surface and ground water to meet local requirements is known as **conjunctive use**.

Que. 2(a) Explain soil regimes of global and local importance.

Ans. 2 (a) Soils begin to develop when either rocks or deposits of loose material are colonized by simple plant and animal life. Once the organic processes of life and death begin to take place among mineral particles or disintegrated rock, differences begin to develop from the surface down through the soil parent material. This vertical differentiation comes about originally from such simple factors as the gradual accumulation of organic matter at the surface and the removal of fine particles and dissolved matter from the top layers by water percolating downward, followed by the deposition of these materials at a lower level.

As climate, vegetation, animal life, and steepness of slope affect soil formation over time, this vertical differentiation becomes more and more apparent. Often, especially in middle latitudes, fully developed soils exhibit a vertical zonation into distinct layers or **horizons** that are distinguished by their different physical and chemical properties.

Regimes of global Importance there are infinite possible combinations of the factors that function together to produce soils of all descriptions. Nevertheless, an examination of the world's soils reveals that they can be separated into a limited number of general types. The characteristics that differentiate these major types can be attributed to their soil-forming regimes, each resulting from a combination of different processes. The differences between these soil-forming regimes are primarily the result of climatic differences and indirectly the result of differences in plant cover.



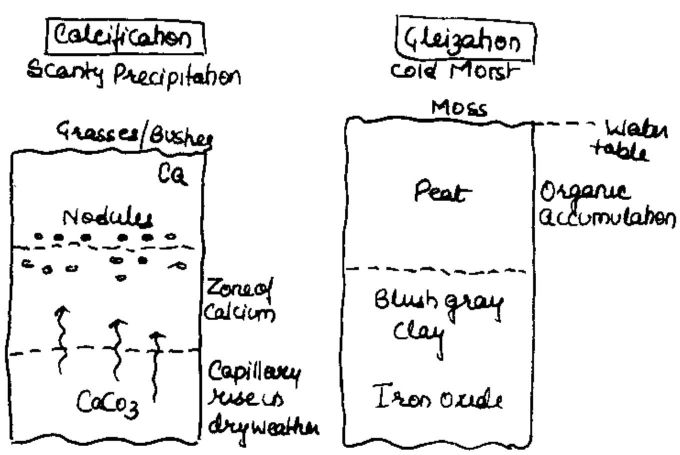
At the broadest generalization, there are three primary soil-forming regimes that relate to climatic differences. These are

laterization, podzolization and calcification. On a local scale, other processes become important but they are of lesser significance in world-wide distribution of soils. Soils may be formed by any one of these processes or by a combination of two or more, primarily depending on the climate but also on surface configuration, vegetation and parent material.

1. Laterization

Laterization is a soil-forming process that occurs in humid tropical and subtropical climates as a result of the high temperatures and abundant precipitation. These effects produce rapid breakdown of rocks and decomposition of nearly all minerals. Despite the dense vegetation that is typical of these climates, little humus is incorporated into the soil because of the rapid decomposition of plant litter and enormous numbers of microorganisms in the soil. Because of the abundance of moisture, eluviation and leaching of all but iron and aluminum oxides play dominant roles in the formation of humid tropical soil.

2. Podzolization This occurs in its purest form in the high middle latitudes, where the climate is moist with short, cool summers and long, severe winters. The typical coniferous forest of this climate is an integral part of the process of podzolizaion. Podzolization can take place beyond the typical cold, moist climate when the parent material is highly acidic, as on the sands common along the east coast of the United States. The pine forests that can grow in such acidic conditions return acids to the soil, promoting the process of podzolization.



3. Calcification

The third distinctive soil-forming process is called **calcification.** In contrast to both laterization and podzolization, which require humid climates, calcification demands climates where evapotranspiration exceeds precipitation. In areas of low precipitation, the air is often loaded with alkali dusts such as calcium carbonate ($CaCO3$). When calm conditions prevail or when it rains, the dust settles across the landscape and accumulates in the soil. The rainfall is just sufficient to translocate these materials to the B horizon of soils. Over hundreds to thousands of years, the $CaCO3$-enriched dust concentrates in the B horizons of soils, forming hard layers of caliches or the much thicker calcretes. These accumulations can be enhanced by the upward (capillary) movement of dissolved alkaline salts in groundwater when the water table is near the surface.

Regimes of Local Importance

Two additional soil-forming processes are important enough to merit consideration. Both are characteristic of areas with locally poor drainage, although they occur under strikingly different climatic conditions.

The first, **salinization,** occurs in stream valleys, interior basins, or other low lying areas in desert regions that have high groundwater tables. The high groundwater can be the result of adjacent mountain ranges or stream flow originating outside a desert region, but increasingly it is the result of extensive irrigation. Rapid evaporation of this water leaves behind the high concentration of soluble salts in the soil that characterizes the soil-forming regime and gradually destroys the agricultural productivity of the area. An extreme example of salinization is the fertile crescent of Mesopotamia (Iraq), where thousands of years of irrigated agriculture in the desert has led to soils too salty to cultivate today.

The second, **gleization,** occurs in poorly drained areas under cold and wet environmental conditions. This process is usually associated with peat bogs, where the soil is an accumulation of humus layers overlying a blue-gray layer of thick, gummy, water-saturated clay. (Unreduced iron in the early stages of decomposition imparts the blue-gray color to the soil). In formerly glaciated, poorly drained regions such as northern Russia, Ireland, Scotland, and Scandinavia, the peat has long been harvested and used as an important source of energy.

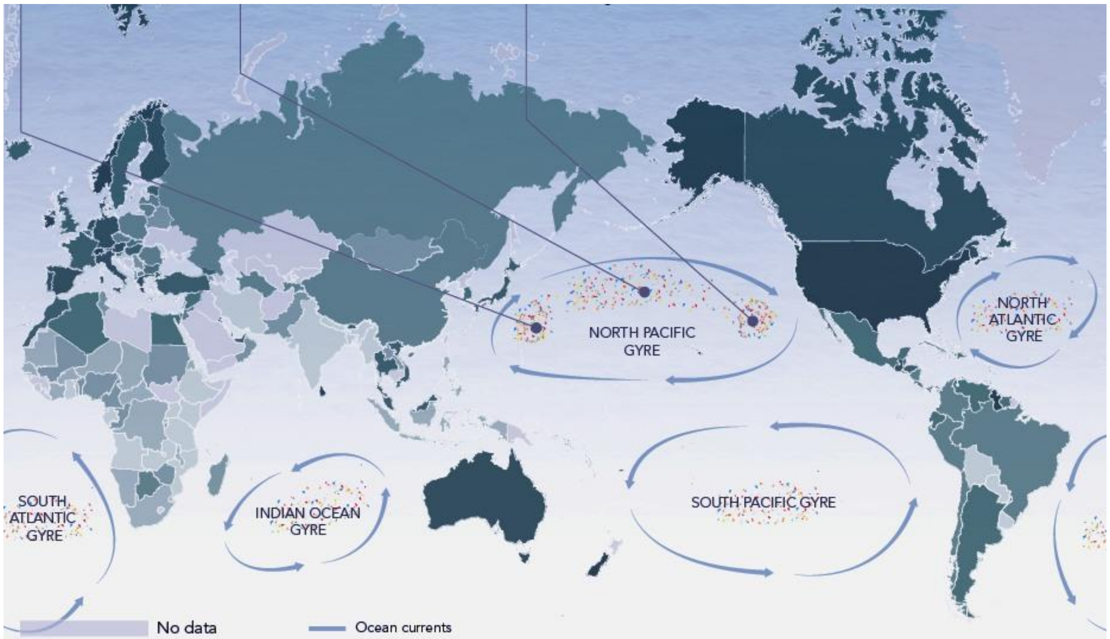
Que.2 (b) Avail detailed account on global attempts to abate marine pollution.

Ans. 2(b) Covering more than 70 percent of our planet, oceans are among the earth's most valuable natural resources. They govern the weather, clean the air, help feed the world, and provide a living for millions. They also are home to most of the life on earth, from microscopicalgae to the blue whale, the largest animal on the planet. Yet we're bombarding them with pollution. By their very nature—with all streams flowing to rivers, all rivers leading to the sea—the oceans are the end point for so much of the pollution we produce on land, however far from the coasts we may be. And from dangerous carbon emissions to choking plastic to leaking oil to constant noise, the types of ocean pollution humans generate are vast. As a result, collectively, our impact on the seas is degrading their health at an alarming rate. Here are some ocean pollution facts that everyone on our blue planet ought to know.

Ocean Acidification It's estimated that by the end of this century, if we keep pace with our current emissions practices, the surface waters of the ocean could be nearly 150 percent more acidic than they are now. More-acidic waters also contribute to the bleaching of coral reefs and make it harder for some types of fish to sense predators and for others to hunt prey. Meanwhile, ocean acidification threatens us land-dwellers, too.

Trash in the Ocean The majority of the garbage that enters the ocean each year is plastic—and here to stay. That's because unlike other trash, the single-use grocery bags, water bottles, drinking straws, and yogurt containers, among eight million metric tons of the plastic items we toss (instead of recycle), won't biodegrade. Instead, they can persist in the environment for a millennium, polluting our beaches, entangling marine life, and getting ingested by fish and seabirds.

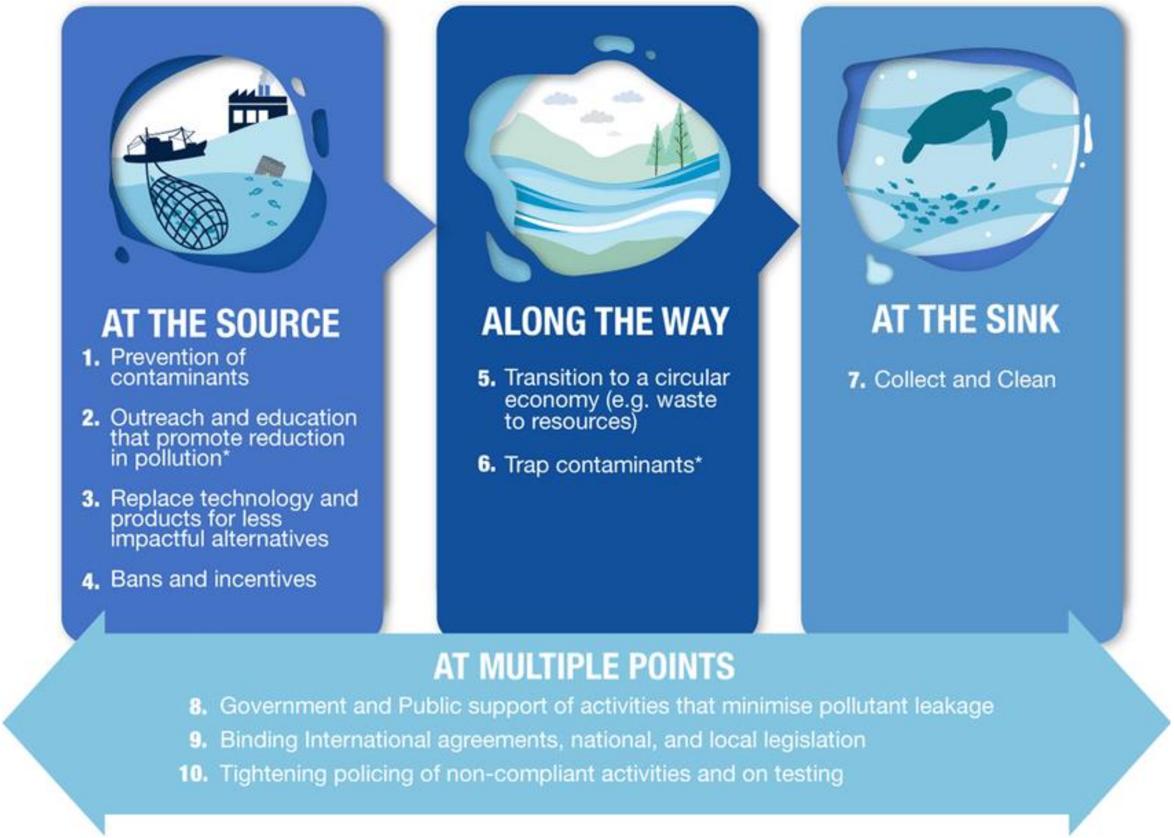
Oil from boats, airplanes, cars, trucks, and even lawn mowers is also swimming in ocean waters. Chemical discharges from factories, raw sewage overflow from water treatment systems, and storm water and agricultural runoff add other forms of marine-poisoning pollutants to the toxic



Ocean Noise The ocean is far from a "silent world." Sound waves travel farther and faster in the sea's dark depths than they do in the air, and many marine mammals like whales and dolphins, in addition to fish and other sea creatures, rely on communication by sound to find food, mate, and navigate. But an increasing barrage of human-generated ocean noise pollution is altering the underwater acoustic landscape, harming—and even killing—marine species worldwide

Offshore Drilling In addition to noise pollution, the oil and gas industry's routine operations emit toxic by-products, release high levels of greenhouse gases, and lead to thousands of spills.

Marine Pollution abatement efforts



London Convention on Marine Pollution

The London Convention or LC-72 is a non-binding treaty which seeks address the problem of deliberate disposal at sea of wastes or other matter from vessels, aircraft, and platforms. But it does not cover discharges from land-based sources such as pipes and outfalls, wastes generated incidental to normal operation of vessels, or placement of materials for purposes other than mere disposal, providing such disposal is not contrary to aims of the Convention.

One regional type of convention is Barcelona Convention, which covers the same problems in the Mediterranean Sea.

International Convention for the Regulation of Whaling

International Convention for the Regulation of Whaling is an international environmental agreement which governs the commercial, scientific, and aboriginal subsistence whaling practices of fifty-nine member nations. It was signed in 1946. By this convention, International

Whaling Commission (IWC) was set up to "provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry".

This organization has been active against the commercial whaling. In 1986, it adopted a moratorium on commercial whaling. This ban still continues. In 1994, it created the Southern Ocean Whale Sanctuary surrounding the continent of Antarctica. Here, the IWC has banned all types of commercial whaling. Only two such sanctuaries have been designated by IWC till date. Another is Indian Ocean Whale Sanctuary by the tiny island nation of the Seychelles.

Wadden Sea Agreement

Wadden Sea is located between the coast of northwestern continental Europe and the range of Frisian Islands. It is a World Heritage site (Dutch and German part) which forms a shallow body of water with tidal flats and wetlands, thus very rich in biodiversity. Wadden Sea is famous for its rich flora and fauna, especially birds such as waders (shorebirds), ducks, and geese. Wadden Sea is protected in cooperation of all three national parks, and cooperation between three countries as follows:

- Schleswig-Holstein Wadden Sea National Park
- Hamburg Wadden Sea National Park
- Lower Saxony Wadden Sea National Park

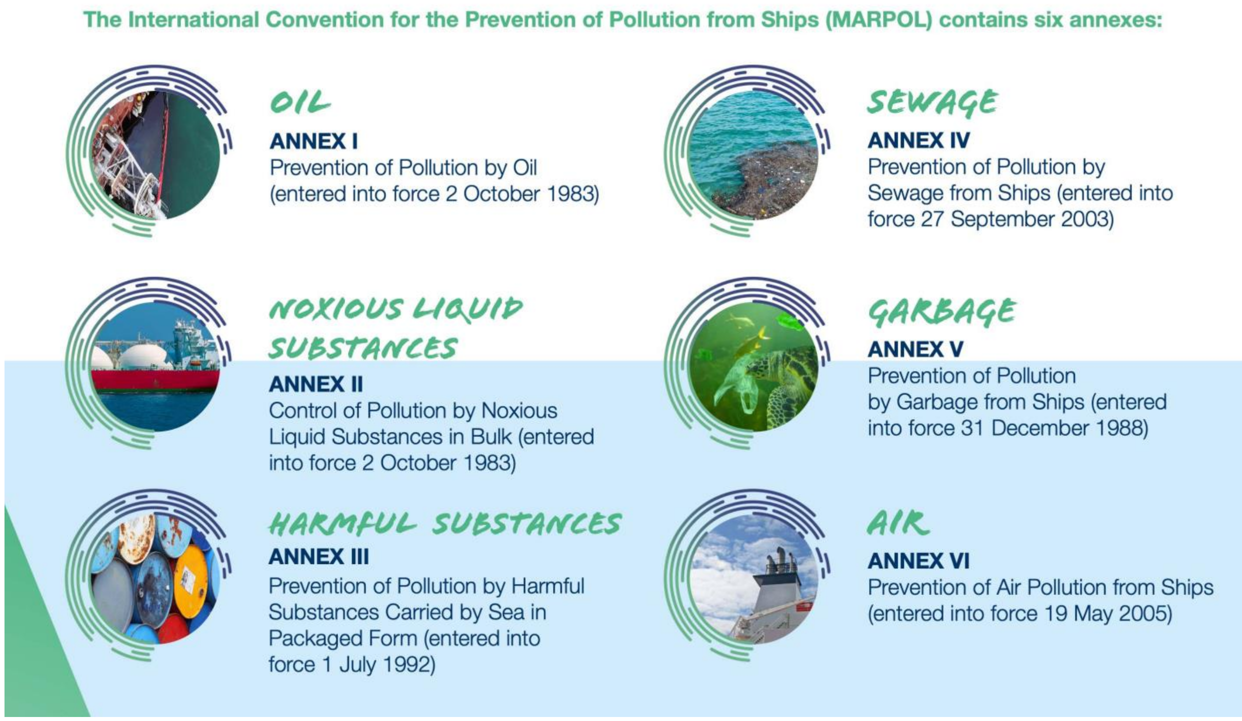
The three countries viz. Netherlands, Germany and Denmark concluded the Wadden Sea Agreement for protection of the Wadden Sea in 1990.

ACCOBAMS

ACCOBAMS refers to "Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area". So, it is cooperation for the protection of Cetaceans in the Black Sea and Mediterranean Sea. It was concluded on the sidelines of Convention on the Conservation of Migratory Species of Wild Animals, in 1996 and came into force in 2001. Currently 21 countries in the Black Sea, Mediterranean Sea and contiguous Atlantic area are parties to this convention.

MARPOL 73/78

MARPOL refers to Marine Pollution. MARPOL 73/78 is the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978. It entered into force on 2 October 1983 and it has 169 parties. It is one of the most important environment conventions on marine pollution and prevents the pollution from Oil Spill, Noxious Liquid Substances carried in Bulk, Harmful Substances carried in Packaged Form, Sewage , Garbage and Air Pollution.



It centers around minimizing the pollution of the seas, including dumping, oil and exhaust pollution. There are 150 countries party to this agreement.

India is a party to MARPOL 73/78. India's enshrined the obligation to inform contravention of provision of MARPOL 73/78 of Merchant Shipping Act 1948

Que. 2 (c) Elaborate multiple barriers that limits distribution of organisms.

Ans. 2(c) Barriers may be defined as the factors which hinder in the normal distribution of animals. These maybe either vast tracts of territory inhospitable to species or narrow bands of environment that may act as narrow fences, preventing species from migration to new regions. For example, Himalaya mountain ranges act as effective barrier between India and Eurasia and does not permit migration of animals from India to Eurasia or vice versa, or a thick forest acts as a barrier for the dispersal of land animals or a desert does not permit the entry and dispersal of forest animals. All the natural barriers to animals migration can be classified into three categories:

Physical barriers:

The physical barriers are high mountain ranges, rivers, lakes and seas which provide obstacles for the dispersal of land animals and land masses for the dispersal of aquatic animals. These can be discussed under the following headings:

Topographical barriers: The high mountain ranges constitute effective topographic barriers, which check the dispersal to terrestrial animals. Their effectiveness increases if the ranges run

parallel to the equator as Himalayan range in India and Alps in Europe. The north of Himalayan range is in the form of high snow-covered mountain peaks, while on the southern side are the hot moist plains of India. The fauna north to Himalayas resembles that of Europe, while to its south is very much similar to that of Africa. Large desert areas, act as great barriers for the dispersal of almost all the land vertebrates. Because of the presence of great desert of Sahara, the flora and fauna of North Africa and South Africa are totally distinct.

Large Bodies of water and Land Masses: Large bodies of water such as giant river systems and oceans act as most effective barriers in the distribution of terrestrial and flightless animals like amphibians, reptiles and mammals. The huge river systems of Amazon and its branches, Brahmaputra and Ganges with their tributaries obstruct the distribution of forest animals. As the water act as barriers to the terrestrial animals, large land masses act as barriers to the aquatic animals both marine as well as freshwater forms. However, powerful swimmers and pelagic forms are not affected by projecting land masses. Even small areas of salt water are nearly absolute barriers to amphibians and fishes.

Impurity and lack of Salinity of sea water: Salinity of oceanic water is almost constant and does not act as an effective barrier for animals' dispersal. The salinity is greatly changed in the areas where rivers enter into the sea and act as a barrier to the littoral animals of the shallow water. The Great Barrier Reef on the east coast of Australia is a well-known barrier which hinders the dispersal of animals.

Vegetation Barriers: Vegetation influences animal distribution and dispersal both directly as well as indirectly. Both presence and absence of vegetation in extremes control the distribution of animals in space. Arboreal animals cannot live and cross areas which are without trees, because trees help them not only in migration from one place to other but also provide food, shelter and protection. For example, primates are abundant in west to North America in Eocene but by the end of Eocene they became extinct due to the replacement of the tropical forest of this region by deciduous forests.

Sheer Distance: Even sheer distance serves as barrier for small sized animals. For example, Dice and Blossom found that seven species of small mammals were sub specifically distinct at Tucson and Yuma, even through there was no barrier to their free dispersal other than distance.

Climatic or Ecological Barriers:

The climatic barriers include all the abiotic factors which control the survival and dispersal of animals. These are:

Temperature: Temperature or thermal extremes on earth are remarkable with lowest recorded temperature of 12F and highest temperature of 56 C. such extremes of temperature variations naturally play on important role in controlling the distribution of animals both cold blooded and warm blooded. The limiting effect is more pronounced on cold blooded animals than on the warm blooded animals. For example, distribution of tigers and elephants is not affected by the change in temperature. Tiger naturally abound in hot districts of India but are also founded in the thick jungles in elevated regions of Altai Mountain chains, Caucasus Hills and Himalayan ranges and even in cold plains of Manchuria but their activities are definitely affected.

Amount of light: Amount of light has indirect effect on animals dispersal since it controls the growth and variety of vegetation.. The sunlight forms a barrrier for nocturnal animals which are unable to sea in daylight.

Moisture: Excess as well as lack of humidity act as barrier for the dispersal of animals. The moisture less climate produces deserts where only those organisms can survive which have developed water retaining devices like theck hide, water bags or water storing contrivances, hygroscopic skin, thorns or spines, etc.

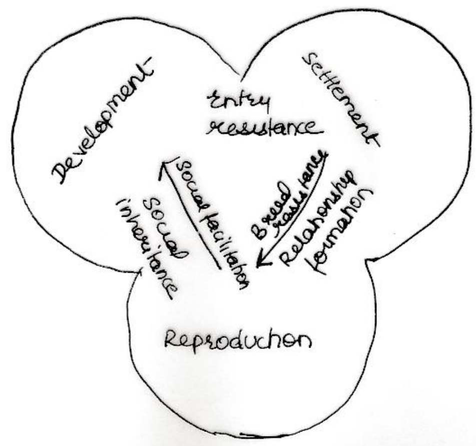
Biological Barriers:

The biological barriers include food and enemies. Certain animals depend upon certain special kind of food. Many kinds of insects are dependent on particular species of plants for their food, shelter and breeding places. Hence, these act as barrier for dispersal of animals.

In addition to all these geographical and biological barriers, several characteristics of animals also tend to limit their dispersal, even in the absence of all other barriers. Some of these can be enumerated as under:

Sedentary Habit: Sedentary habit of animals makes them to aggregate in a particular area only.

Home Range or Territoriality: Animals which have power of locomotion do not like to move out of their particular area which they have already occupied. Rather they preps to stay with their kith and kin. This is known as home range.



The social environment can impose many challenges for animals as they attempt to disperse and reproduce.

The barriers arising from the social environment can generate a difference between where animals can move and where they recruit. We define social resistance as the contribution of the social environment to the difference between physical connectivity and gene flow.

Social resistance can act as a driver of life-history evolution by selecting for strategies that allow individuals to overcome social barriers.

By bridging individual social behaviour and landscape genetics, the social resistance hypothesis allows a greater understanding of the feedback between landscape-level processes and individual-level social behaviour.

Que. 3(a) Explain Allen-Bergmann rules on adaptability of organisms.

Ans.3 (a) The organism, in order to maintain the constancy of its internal environment (a process called homeostasis) despite varying external environmental conditions that tend to upset its homeostasis generates following responses

Regulate: Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc. All birds and mammals, and a very few lower vertebrate and invertebrate species are indeed capable of such regulation (thermoregulation and osmoregulation). Evolutionary biologists believe that the 'success' of mammals is largely due to their ability to maintain a constant body temperature and thrive whether they live in Antarctica or in the Sahara desert. Plants, on the other hand, do not have such mechanisms to maintain internal temperatures.

Conform: An overwhelming majority (99 per cent) of animals and nearly all plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature. In aquatic animals, the osmotic concentration of the body fluids changes with that of the ambient water osmotic concentration. These animals and plants are simply conformers.

Thermoregulation is energetically expensive for many organisms. This is particularly true for small animals like shrews and humming birds. Heat loss or heat gain is a function of surface area. Since small animals have a larger surface area relative to their volume, they tend to lose body heat very fast when it is cold outside; then they have to expend much energy to generate body heat through metabolism. This is the main reason why very small animals are rarely found in polar regions. During the course of evolution, the costs and benefits of maintaining a constant internal environment are taken into consideration. Some species have evolved the ability to regulate, but only over a limited range of environmental conditions, beyond which they simply conform.

If the stressful external conditions are localised or remain only for a short duration, the organism has two other alternatives. **Migrate :** The organism can move away temporarily from the stressful habitat to a more hospitable area and return when stressful period is over. **Suspend:** In bacteria, fungi and lower plants, various kinds of thick walled spores are formed which help them to survive unfavourable conditions – these germinate on availability of suitable environment. They do so by reducing their metabolic activity and going into a date of 'dormancy'. In animals, the organism, if unable to migrate, might avoid the stress by escaping in time. The familiar case of bears going into hibernation during winter is an example of escape in time. Under unfavourable conditions many zooplankton species in lakes and ponds are known to enter diapause, a stage of suspended development

Adaptations

While considering the various alternatives available to organisms for coping with extremes in their environment, we have seen that some are able to respond through certain physiological adjustments while others do so behaviourally (migrating temporarily to a less stressful habitat). These responses are also actually, their adaptations. So, we can say that adaptation is any attribute of the organism (morphological, physiological, behavioural) that enables the organism to survive and reproduce in its habitat. Many adaptations have evolved over a long evolutionary time and are genetically fixed.

Some organisms show behavioural responses to cope with variations in their environment. Desert lizards lack the physiological ability that mammals have to deal with the high temperatures of their habitat, but manage to keep their body temperature fairly constant by behavioural means. They bask in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the ambient temperature starts increasing.

Some species are capable of burrowing into the soil to hide and escape from the above-ground heat

Ecogeographic rules developed by Karl Bergmann and Joel Asaph Allen in the nineteenth century were derived from a geometric evaluation of the most efficient form for maintaining core body temperature under varying thermal conditions. Bergmann's rule states that within a wide ranging morphologically variable homeothermic (warm blooded) species, larger body size variants will be found in the colder parts of the range and smaller variants will be found in the warmer parts of the range. Allen's rule similarly states that in wide ranging homeotherms, the length of appendages (arms, legs, etc.) is shorter in variants from colder climates, while they are longer in those from warmer climates. Several studies comparing populations globally appear to confirm that human morphological variation conforms to Bergmann's and Allen's rules. Fossil hominins appear to follow the rules as well. Results from most but not all physiological functional studies also support the rules.

Bergmann's rule is an ecogeographical rule that states that within a broadly distributed taxonomic clade, populations and species of larger size are found in colder environments, while populations and species of smaller size are found in warmer regions. Although originally formulated in terms of species within a genus, it has often been recast in terms of populations within a species. It is also often cast in terms of latitude. It is possible that the rule also applies to some plants.

The rule is named after nineteenth century German biologist Carl Bergmann, who described the pattern in 1847, although he was not the first to notice it. Bergmann's rule is most often applied to mammals and birds which are endotherms, but some researchers have also found evidence for

the rule in studies of ectothermic species. While Bergmann's rule appears to hold true for many mammals and birds, there are exceptions.

Larger-bodied animals tend to conform more closely to Bergmann's rule than smaller-bodied animals, at least up to certain latitudes. This perhaps reflects a reduced ability to avoid stressful environments, such as by burrowing. In addition to being a general pattern across space, Bergmann's rule has been reported in populations over historical and evolutionary time when exposed to varying thermal regimes. In particular, temporary, reversible dwarfing of mammals has been noted during two relatively brief upward excursions in temperature during the Paleogene: the Paleocene-Eocene thermal maximumand the Eocene Thermal Maximum .

Allen's rule is an eco geographical rule formulated by Joel Asaph Allen in 1877, broadly stating that animals adapted to cold climates have shorter limbs and bodily appendages than animals adapted to warm climates. More specifically, it states that the body surface area-to-volume ratio for homeothermic animals varies with the average temperature of the habitat to which they are adapted (i.e. the ratio is low in cold climates and high in hot climates).

Allen's rule predicts that endothermic animals with the same body volume should have different surface areas that will either aid or impede their heat dissipation.

Because animals living in cold climates need to conserve as much heat as possible, Allen's rule predicts that they should have evolved comparatively low surface area-to-volume ratios to minimize the surface area by which they dissipate heat, allowing them to retain more heat. For animals living in warm climates, Allen's rule predicts the opposite: that they should have comparatively high ratios of surface area to volume. Because animals with low surface area-to-volume ratios would overheat quickly, animals in warm climates should, according to the rule, have high surface area-to-volume ratios to maximize the surface area through which they dissipate heat

To conclude. Mammals from colder climates generally have shorter ears and limbs to minimise heat loss. (This is called the Allen's Rule.) In the polar seas aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces loss of body heat. Some organisms possess adaptations that are physiological which allow them to respond quickly to a stressful situation.

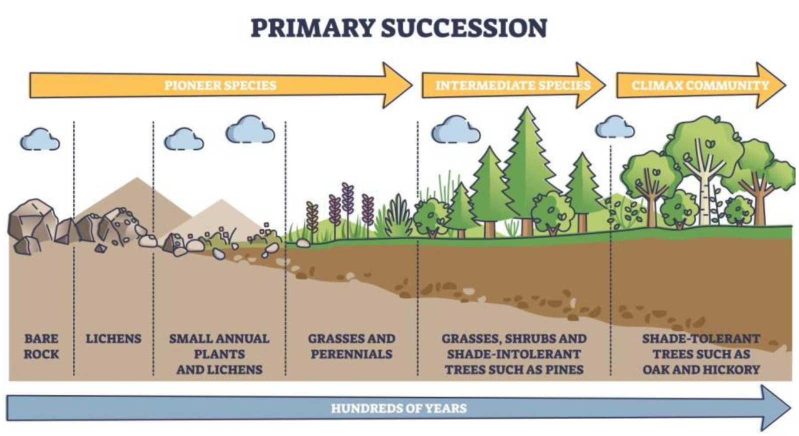
In most animals, the metabolic reactions and hence all the physiological functions proceed optimally in a narrow temperature range (in humans, it is – 370C). But there are microbes

(archaebacteria) that flourish in hot springs and deep sea hydrothermal vents where temperatures far exceed 1000C.

Que. 3 (b) What is meant by Ecological succession? Write the details of aquatic succession.

Ans. 3 (b) The phenomenon of orderly transition from one biotic community to another is called **ecological** or **natural succession**. Natural succession occurs because the physical environment may be gradually modified by the growth of the biotic community itself, such that the area becomes more favourable to another group of species and less favourable to the present occupants. Ecological succession is the process by which natural communities replace (or "succeed") one another over time. For example, when an old farm field in the midwestern U.S. is abandoned and left alone for many years, it gradually becomes a meadow, then a few bushes grow, and eventually, trees completely fill in the field, producing a forest.

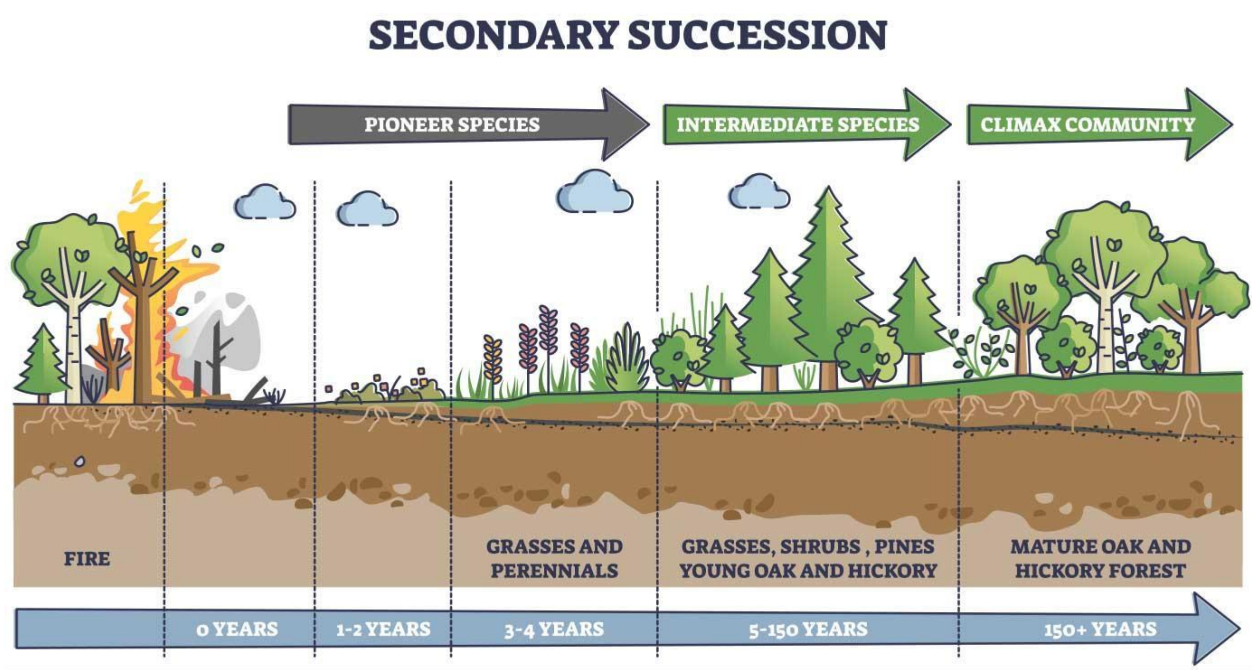
Each plant community creates conditions that subsequently allow different plant communities to thrive. For example, early colonizers like grasses might add nutrients to the soil, whereas later ones like shrubs and trees might create cover and shade. Succession stops temporarily when a "climax" community forms; such communities remain in relative equilibrium until a disturbance restarts the succession process. There are two major types of ecological succession: primary succession and secondary succession.



Primary succession happens when a new patch of land is created or exposed for the first time. This can happen, for example, when lava cools and creates new rocks, or when a glacier retreats and exposes rocks without any soil. During primary succession, organisms must start from scratch. First, lichens might attach themselves to rocks, and a few small plants able to live without much soil might appear. These are known as "pioneer species."

Gradually, the decomposition of those plants contributes to soil formation, and more and larger plants begin to colonize the area. Eventually, enough soil forms and enough nutrients become available such that a climax community, like a forest, is formed. If the site is disturbed after this point, secondary succession occurs.

Secondary succession happens when a climax community or intermediate community is impacted by a disturbance. This restarts the cycle of succession, but not back to the beginning—soil and nutrients are still present.



For example, after a forest fire that kills all the mature trees on a particular landscape, grasses might grow, followed by shrubs and a variety of tree species, until eventually the community that existed before the fire is present again.

Other related types

Autogenic succession: the replacement of one community by the next results from changes in the physical environment that have been produced by the resident organisms. These changes tend to render the site less optimal for the organisms producing the change and more optimal for those organisms that replace them.

Allogenic succession: it occurs when geological processes cause changes in the physical environment, which in turn lead to changes in the biota.

Biogenic succession: it occurs when there is a sudden interference with an autogenic or allogenic succession by a living organism which becomes the major agent of successional change, at least temporally. A sudden change in herbivore pressure on the plant community or the sudden removal of a segment of the plant community by a pathogen could be two good examples.

Although, change in the composition of the biota over time is a fundamental characteristic of all ecosystems, the rate of changes varies widely in different seres and between the different stages of a single sere. In most areas, change does not continue indefinitely. Communities development in which rates of change become exceedingly slow, or in which the composition of the biota remains approximately constant for a long period of time, are called **climax**. These stable communities represent either the final or an indefinitely prolonged stage of a sere.

Succession occurs as the result of either autogenic processes (associated with the living community) or allogenic processes (associated with the physical environment).

Examples of allogenic succession can be observed along the banks of a meandering river in a valley floodplain, where succession starts on recently deposited sandbars. Such examples are less common than the products of autogenic succession, which is the result of three major biotic mechanisms:

Colonization It is a process with two components: invasion and survival. The rate at which a site is colonized depends on both the rate (numbers per unit time) at which individual organisms (seed, spores, immature or mature individuals) arrive at the site, and on their success at becoming established and surviving.

Alteration of the Physical Characteristics of the Ecosystem Occupying the site, a species inevitably changes the site conditions, and the changes are frequently not favorable to the continued occupancy of the site by that species. The changes may either reduce the competitive abilities of the resident species or increase those of the invading species, or both. The net result is the replacement of one group of species by another group.

Displacement of Species by Antibiosis, Autoxicity and Competition. Not only do plants alter the microclimate and the physical and inorganic chemical characteristics of the soil, they also alter their organic chemical environment. The plants produce a wide variety of chemicals to inhibit germination and/or growth of other species (allelopathic substances). In fact, allelopathy may serve to accelerate succession, whereas in others it impedes it.

Rate of Successional Change depend on

The degree of environmental change that must occur before one community can be replaced by another: the greater the change, the more prolonged the stage.

The typical primary **hydrosere or xerosere** involve extensive change. In a xerosere, one starts with a completely unmodified microclimate, and little soil or unconsolidated soil parent material. There is little or no soil moisture storage capacity, nutrient retention capacity or available nutrient capital, therefore the degree of environmental change is enormous. In case of hydrosere, it starts from a nutrient-poor aquatic environment through semiterrestrial condition to a forested condition. The ecological conditions between the start and finish of the sere are enormously different.

The productivity of the organisms and the efficiency with which they produce environmental change: more productive and efficient the organisms, the shorter the duration of the seral stages.

The living community in early xerarch and hydrarch is composed of small organisms that either grow very slowly or are very short-lived and accumulate very little biomass. The extensive ecological changes that are necessary early in xerarch and hydrarch succession are associated with diminutive and frequently slow-growing life forms. Consequently, rates of autogenic succession are very slow in these seral stages.

The situation in mesarch succession is quite different, with very much less environmental alteration involved and a productive, rapidly growing community of plants involved in causing it. Most mesarch seral stages involve a single generation of plants, whereas most xerarch and hydrarch seral stages involve many generations.

The longevity of the organisms dominating each seral stage: the longer lived the organisms, the longer the stage may last.In mesarch succession, the length of a seral stage is partly determined by the longevity of the organisms involved, especially in midseral and subclimax stages. The subclimax Douglas-fir stage in the western hemlock zone of British Columbia can last for many centuries before it is replaced by the climax western hemlock-western red cedar, simply because of the great age reached by Douglas-fir.

The degree to which communities at any particular stage occupy and dominate the site and resist invasion by other species: the better developed the community, the more resistant to invasion and the longer lasting.

Variable combinations of these four determinants of the rate succession and duration of particular seral stages precludes any reliable general statement about rates and durations. Anyway, there are some points to be considered:

- Rates of succession are generally slower in primary than in secondary succession because of the greater degree of environmental alteration that is involved.
- Rates of succession are much faster in mesarch.
- Rates of succession in the earlier stages of xeroseres and hydroseres are slower than in later stages. The opposite is true for mesarch succession.

- The duration of any particular stage will be greatly influenced by the timing and rate of invasion of the site by reproductive propagules of individuals of the subsequent seral stage. Where such invasion is slow or delayed, a seral plant community may become very well stablished, resist invasion and consequently, lasts very much longer than where such invasion is rapid and immediate (relay floristics & initial vegetative composition).

- Succession will be much faster in climates that promote high rates of NPP and biomass accumulation than in climates that limit plant growth.

Aquatic Succession

Another example of natural succession is seen as lakes or ponds are gradually filled and taken over by the surrounding terrestrial ecosystem. This process occurs because of certain quantity of soil particles is inevitably eroded from the land and settles out in ponds or lakes, gradually filling them. Aquatic vegetation produces detritus that also contributes to the filling process. As the buildup occurs, terrestrial species can advance, and aquatic species move farther out into the lake. In short, the shoreline gradually advances toward the center of the lake until, finally, the lake disappears together.

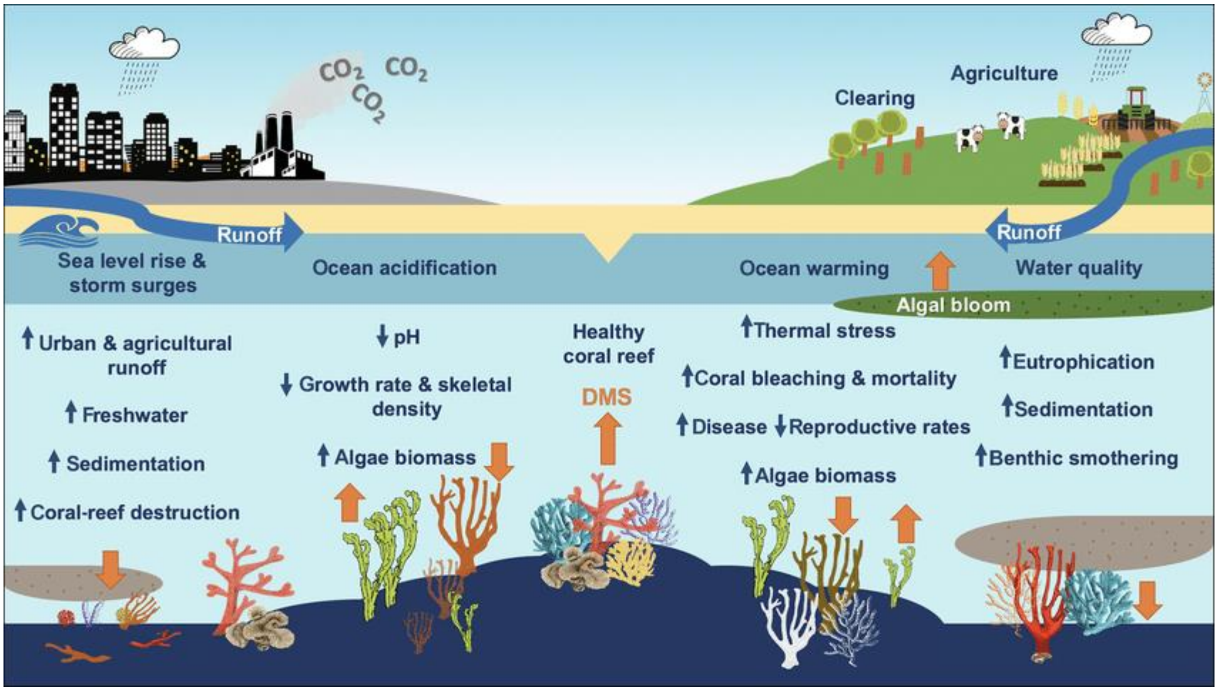
Que. 3 (c) What are the challenges faced by coral reefs? Examine the requirement of coral reef protection

Ans. 3(c) Zillions of coral calcium carbonate skeletons, cemented together over a period ranging from a few thousand to millions of years, have made up such reefs. Corals have a symbiotic relationship with plant-like cells called zooxanthellae. The zooxanthellae provide corals with food through photosynthesis, and in return, the coral provides them with shelter and nutrients. It is these zooxanthellae that give most corals (and therefore, the reefs) their rainbow-like colours. Coral reefs are typically located in tropical oceans near the equator and generally grow at depths shallower than 70 m. They are extremely sensitive temperature; the optimal temperature for them to survive is 23 C – 25 C. The Great Barrier Reef off the coast of Queensland, Australia, is arguably the world’s most well-known coral reef. India too is home to many beautiful coral reefs. The mainland coast of India has two widely separated areas containing reefs: the Gulf of Kutch in the northwest and the Palk Bay and the Gulf of Mannar in the southeast.

Coral reefs are home to an estimated 25 percent of all marine life and have been rightly dubbed as the ‘rainforest of oceans’. Over 4,000 species of fish have been recorded as inhabiting coral reefs. Home to sponges, sea slugs, oysters, clams, crabs, shrimps, sea worms, starfish, sea urchins, sea birds, jellyfish, and sea anemones, each reef in the world is a universe of biodiversity by itself. They form an important source of protein and livelihood for the communities living along coastlines; about 500 million people are believed to have some level of dependence upon coral reefs. They also serve as a barrier against natural disasters such as hurricanes and typhoons. Independent research supported by the World Wildlife Fund (WWF) shows that coral reefs provide annually in net benefits in goods and services to world economies, including, tourism, fisheries and coastal protection.

Challenges to coral reefs

For their survival, coral reefs have to face many challenges. They are fragile ecosystems that have been bearing the onslaught of **coral mining, pollution, diseases, blast fishing, overfishing, rampant tourism, and most recently, climate change.** Corals have been traditionally used as raw material (calcium carbonate) by the cement and lime industry in India. Extensive areas were leased by the Indian government for coral mining. Black corals have traditionally been made into amulets, worn to ward off the evil eye and illnesses.. Although trade has mainly focussed on species that are in huge demand by the jewellery sector. Corals are easily damaged by pollution. Sewage discharge into the waters that are home to corals in the inhabited Lakshadweep Islands has wreaked havoc on the reefs. The increased sedimentation, nutrients, toxins, and the introduction of pathogens disturb the ecological balance of the reefs and eventually destroy them.



Tourism-derived damage is caused by trampling of corals by snorkelers and divers. Heavy boat anchors can smash even the sturdiest corals. Anchor chains and lines have been known to scrape coral and wrap around them, breaking off pieces of coral colonies as the boats sway back and forth and pull on the line.

Perhaps one of the greatest threats to coral reefs is the **aquarium trade**. Recent decades have recorded a dramatic rise in the export of both live and dead coral reef fish. Parrotfishes from the Seychelles and Persian Gulf are now sold by fish retailers in London. The unprecedented demand for live reef fish looked on as ornamentals in home aquariums is alarming.. Herbivores fishes, including three groups – bio-eroders, scrapers, and grazers – play different and complementary roles in ensuring healthy coral reefs, but they constitute a large component of the live fish trade today. Bio-eroders, like the parrotfish, remove dead corals, exposing the hard, reef matrix for the settlement, growth, and survival of coralline algae and corals.

Globally, the main factor attributing to the death of coral has been '**coral bleaching'**. During such episodes, the sea surface temperature in the tropics rises by 1 C – 2 C above the seasonal maximum, which is enough to stress the corals. They expel all or some of their colour-providing zooxanthellae, which leads to a lighter or completely white appearance; hence the term 'bleached'.

Certain coral reefs survive partially and go on to make good recoveries after some time, while others are permanently wiped out. Not enough is known about what factors contribute to good recoveries (i.e. a flip over from 'dead cover' to 'live cover'), but maintaining 'no-take areas' (where fishing and other human activities are prohibited) appears to allow Mother Nature enough time to get back on her feet. The timescale for natural recovery of reefs from major coral loss, such as the mass bleaching and mortality experienced in the Indian Ocean in 1998, appears to be at least 10 years. However, even the largest 'no-take areas' in the world are not self-sustaining, because they are too small relative to the scale of natural and human disturbances, and to the dispersal distances of many larvae and migrating adults. Most no-take areas are a few square kilometres or less in size, and they are invariably surrounded by vastly larger areas that are often already badly degraded.

It is particularly alarming that models based on the Intergovernmental Panel on Climate Change's Scenario (doubling of atmospheric carbon dioxide levels by 2100) predict that the temperature tolerances of reef-building corals will exceed permanently within the next few decades. What does this mean for the reefs and their human dependents?

In order, to conserve coral reefs, it is vital to have an understanding of the ecology of the coral reefs, and by extension, the relationship between local populations, and reef resources.

Dealing with the coral conundrum

Many studies have been spurred by the latest global coral bleaching episodes and loss of fisheries, leading to significant discoveries that may help coral reef conservation.

The Coral Reef Degradation in the Indian Ocean (CORDIO) project, a collaborative programme involving researchers from 11 countries in the central and western Indian Ocean, has aimed to fill in the missing pieces of the coral reef data puzzle. The CORDID project believes that understanding ecological processes (such as herbivory and bio-erosion) and not just static measures such as coral cover and biomass. Connectivity of coral reefs through ocean currents and coral larval dispersal will fundamentally affect the recovery and survival of coral reefs. Therefore, we need to think of broad scale projects that are replicable on a region-wide basis and not just small-scale research at individual study sites.

CORDIO has also established research projects on alternative livelihoods for subsistence fishermen. Multiple threats have already reduced fisheries productivity and the ecological health of many reefs in the region, with climate change-induced degradation adding to the unpredictability. Against this background, project proposals have been written in a number of areas, such as investigating fishing community household production systems and accessible options for alternatives and development of small-scale mariculture of fish and crabs.

Coral transplantation

Coral transplantation is a fairly new idea in this field. About two decades ago, the well-established scientific field of terrestrial forestation led scientists to propose a new coral reef restoration concept, deriving its rationale from silviculture. This concept involves two steps: rearing coral 'seedlings' in specially designed nurseries to plantable size; and then, transplanting the seedlings in damaged coral reef areas. The key lesson is that the cost of active rehabilitation of coastal habitats is substantial and likely to be far more than the costs of implementing effective protection of the habitat that may in time allow natural recovery.

Que. 4 (a) What are the identified causes of human impact on ecology?

Ans. 4 (a) Every organism is adapted to live in a certain habitat. If a habitat is altered or destroyed, the organisms adapted to that habitat must either find a new habitat or die. If a species is generalized, it may be able to occupy another niche. Specialized species almost always die with their habitats. The disappearance of a species from all or part of the species' geographical range is called **extinction**.

When the last population of a species dies, some diversity in the ecosystem is lost. Variety of species in an ecosystem is known as biodiversity. Because the extinction of a species affects factors such as the flow of energy and matter and the habitats of other organisms, a loss in biodiversity can upset the balance, health, and stability of an ecosystem.

Extinction

Extinctions are a natural part of ecosystem function. More than 99 percent of the species that have lived on Earth are extinct today. All ecosystems change, and niches appear and disappear with these changes. Species that lack adaptations for survival in a changing ecosystem become extinct. Other species may evolve to fill new niches or empty niches left by extinct species. The rates of species extinction and species appearance are not constant. The rate of extinction and evolution of families of animals since the Cambrian period is never zero. Relatively short periods of time in which many species die are called mass extinction. Mass extinctions are typically followed by rapid evolution as the few organisms that survive evolve to fill vacant niches. Earth may currently be experiencing another mass extinction. The activities of one species – humans – are causing many other species to become extinct each year.

It is estimated that the current rate of species extinction is between 1,000 and 100,000 times more rapid than the average rate during the last several billion years. The growth of human populations, consumption levels, and mobility is the root of most of the serious threats to biodiversity today.

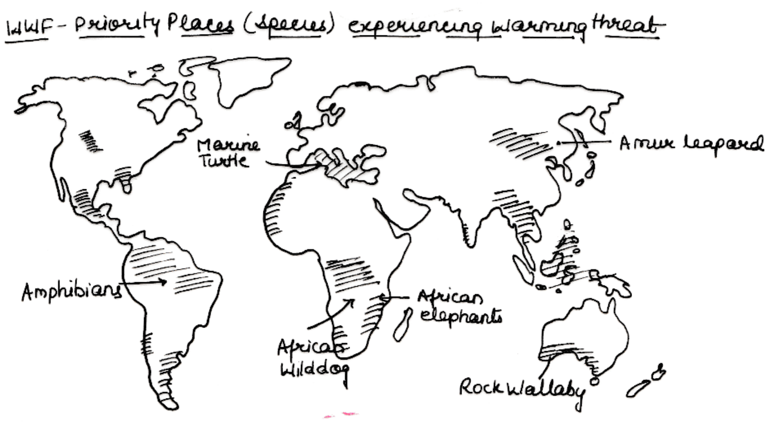
The state of the earth's species (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

- Two species of vertebrate, animals with a back bone, have gone extinct every year, on average, for the past century.
- Currently around 41 per cent of amphibian species and more than a quarter of mammals are threatened with extinction.
- There are an estimated 8.7 million plant and animal species on our planet and about 86 percent of land species and 91 percent of sea species remain undiscovered.

- Of the ones we do know, 1,204 mammal, 1,469 bird, 1,215 reptile, 2,100 amphibian, and 2,386 fish species are considered threatened.
- Also threatened are 1,414 insect, 2,187 mollusk, 732 crustacean, 237 coral, 12,505 plant, 33 mushroom, and six brown algae species.
- The global populations of 3,706 monitored vertebrate species - fish, birds, mammals, amphibians, and reptiles - declined by nearly 60 per cent from 1970 to 2012.
- More than 25,000 species of 91,523 assessed for the 2017 'Red List' update were classified as 'threatened'.
- Of these, 5,583 were 'critically' endangered, 8,455 'endangered', and 11,783 'vulnerable'.

The negative impacts of humans on biodiversity are due to,

H.I.P.P.C.O.



There are many threats to biodiversity today. The biggest ones can be remembered by using the acronym H.I.P.P.C.O.: **H**abitat Loss, **I**nvasive Species, **P**ollution, Human **P**opulation,Climate change and **O**verharvesting.

Habitat Loss

This occurs when a particular area is converted from usable to unusable habitat. Industrial activities, agriculture, aquaculture, mining, deforestation, and water extraction are all central causes of habitat loss. This includes deforestation for wood for cooking food. Habitat fragmentation, the loss of large units of habitat, is also a serious threat to biodiversity.

Invasive Species

When an animal, plant, or microbe moves into a new area, it can affect the resident species in several different ways. New species can parasitize or predate upon residents, hybridize with them, compete with them for food, bring unfamiliar diseases, modify habitats, or disrupt important interactions. One famous and striking example of an invasive species is the brown tree snake in Guam. Native to Australia, the snake was accidentally transported to Guam in ship cargo following World War II. Because Guam had basically no predators to keep the snake population in check, it rapidly multiplied and caused the extirpation of most of the resident bird species. *Extirpation* means extinction within a region: the species survives elsewhere, but not in that region.

Pollution

The discharge of toxic synthetic chemicals and heavy metals into the environment has a huge impact on species abundance and can lead to extinctions. It's important to remember that substances that are "natural" can become pollution when they are too abundant in a certain area. For example, nitrogen and phosphorous are important nutrients for plant growth, but when they concentrate in water systems after being applied as agricultural fertilizers, they can cause "dead zones" that are uninhabitable for fish and other wildlife. Also, carbon dioxide is a "natural" component of the atmosphere but is considered a pollutant when emitted by human industrial activities.

Bioaccumulation is an important concept connected with pollution. This is the process of chemicals becoming increasingly concentrated in animal tissues as they move up the food chain. Killer whales provide an example of how bioaccumulation can be a serious problem for biodiversity, and especially for marine mammals. Many agricultural and industrial chemicals are persistent organic pollutants (POPs), which do not seem to cause biological damage at very low concentrations. However, these POPs are easily incorporated into organisms like bacteria, phytoplankton, and other invertebrates at the bottom of marine food chains. As those organisms are eaten by fish, and fish are eaten by marine mammals, the POPs move up the food chain. If a killer whale eats 100 king salmon, she incorporates all the POPs that were in those salmon into her body tissues, meaning that over time the concentrations of POPs in her body can become quite high. At these higher concentrations, many POPs have been shown to cause disruptions to hormone levels and immune systems, and increase birth defects. Anything that eats high on the food chain (such as humans!) is at risk of impacts from bioaccumulation of toxins.

Human Population In the year 1800, there were fewer than 1 billion people on earth, and today there are about 6.8 billion. Even without the vast increases in per capita resource use that have occurred during this period, the pressures on biodiversity would have increased during this time period simply based on population growth. While the impacts that each human has on biodiversity varies widely depending on the types and amounts of resources that he or she uses (as in the I=PAT equation), overall, increasing populations have lead to increasing threats to biodiversity.

Overharvesting This includes targeted hunting, gathering, or fishing for a particular species as well as incidental harvesting such as by catch in ocean fisheries. The mega fauna extinction example earlier was an example of overharvesting causing biodiversity loss.

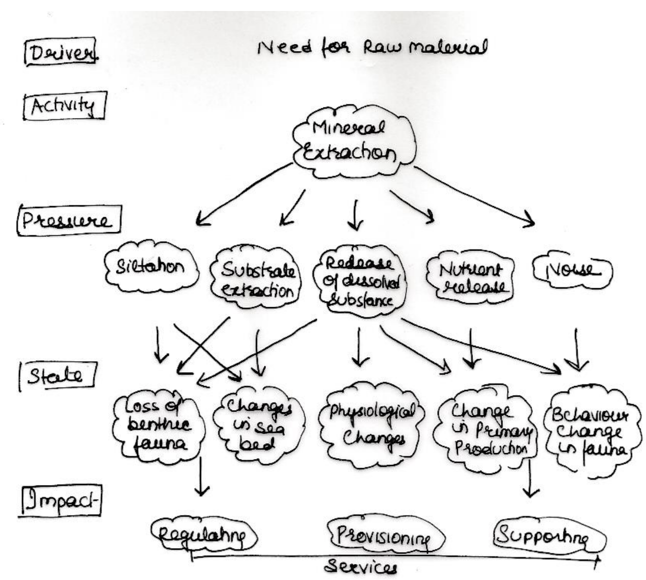
Ocean fisheries have been particularly vulnerable to overharvesting during the post-WWII period because of technological developments like refrigeration, sonar, larger nets, and onboard processing. The cod fishery in the Northwestern Atlantic Ocean was an important commercial fishery for hundreds of years, but only a few decades of intense harvesting using these new technologies in the late twentieth century led to a population collapse. The population declined by over 90%, and fishing for the species was closed in both Canada and the United States. The loss of a top predator like cod, along with reductions of other top predator fish populations like haddock and flounder, has led to an explosion in prey fish populations like herring, capelin and shrimp.

Climate Change and Biodiversity Loss

climate change is impacting ecosystems in several ways, including via temperature shifts. These shifts are making it difficult or even impossible for many species to survive. As the climate changes more and more, biodiversity will face ever greater threats. Likewise, efforts to conserve biodiversity will face ever greater challenges. Indeed, some are starting to speak about *conservation triage* as a situation in which not all species can be saved, forcing conservationists to decide which species to protect. This use of the term *triage* is adapted from its use in medical crises, such as in emergency response to natural disasters.

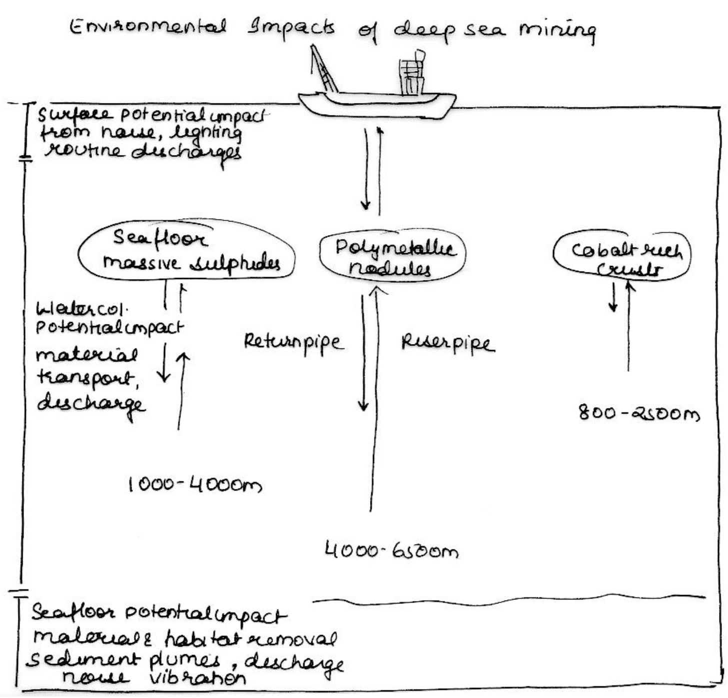
Qus. 4 (b) Explore the likely impacts of mobilized benthic mining.

Ans. 4 (b) The commercial exploitation of deep-sea mineral resources has not started yet. However, in the last 15 years, interest in exploration for and exploitation of these resources has greatly increased Currently, there are four major resource types that are being considered for commercial exploitation from habitats deeper than 200 m depth: manganese nodules, cobalt-rich crusts, seafloor massive sulphides and phosphorite nodules. Each of these resources is found in a specific habitat with particular geochemical and biological characteristics, which will define the significance of the mining impact and the ecosystem recovery potential. Each of these mineral resources, their associated ecosystems and main expected impacts and recovery potential form mining activities are as-



Manganese Nodules are poly metallic concretions made of manganese and iron sulphides which form by precipitation from the ambient sea-water over millions of years. Manganese nodules are rich in manganese, copper, cobalt and nickel and are found on abyssal plains, particularly in the Pacific Ocean. The sediments support rich communities of with larger animals such as holothurians, sea urchins, sea stars, polycahetes and octocorals also present, but in lower abundance. The nodules are colonised by large single-celled foraminifera. The processes in these abyssal plains are very slow, with very slow sedimentation rates and very weak bottom currents. Additionally, nodules are formed at geological-time scales. Thus, the recovery and recolonization of these ecosystems will be extremely slow and not at the ecological time-scales that mining-licenses will operate, making robust spatial management plans more valuable than possible restoration measures.

Cobalt-Rich Ferromanganese Crusts form by precipitation from the seawater over millions of years over all rocky surfaces free of sediment in the deep oceans. Potentially exploitable crusts are found on the flanks of seamounts, knolls and ridges at depths of 800–2500 m. These crusts are rich in cobalt, nickel and platinum. Although little is known of the fauna specifically on cobalt-rich crusts (in comparison to that of seamounts), these geomorphological structures provide substrate for a variety of sessile filter feeders, such as corals and sponges, and other motile fauna including crustaceans and echinoderms. **Seafloor Massive Sulphides** (SMS) form through the precipitation of metals from the fluids at hydrothermal vents, typically at depths between 1000 and 3000 m. SMS are sources of copper, gold, silver, zinc and lead. Vent communities are characterised by very high abundances and biomass of highly adapted species, with a high degree of endemism, supported by microbial chemoautotrophy .



These systems are very dynamic and subjected to sporadic volcanic eruptions, particularly in fast-spreading ridges, as well as changes in the activity of individual chimneys and sources of diffuse flow. There are two scientifically documented cases where naturally impacted vent communities from volcanic eruptions recovered one decade after the eruption. However, these processes took place in fast-spreading ridges, while the major SMS identified to date are on slow-spreading ridges, which are much less dynamic systems. The recovery of such ecosystems from mining depends, thus, on the habitat itself, as well as on the availability of larvae, juveniles or mobile adults from intact populations that are able to disperse to and colonise the new vents systems post-mining. However, mining will add on to the existing

natural loss of critical habitat, and cumulative impacts may result in significant changes in the abundance and distribution of vent species. Because of the rarity of active hydrothermal vent systems, their unique fauna and the challenges of identifying representative systems for area-based management, it has been proposed that active hydrothermal vents are protected legally from direct and indirect mining impacts.

Phosphorite Nodules are formed from limestone deposits following chemical reactions in areas with upwelling and high surface productivity on upper continental slopes (200–400 m). Phosphorite nodules contain products used to make phosphate fertiliser and they have recently been explored off New Zealand and Namibia. In these regions, the dominant fauna includes echinoderms, galatheid crabs, sponges, corals and bryozoans, and abundant amphipods in the sediment. However, the impacts of potential mining of the mineral resources on the upper continental margin have been little investigated.

Impacts of Deep-Sea Mining

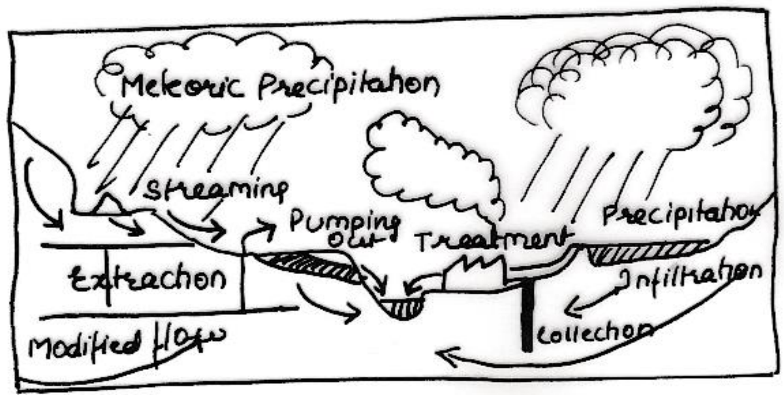
The main impacts of deep-sea mining on the seafloor include the depletion or physical damage to the habitat and fauna by the mining equipment, changes in seafloor topography and geochemical characteristics, creation of sediment plumes and potential toxicity from metal and/or process chemicals release.

Additionally, light and noise may be an issue for deep-water fauna and sediment plumes may impact pelagic life, including larvae and juveniles. These processes will affect the composition, structure and functioning of the faunal communities in different ways depending on the ecosystem considered. For example, mining manganese nodules at abyssal plains, where processes such as nodule formation and sedimentation are extremely slow (millennia), will have a very significant and long-lasting impact on the ecosystem.

Que. 4 (c) What is the relation between economic geology and environment?

Ans. 4 (c) Mining, viz **economic geology** can yield a range of benefits to societies, but it may also cause conflict, not least in relation to above-ground and sub-surface land use. Similarly, mining can alter environments, but remediation and mitigation can restore systems. Boreal and Arctic regions are sensitive to impacts from development, both on social and environmental systems. Native ecosystems and aboriginal human communities are typically affected by multiple stressors, including climate change and pollution, for example.

Mining can also have positive and negative impacts on humans and societies. Negative impacts include those on human health (e.g. and living standards, for example. Mining is also known to affect traditional practices of Indigenous peoples living in nearby communities, and conflicts in land use are also often present, as are other social impacts including those related to public health and human wellbeing.



In terms of positive impacts, mining is often a source of local employment and may contribute to local and regional economies . Remediation of the potential environmental impacts, for example through water treatment and ecological restoration, can have positive net effects on environmental systems . Mine abandonment, decommissioning and repurposing can also have both positive and negative social impacts. Examples of negative impacts include loss of jobs and local identities , while positive impact can include opportunities for new economic activities , e.g. in the repurposing of mines to become tourist attractions.

Mining activities, including prospecting, exploration, construction, operation, maintenance, expansion, abandonment, decommissioning and repurposing of a mine can impact social and environmental systems in a range of positive and negative, and direct and indirect ways.

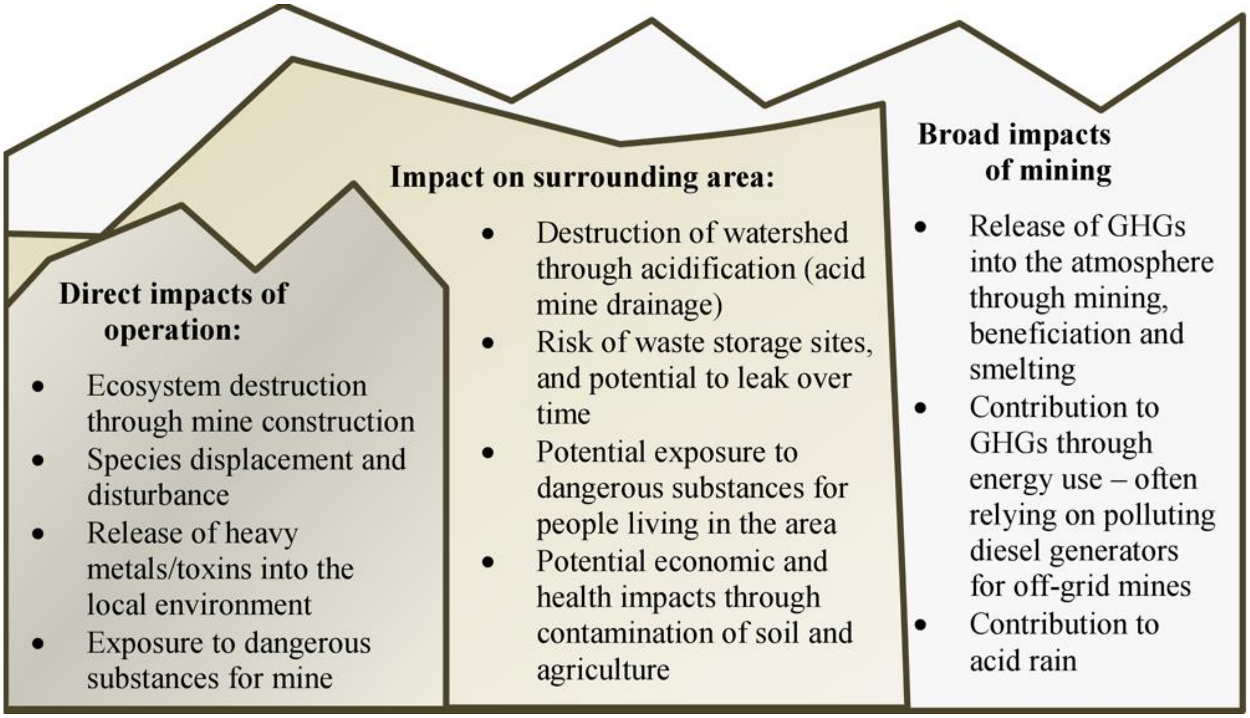
Mine exploration, construction, operation, and maintenance may result in land-use change, and may have associated negative impacts on environments, including deforestation, erosion, contamination and alteration of soil profiles, contamination of local streams and wetlands, and an increase in noise level, dust and emissions.

Mine abandonment, decommissioning and repurposing may also result in similar significant environmental impacts, such as soil and water contamination

Beyond the mines themselves, infrastructure built to support mining activities, such as roads, ports, railway tracks, and power lines, can affect migratory routes of animals and increase habitat fragmentation.

Mining in the Arctic

Boreal and Arctic regions are sensitive to impacts from mining and mining-related activities , both on social and environmental systems: these northern latitudes are often considered harsh and thus challenging for human activities and industrial development. However, the Arctic is home to substantial mineral resources and has been in focus for mining activities for several 100 years, with a marked increase in the early 20th century and intensifying interest in exploration and exploitation in recent years to meet a growing global demand for metals . Given the region's geological features and society's need for metals, resource extraction is likely to dominate discourse on development of northern latitudes in the near future. As of today, there were some 373 mineral mines across Alaska, Canada, Greenland, Iceland, The Faroes, Norway (including Svalbard), Sweden, Finland and Russia , with the top five minerals being gold, iron, copper, nickel and zinc.



Environmental Effects

Environmental issues can include erosion, formation of sinkholes, loss of biodiversity, and contamination of soil, groundwater and surface water by chemicals from mining processes. In some cases, additional forest logging is done in the vicinity of mines to create space for the storage of the created debris and soil. Contamination resulting from leakage of chemicals can also affect the health of the local population if not properly controlled. Extreme examples of pollution from mining activities include coal fires, which can last for years or even decades, producing massive amounts of environmental damage.

Waste

Ore mills generate large amounts of waste, called tailings. These tailings can be toxic. Tailings, which are usually produced as a slurry, are most commonly dumped into ponds made from naturally existing valleys. These ponds are secured by impoundments (dams or embankment dams). Subaqueous tailings disposal is another option. The mining industry has argued that submarine tailings disposal, which disposes of tailings in the sea, is ideal because it avoids the risks of tailings ponds; although the practice is illegal in the United States and Canada, it is used in the developing world.

The waste is classified as either sterile or mineralised, with acid generating potential, and the movement and storage of this material forms a major part of the mine planning process. When the mineralised package is determined by an economic cut-off, the near-grade mineralised waste is usually dumped separately with view to later treatment should market conditions change and it becomes economically viable.

Mitigation measures

'Mitigation measures' (as described in the impact assessment literature) are implemented to avoid, eliminate, reduce, control or compensate for negative impacts and ameliorate impacted systems . Such measures must be considered and outlined in environmental and social impact assessments (EIAs and SIAs) that are conducted prior to major activities such as resource extraction . Mitigation of negative environmental impacts in one system (e.g. water or soil) can influence other systems such as wellbeing of local communities and biodiversity in a positive or negative manner . A wide range of technological engineering solutions have been implemented to treat contaminated waters (e.g. constructed wetlands , reactive barriers treating groundwater , conventional wastewater treatment plants). Phytoremediation of contaminated land is also an area of active research .

Mitigation measures designed to alleviate the negative impacts of mining on social and environmental systems may not always be effective, particularly in the long-term and across systems, e.g. a mitigation designed to affect an environmental change may have knock on changes in a social system. Indeed, the measures may have unintentional adverse impacts on environments and societies. To date, little research appears to have been conducted into itigation measure effectiveness, and we were unable to find any synthesis or overview of the systems-level effectiveness of metal mining mitigation measures.

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Way forward After mining finishes, the mine area must undergo rehabilitation. Waste dumps are contoured to flatten them out, to further stabilise them. If the ore contains sulfides it is usually covered with a layer of clay to prevent access of rain and oxygen from the air, which can oxidise the sulfides to produce sulfuric acid, a phenomenon known as acid mine drainage. This is then generally covered with soil, and vegetation is planted to help consolidate the material. Eventually this layer will erode, but it is generally hoped that the rate of leaching or acid will be slowed by the cover such that the environment can handle the load of acid and associated heavy metals. There are no long term studies on the success of these covers due to the relatively short time in which large scale open pit mining has existed. It may take hundreds to thousands of years for some waste dumps to become "acid neutral" and stop leaching to the environment. The dumps are usually fenced off to prevent livestock denuding them of vegetation. The open pit is then surrounded with a fence, to prevent access, and it generally eventually fills up with ground water. In arid areas it may not fill due to deep groundwater levels.

The Sustainable Development Goals

- SDG 6 relates to water pollution and the release of hazardous chemicals, the treatment of wastewater and efficiency of water use.
- SDG 8 promotes inclusive and sustainable economic growth and employment.
- SDG 9 promotes the safe management of industrial installations to make them sustainable.
- SDG 12 encourages the shift to more sustainable consumption and production patterns, structured over eight targets. This includes the use of natural resources and the integration of sustainable practices into production processes.
- SDG 13 requires that countries and the international community take urgent action to strengthen resilience and combat climate change and its impact.
- SDG 14 (Life below water) and 15 (Life on land) are connected to mining's impact on biodiversity.
- SDG 16 ensures participatory decision making by involving the public in discussions related to the prevention of, and preparedness for, hazardous activities.

Que. 5 (a) What are the components of Integrated Forest Management System?

Ans. 5(a) The National Forest Policy aims for 33% of the country's geographical area under the forest cover for ecological and environmental security. While aiming to expand the forest cover in the country, it is equally important to improve the state and quality of existing forests and protect them against various threats and drivers of degradation. The threats to forests include encroachments, forest fires, illicit felling for timber and firewood, grazing, diseases and incursion of weeds and other invasive species, etc.

With a view to minimizing fire hazards and controlling forest fires a Centrally Sponsored Scheme "Integrated Forest Protection Scheme" was launched. The Integrated Forest protection Scheme (IFPS) has been revised and renamed "Intensification of Forest Management Scheme" (IFMS). The components of the scheme included forest fire control and management, survey, demarcation and preparation of working plans, strengthening of infrastructure such as roads, camp offices, watch towers, improved mobility, providing fire arms and use of modern information and communication technology etc.

The funding pattern is on cost sharing basis for N-E States including Sikkim and special category States Himachal Pradesh, Jammu & Kashmir & Uttarakhand, the Central Share is 90% and the State's Share is 10%. For rest of the states the Central Share is 75% and State's Share is 25%.

During the 12th Plan Period Intensification of Forest Management Scheme (IFMS) and National Afforestation Program remained under a new scheme called Afforestation & Forest Management. The Provision for procurement of Arms and Ammunitions is made under this Scheme in which the Ministry of Environment and Forests provides financial assistance in the form of grants-in-aid to State/Union Territory Governments for strengthening of infrastructure and protection machinery according to the proposal received from them.

Main components of Intensification of Forest Management Scheme (IFMS) are:

1. **Forest Fire Control & Management**: Creation of fire-lines, Construction of watch towers, and Engagement of firewatchers and assistance to Joint Forest Management Committees (JFMC)
2. **Strengthening of Infrastructure:** Construction of field offices, transit camps, inspection huts, forest roads and provision for field vehicles, computers, GIS and other equipments including arms and ammunitions.
3. **Survey, Demarcation and Working Plan Preparation:** Field survey, boundary demarcation, enumeration, Purchase of Material for working plan preparation and Purchase of equipment for survey and enumeration (GPS etc).

4. **Protection and conservation of Sacred Groves:** Inventorization of the Sacred Groves in each State/UT, Cultural operations including weeding, bush cutting, ANR, soil moisture conservation works and Research/ studies and other miscellaneous works.
5. **Conservation and Restoration of Unique Vegetation & Ecosystem:** Inventorization of the resources and Research & Development studies to develop protocols to improve its regeneration, mass multiplication, specific studies related to trade, policy and support for various cultural operations.
6. **Control and Eradication of Forest Invasive Species:** Providing assistance to the State/ UT Forest Department and their research organizations for carrying out studies and research on Forest Invasive Species, and their control and management. The Studies and research include activities such as survey, surveillance, biological studies, field control trials, etc.
7. **Preparedness for Meeting Challenges of Bamboo Flowering and Improving Management of Bamboo Forests:** The activities under this component would include- support to the State/UT Forest Department and to their research institutions for carrying out studies, research, surveillance and survey of the bamboo areas and in the event of detection of flowering (gregarious/ sporadic). In addition to this it aims to improve the management of bamboo areas for removing decongestion, improving clump/ Culm quality, gap planting, use of quality planting material, etc.

Que. 5 (b) Chronology of growth of environment education

Ans. 5 (b) Environmental Education (EE) connects us to the world around us, teaching us about both natural and built environments. EE raises awareness of issues impacting the environment upon which we all depend, as well as actions we can take to improve and sustain it. Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions.

The components of environmental education are:

- Awareness and sensitivity to the environment and environmental challenges
- Knowledge and understanding of the environment and environmental challenges
- Attitudes of concern for the environment and motivation to improve or maintain environmental quality
- Skills to identify and help resolve environmental challenges
- Participation in activities that lead to the resolution of environmental challenges

Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills.

Chronology of growth of environment education

United Nations Conference on the Human Environment, byname Stockholm Conference, the first United Nations (UN) conference that focused on international environmental issues. The conference, held in Stockholm, 1972, reflected a growing interest in conservation issues worldwide and laid the foundation for global environmental governance. The final declaration of the Stockholm Conference was an environmental manifesto that was a forceful statement of the finite nature of Earth's resources and the necessity for humanity to safeguard them. The Stockholm Conference also led to the creation of the United Nations Environment Programme (UNEP) in December 1972 to coordinate global efforts to promote sustainability and safeguard the natural environment.

The World Summit on Sustainable Development (WSSD) was held in Johannesburg in 2002 to review progress since the Rio conference in 1992, and to agree a new global deal on sustainable development. Unlike its predecessor, it was primarily concerned with implementation rather than with new treaties and targets, although a number of new targets were agreed, for example one on sanitation. Failure to agree a target on renewable energy was regarded as a major disappointment of the conference. Climate change is the big environmental problem that humanity will face over the next decade, but it isn't the only one.

The third decade of the 21st century has begun and the environmental challenges we have ahead of us, set out in the UN's 2030 Agenda for Sustainable Development, are many. This global plan of action adopted in 2015 puts forward specific measures to achieve a world that is fairer, more prosperous and more respectful of the environment within ten years. In this regard, the UN itself warns that we are running late, and the question now is whether we still have time to save the planet. The main global environmental problems which the UN says we must resolve this decade: ***climate change mitigation and adaptation, pollution problems and their effect on health, protecting the oceans, the energy transition and renewable, a sustainable food model, protecting biodiversity, sustainable urban development and mobility, hydric stress and water scarcity, extreme meteorological phenomena, overpopulation and waste management***

Environmental education, properly understood, should constitute a comprehensive lifelong education, one responsive to changes in a rapidly changing world. It should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving life and protecting the environment with due regard given to ethical values.

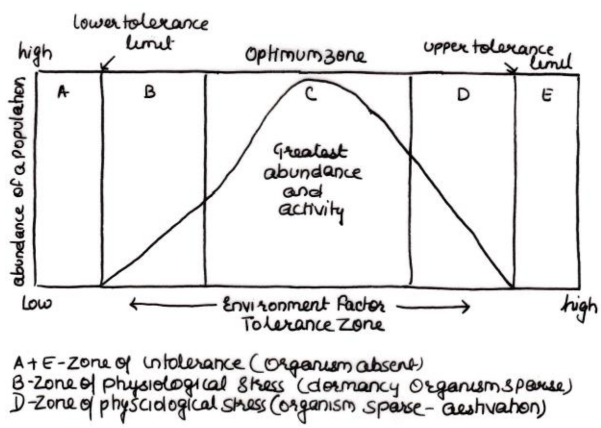
Que. 5(c) Briefly explain the limits of tolerance.

Ans. 5 (c) Ecology at the organism level is essentially physiological ecology which tries to understand how different organisms are adapted to their environments in terms of not only survival but also reproduction. Abiotic factors are any non-living things in an environment. Examples of abiotic factors are sunlight, water, soil, temperature and precipitation. These factors affect ecosystems in different ways. Plants need sunlight to undergo photosynthesis so they can provide food for themselves. The plants are then eaten by other organisms for energy. Where plant species are located is dependent on temperature, precipitation, and sunlight. All of the living organisms also need water to continue to survive. Sometimes, human activities can disrupt abiotic factors and cause change in environments.

Every species is able to survive within a range of each abiotic factor, which is called a tolerance range. Every species has a tolerance range for every abiotic factor. When an organism nears the upper and lower limits of tolerance, it will begin to experience stress. This will lower their health and rate of growth and reproduction. The organisms in the optimum tolerance range are the best adapted. The chart on the left shows how the number of organisms varies depending on what level of tolerance they are at. *The key elements that lead to much variation in the physical and chemical conditions of different habitats* are temperature, water, light and soil(abiotic) and also – pathogens, parasites, predators and competitors – of the organism with which they interacts constantly(biotic components)

Optimum, Zones of Stress, and Limits of Tolerance – In any study of ecology, a primary observation is that different species thrive under different conditions. This principle applies to all living things, both plants and animals. Some survive in warmth; others do best in cooler situations. Some tolerate freezing; others do not. Some require bright sun; others do best in share. Aquatic systems are divided into fresh and salt water, each with its respective fish and other organisms.

Laboratory experiments clearly bear out the fact that different species are best adapted to different conditions. Organisms can be grown under controlled conditions where one factor is varied while other factors are held constant. Such experiments demonstrate that for every factor there is an **optimum**, a certain level at which the organisms do best. At higher or lower levels the organisms do less well, and at further extremes they may not be able to survive at all.



The point at which the best response occurs is called the optimum, but since this often occurs over a range of several degrees, it is common to speak of an optimal range. The entire span that allows any growth at all is called the **range of tolerance**. The points at the high and low ends of the range of tolerance are called the **limits of tolerance**. Between the optimal range and the high or low limit of tolerance, there are **zones of stress**. That, as the factor is raised or lowered from the optimal range, the organisms experience increasing stress, until, at either limit of tolerance, they cannot survive.

Of course, not every species has been tested for every factor; however, the consistence of such observations leads us to conclude that the following is a fundamental biological principle: ***Every species (both plant and animal) has an optimum range, zones of stress, and limits of tolerance with respect to every abiotic factor*.**

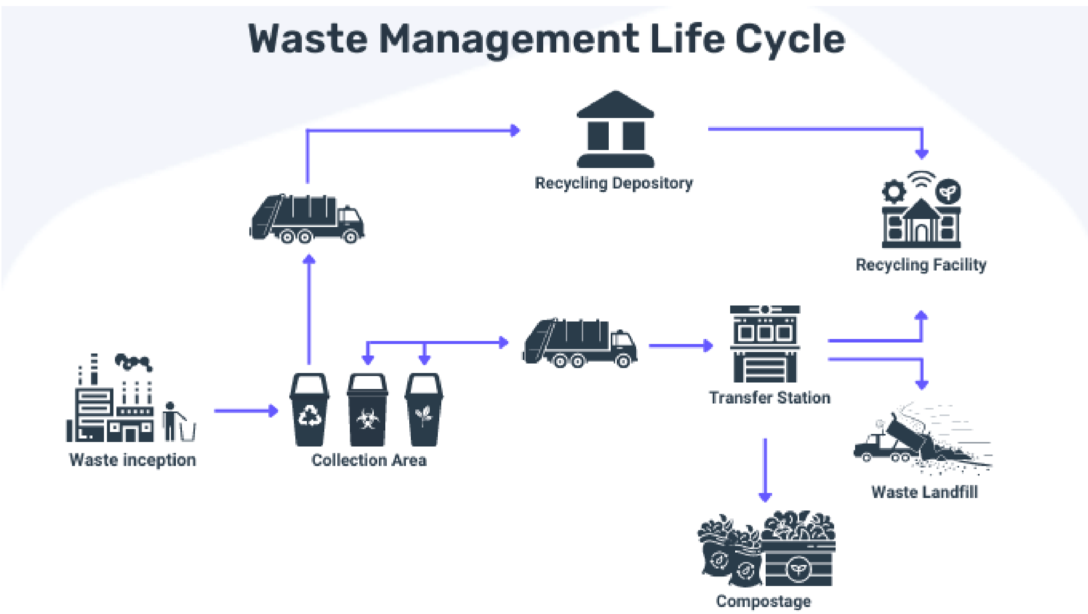
This line of experimentation also demonstrates that different species vary in characteristics with respect to the values at which the optimum and limits of tolerance occur. For instance, what may be an optimal amount of water for one species may stress a second and result in the death of a third. Some plants cannot tolerate any freezing temperatures, others can tolerate slight but not intense freezing, and some actually require several weeks of freezing temperatures in order to complete their life cycles. Also, some species have a very broad range of tolerance, whereas others have a much narrower range. While optimums and limits of tolerance may differ from one species to another, there may be great overlap in their ranges of tolerance.

The concept of a range of tolerance does not just affect the growth of individuals; in so far as the health and vigor of individuals affect reproduction and survival of the next generation, the population is also influenced. That is, the population density (individuals per unit area) of a species will be greatest where all conditions are optimal, and population density will decrease as any one or more conditions depart from the optimum.

Que. 5 (d) How the waste management has evolved as big challenge in world?

Ans. 5 (d) The world generates 2.01 billion tonnes of municipal solid waste annually, with at least 33 percent of that—extremely conservatively—not managed in an environmentally safe manner. Worldwide, waste generated per person per day averages 0.74 kilogram but ranges widely, from 0.11 to 4.54 kilograms. Though they only account for 16 percent of the world's population, high-income countries generate about 34 percent, or 683 million tonnes, of the world's waste.

When looking forward, global waste is expected to grow to 3.40 billion tonnes by 2050, more than double population growth over the same period. Overall, there is a positive correlation between waste generation and income level. Daily per capita waste generation in high-income countries is projected to increase by 19 percent by 2050, compared to low- and middle-income countries where it is expected to increase by approximately 40% or more.



Waste generation initially decreases at the lowest income levels and then increases at a faster rate for incremental income changes at low income levels than at high income levels. The total quantity of waste generated in low-income countries is expected to increase by more than three times by 2050. The East Asia and Pacific region is generating most of the world's waste, at 23 percent, and the Middle East and North Africa region is producing the least in absolute terms, at 6 percent. However, the fastest growing regions are Sub-Saharan Africa, South Asia, and the Middle East and North Africa, where, by 2050, total waste generation is expected to more than triple, double, and double respectively. In these regions, more than half of waste is currently openly dumped, and the trajectories of waste growth will have vast implications for the environment, health, and prosperity, thus requiring urgent action.

Waste collection is a critical step in managing waste, yet rates vary largely by income levels, with upper-middle- and high-income countries providing nearly universal waste collection. Low-income countries collect about 48 percent of waste in cities, but this proportion drops drastically to 26 percent outside of urban areas. Across regions, Sub-Saharan Africa collects about 44 percent of waste while Europe and Central Asia and North America collect at least 90 percent of waste.

Waste composition differs across income levels, reflecting varied patterns of consumption. High-income countries generate relatively less food and green waste, at 32 percent of total waste, and generate more dry waste that could be recycled, including plastic, paper, cardboard, metal, and glass, which account for 51 percent of waste. Middle- and low-income countries generate 53 percent and 57 percent food and green waste, respectively, with the fraction of organic waste increasing as economic development levels decrease. In low-income countries, materials that could be recycled account for only 20 percent of the waste stream. Across regions, there is not much variety within waste streams beyond those aligned with income. All regions generate about 50 percent or more organic waste, on average, except for Europe and Central Asia and North America, which generate higher portions of dry waste.

Globally, most waste is currently dumped or disposed of in some form of a landfill. Some 37 percent of waste is disposed of in some form of a landfill, 8 percent of which is disposed of in sanitary landfills with landfill gas collection systems. Open dumping accounts for about 31 percent of waste, 19 percent is recovered through recycling and composting, and 11 percent is incinerated for final disposal. Adequate waste disposal or treatment, such as controlled landfills or more stringently operated facilities, is almost exclusively the domain of high- and upper-middle-income countries. Lower-income countries generally rely on open dumping; 93 percent of waste is dumped in low-income countries and only 2 percent in high-income countries. Three regions openly dump more than half of their waste—the Middle East and North Africa, Sub-Saharan Africa, and South Asia. Upper-middle-income countries have the highest percentage of waste in landfills, at 54 percent. This rate decreases in high-income countries to 39 percent, with diversion of 36 percent of waste to recycling and composting and 22 percent to incineration. Incineration is used primarily in high-capacity, high-income, and land-constrained countries.

Based on the volume of waste generated, its composition, and how it is managed, it is estimated that 1.6 billion tonnes of carbon dioxide (CO_2) equivalent greenhouse gas emissions were generated from solid waste treatment and disposal, or 5 percent of global emissions. This is driven primarily by disposing of waste in open dumps and landfills without landfill gas collection systems. Food waste accounts for nearly 50% of emissions. Solid waste–related

emissions are anticipated to increase to 2.38 billion tonnes of CO_2-equivalent per year by 2050 if no improvements are made in the sector.

In most countries, solid waste management operations are typically a local responsibility, and nearly 70 percent of countries have established institutions with responsibility for policy development and regulatory oversight in the waste sector. About two-thirds of countries have created targeted legislation and regulations for solid waste management, though enforcement varies drastically. Direct central government involvement in waste service provision, other than regulatory oversight or fiscal transfers, is uncommon, with about 70 percent of waste services being overseen directly by local public entities. At least half of services, from primary waste collection through treatment and disposal, are operated by public entities and about one-third involve a public-private partnership. However, successful partnerships with the private sector for financing and operations tend to succeed only under certain conditions with appropriate incentive structures and enforcement mechanisms, and therefore they are not always the ideal solution.

Financing solid waste management systems is a significant challenge, even more so for ongoing operational costs than for capital investments, and operational costs need to be taken into account upfront. In high-income countries, operating costs for integrated waste management, including col-lection, transport, treatment, and disposal, generally exceed $100 per tonne. Lower-income countries spend less on waste operations in absolute terms, with costs of about $35 per tonne and sometimes higher, but these countries experience much more difficulty in recovering costs. Waste management is labor intensive and costs of transportation alone are in the range of $20–$50 per tonne. Cost recovery for waste services differs drastically across income levels. User fees range from an average of $35 per year in low-income countries to $170 per year in high-income countries, with full or nearly full cost recovery being largely limited to high-income countries. User fee models may be fixed or variable based on the type of user being billed. Typically, local governments cover about 50 percent of investment costs for waste systems, and the remainder comes mainly from national government subsidies and the private sector.

Effects of waste dumping

- Naturally, simply dumping waste on the planet has consequences. The effects of waste dumping and improper waste management include:
- Pollution of soil: Waste can leak hazardous chemicals into the soil and from their into our food.
- Air pollution: The burning of waste at landfills release toxic substances into the air, including extremely poisoning dioxin.
- Pollution of oceans: 13 million tonnes of plastic end up in the world's oceans each year. If we keep dumping plastic in the oceans, by 2050 there will be more plastic than fish in the sea.
- Pollution of groundwater: 280 billion tons of groundwater is being polluted every year - that's 9000 tons every second.

Way Forward For a long time, our economy has been 'linear'. This means that raw materials are used to make a product, and after its use any waste (e.g. packaging) is thrown away. In an economy based on recycling, materials are reused. For example, waste glass is used to make new glass and waste paper is used to make new paper. To ensure that in the future there are enough raw materials for food, shelter, heating and other necessities, our economy must become circular. That means preventing waste by making products and materials more efficiently and reusing them. If new raw materials are needed, they must be obtained sustainably so that the natural and human environment is not damaged.

Que. 5 (e) "Economic planning is reoriented towards environmentalism" elucidate.

Ans. 5 (e) *After brief introduction of concept of environmentalism, the answer will be same as sustainable development (Answer of 7a Suggest the requirement of planning for sustainable development.)*

Note: when you encounter such near repeated questions you must choose only one

Que. 6 (a) Write note on the approaches to combat decertification applied in India.

Ans. 6 (a) Dry lands are limited by rainfall, high evapotranspiration and show a gradient increase in productivity from hyper-arid to arid and semi-arid to dry sub-humid areas, on decreasing aridity or moisture deficit. Dry lands in India contribute to over 70 percent of the total cultivated area and about 50 percent of the total geographic area is affected by desertification. Land degradation is particularly problematic for both environmental sustainability and poverty reduction in dryland areas. The UN Convention to Combat Desertification (UNCDD) and others use "desertification" to describe dryland degradation which is caused due to several factors including climatic variations and human activities. Depending on the level of aridity, dryland biodiversity is relatively rich, still relatively secure and is critical for the provision of dryland services. Of 25 global "biodiversity hot spots" identified by Conservation International, 8 are in drylands. So to conserve dryland are very important to ensure food security, conserve rich biodiversity of drylands and improve livelihoods of dryland people. To conserve the scarce resources of drylands a number of practices or methods are used which constitute dryland conservation technologies. These technologies are agronomic or cultural practices like conservation tillage, mulching, organic manure application, contour farming, strip cropping, use of wind breaks, allay cropping, vegetative barriers etc. and mechanical or engineering methods which include basin listing, sub-soiling, terracing, contour bunding, contour trenching, use of gully plugs, check dams and water harvesting structures like community tanks, intra-terrace water harvesting and roof top water harvesting etc. In spite of these practices or methods there are several other measures which can be applied for dryland conservation.

These approaches are –

- Sustainable farming practices.
- Precision conservation,
- Integrated watershed approach, and
- Use of agro forestry

Agronomic or cultural practices Agronomic or cultural practices for soil and water conservation in drylands help to intercept rain drops and reduce the splash effect, help to obtain a better intake of water by the soil by improving the organic matter content and soil structure; help to retard and reduce the surface runoff through the use of mulches, strip cropping, mixed cropping and contour cultivation. Use of vegetation on mechanical structures such as gully checks and water harvesting structures etc. enhance their strength and extent their life span.

Mechanical and engineering methods These are permanent structures used to supplement the agronomical practices, when the later alone are not adequately effective. These measures play a vital role in controlling soil erosion and reducing runoff. These are used mostly in drylands where the slope of the soil is more than permissible limit. The main objective of the mechanical methods for controlling soil erosion are: (i) to increase the time of concentration by intercepting the runoff and thereby providing an opportunity for the infiltration of water, and (ii) to divide a long slope into several short ones so as to reduce the velocity of the runoff and thus preventing erosion. These measures are basin listing, sub-soiling, terracing, contour bunding, contour trenching, gully plugging, check dams and water harvesting structure for hilly areas.

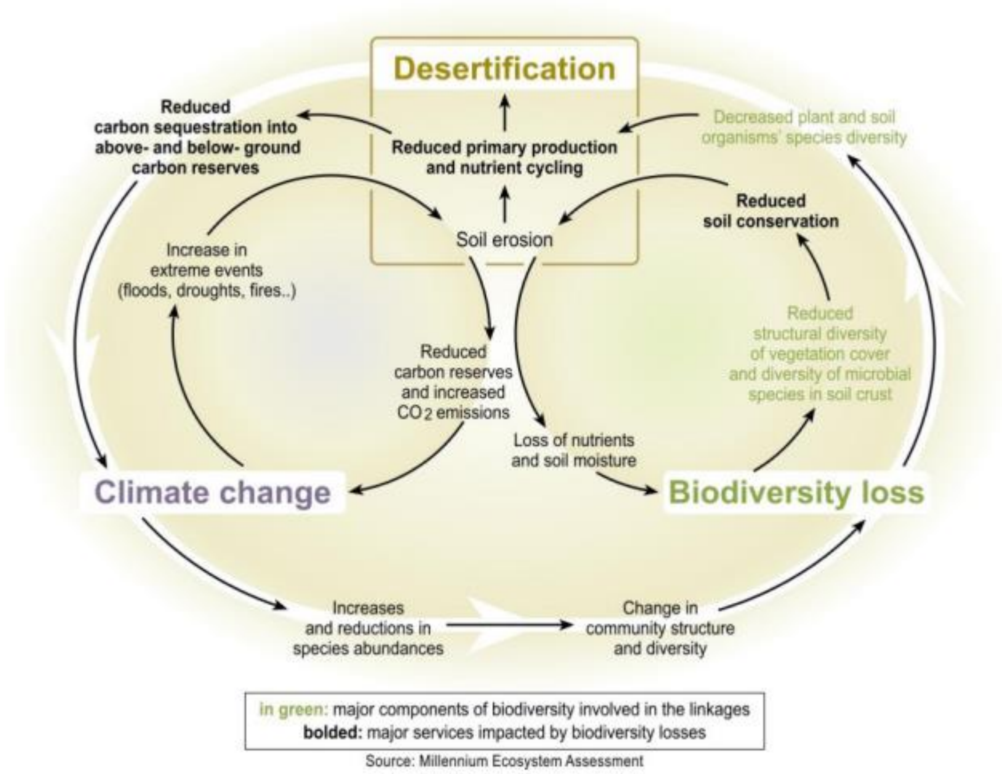
Water harvesting structures for dry hilly areas Water harvesting is a prominent and technically feasible technology in arid hilly areas. It helps in runoff harvesting and ground water recharging. Different types of water harvesting structures are used for efficient utilization of rainfall. Such as community tanks, inter-terrace runoff harvesting, hill spring outflow harvesting and rooftop harvesting structures. Runoff utilization is increasingly becoming a common practice in dryland conservation agriculture

Sustainable farming practices The past decades have witnessed a dramatic change in agriculture with food production soaring due to green revolution. The green revolution entailed the use of improved technologies like high yielding crop varieties, expansion of irrigation, mechanization and the use of chemical fertilizers and pesticides. Sustainable agriculture practices are not new, but drawn on traditional knowledge and practices, adopted to ensure food security and maintaining productivity of dryland ecosystems on sustainable basis. These practices are conservation tillage, integrated nutrient management, agroforestry, water harvesting, livestock integration, use of mulches, green manuring and integrated pest management etc. to maximize productivity without compromising the needs of the future generations.

Precision conservation Precision conservation offers an alternative to integrate the use of spatial technologies such as global position system (GPS, remote sensing (RS) and geographic information system (GIS) and the ability to analyze the spatial relationship within and among mapped data to develop management plans that account for the temporal and spatial variability of flows in the environment. Hence precision conservation practices helps to maintain maximum production by improving soil and water conservation by developing efficient land use management plans. Precision conservation is an innovative three tier approach comprising a set of spatial technologies and procedures linked to mapped variables, which is used to implement conservation management practices that take into account spatial and temporal variability across natural and agricultural systems.

Integrated watershed approach An approach towards dry land conservation. Basically a watershed is a basin like landform defined by high points and ridge lines that descend into lower elevations and stream valleys. A watershed carried water "shed" from the land after rainfalls and snow melts. Drop by drop water is channeled into soils, groundwater, creaks and streams making its way to rivers and eventually the sea. In other words, a watershed is a geohydraulic unit or piece of land that drain at a common point. The aim of watershed management is to ensure that every drop of water and every square foot of land are best utilized. Integrated watershed approach is not only anti-erosion and anti-runoff approach but also a comprehensive integrated approach of land and water resource management. This approach is preventive, progressive, corrective as well as curative.

Role of agro forestry in soil and water conservation in dry land ecosystems Agro forestry is the science of developing integrated self-sustainable land use systems in which trees are grown on farm lands along with field crops. It includes the introduction and/or retention of tree crops for timber and fodder, fruit trees, shrubs, bamboos, canes and palms along with cultivated filed crops including pasture simultaneously or sequentially on the same piece of land and at the same time to meet the ecological and socio-economic needs of the people. A well planned and properly managed agroforestry programme substantially increases the yield of the land and maintains sustained productivity.



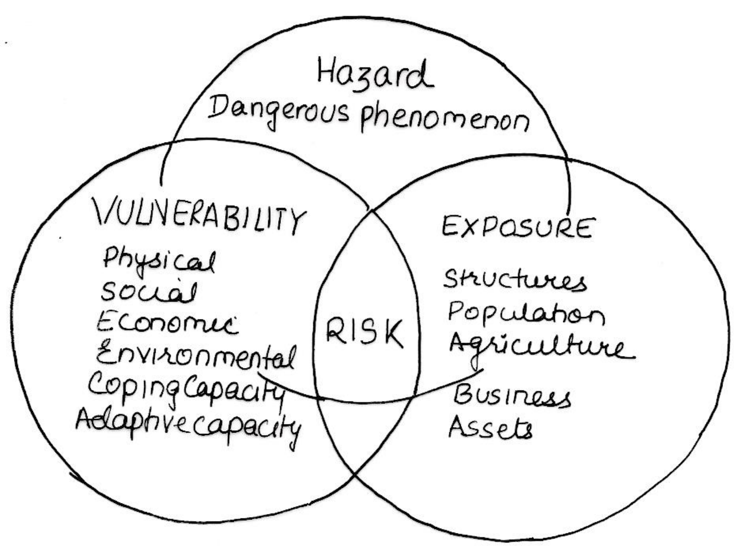
Besides above mentioned systems, two main practices are adopted with the object of intensifying farming on slopes along with reducing soil erosion and increasing moisture conservation. These are (i) Sloping Agriculture Land Technology (SALT), and (ii) Biomass Transfer Technology (BTT).

Sloping Agriculture Land Technology (SALT) The sloping agricultural land technology (SALT) is a farming system developed by the3 Mindanao Baptist Rural Life Centre in the southern Philippines during the 1970s. Basically attuned to the production needs of small-scale hill farmers, this agroforestry technology has gained wide popularity in Asia because it is culturally appropriate, economically sound and is designed to limit soil erosion. SALT is a technology package of soil conservation and food production that integrates several soil conservation measures. Basically, the SALT method involves planting field crops and perennial crops in bands 3-5 m wide between double rows of nitrogen-fixing shrubs and trees planted along the contour. These minimize soil erosion and maintain the fertility of the soil. SALT helps considerably in the establishment of a stable ecosystem, the double hedge rows of leguminous shrubs or trees prevent soil erosion. Their branches are cut every 30-45 days and incorporated back into the soil to improve its fertility. The crops provide permanent vegetative cover which aids the conservation of both water and soil.

Biomass transfer technology (BTT) Various agroforestry technologies are finding enormous application in the east and central African (ECA) region and are lifting many out of poverty and mitigating declining agricultural productivity and natural resources. One such example is biomass transfer in which trees that are rich in mineral elements (fertilizer trees), when integrated with inorganic fertilizer can double or triple crops yields in degraded lands.Biomass transfer technology involves the growing of trees/shrubs along boundaries or contours on farms or the collection of the same from off-farm niches such as roadsides and applying the leaves on field at planting.

Ans. 6 (a) In light of Sendai Framework, outline the aspects of National Disaster Management Plan.

Que. 6 (b) The National Disaster Management Plan (NDMP) provides a framework and direction to the government agencies for all phases of disaster management cycle .The NDMP is a dynamic document in the sense that it will be periodically improved keeping up with the global best practices and knowledge base in disaster management. It is in accordance with the provisions of the Disaster Management Act, the guidance given in the National Policy on Disaster Management (NPDM), and the established national



practices. Relevant agencies – central or state – will carry out disaster management activities in different phases in the disaster-affected areas depending on the type and scale of disaster.

The NDMP provides a framework covering all aspects of the disaster management cycle. It covers disaster risk reduction, mitigation, preparedness, response, recovery, and betterment reconstruction. It recognises that effective disaster management necessitates a comprehensive framework encompassing multiple hazards. The NDMP incorporates an integrated approach that ensures the involvement of government agencies, numerous other relevant organisations, private sector participants, and local communities.

The NDMP recognizes the need to minimize, if not eliminate, any ambiguity in the responsibility framework. It, therefore, specifies who is responsible for what at different stages of managing disasters. The NDMP is envisaged as ready for activation at all times in response to an emergency in any part of the country. It is designed in such a way that it can be implemented as needed on a flexible and scalable manner in all phases of disaster management:

a) mitigation (prevention and risk reduction),

b) preparedness,

c) response and

d) recovery (immediate restoration to long-term betterment reconstruction).

The NDMP provides a framework with role clarity for rapid mobilization of resources and effective disaster management by the Central and State Governments in India. While it focuses primarily on the needs of the government agencies, it envisages all those involved in disaster management including communities and non-government agencies as potential users. The NDMP provides a well defined framework for disaster management covering scope of work and roles of relevant agencies along with their responsibilities and accountability necessary to ensure effective mitigation, develop preparedness, and mobilize adequate response.

Objectives

Along with the mandate given in the DM Act 2005,the national plan has incorporated the national commitment towards the Sendai Framework.

Accordingly, the broad objectives of the NDMP are:

- Improve the understanding of disaster risk, hazards, and vulnerabilities
- Strengthen disaster risk governance at all levels from local to centre
- Invest in disaster risk reduction for resilience through structural, non-structural and financial measures, as well as comprehensive capacity development
- Enhance disaster preparedness for effective response
- Promote "Build Back Better" in recovery, rehabilitation and reconstruction
- Prevent disasters and achieve substantial reduction of disaster risk and losses in lives, livelihoods, health, and assets (economic, physical, social, cultural and environmental)
- Increase resilience and prevent the emergence of new disaster risks and reduce the existing risks
- Promote the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures to prevent and reduce hazard exposure and vulnerabilities to disaster
- Empower both local authorities and communities as partners to reduce and manage disaster risks
- Strengthen scientific and technical capabilities in all aspects of disaster management
- Capacity development at all levels to effectively respond to multiple hazards and for community-based disaster management
- Provide clarity on roles and responsibilities of various Ministries and Departments involved in different aspects of disaster management
- Promote the culture of disaster risk prevention and mitigation at all levels
- Facilitate the mainstreaming of disaster management concerns into the developmental planning and processes

Sendai Framework

The NDMP is consistent with the approaches promoted globally by the United Nations, in particular the Sendai Framework for Disaster Risk Reduction 2015-2030 (hereafter "Sendai Framework")adopted at the Third UN World Conference in Sendai, Japan, 2015 as the successor instrument to the Hyogo Framework for Action 2005-2015. It is a non-binding agreement, which the signatory nations, including India, will attempt to comply with on a voluntary basis. However, India will make all efforts to contribute to the realization of the global targets by improving the entire disaster management cycle in India by following the recommendations in the Sendai Framework and by adopting globally accepted best practices.

The Sendai Framework was the first international agreement adopted within the context of the post-2015 development agenda. Two other major international agreements followed it in the same year:

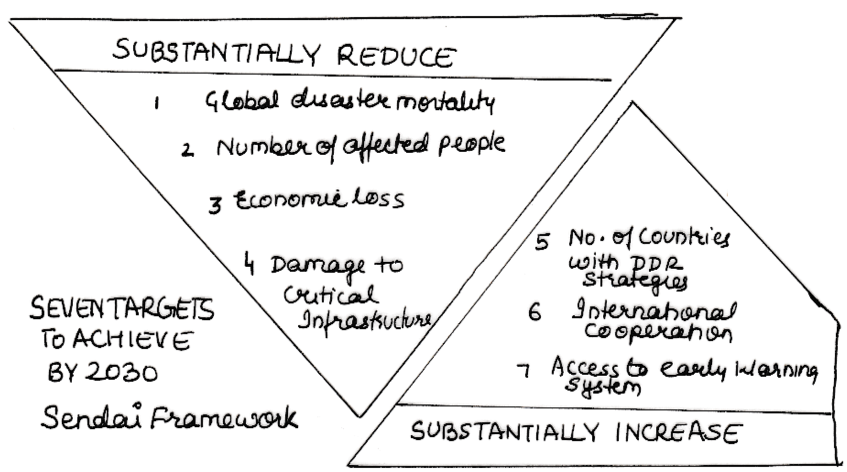
DRR is a common theme in these three global agreements. The Paris Agreement on global climate change points to the importance of averting, minimizing, and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage. These three agreements recognize the desired outcomes in DRR as a product of complex and interconnected social and economic processes, which overlap across the agendas of the three agreements. Intrinsic to sustainable development is DRR and the building of resilience to disasters. Further, effective disaster risk management contributes to sustainable development.

In the domain of disaster management, the Sendai Framework provides the way forward for the period ending in 2030. **There are some major departures in the Sendai Framework:**

- For the first time the goals are defined in terms of outcome-based targets instead of focusing on sets of activities and actions.
- It places governments at the center of disaster risk reduction with the framework emphasizing the need to strengthen the disaster risk governance.
- There is significant shift from earlier emphasis on disaster management to addressing disaster risk management itself by focusing on the underlying drivers of risk.
- It places almost equal importance on all kinds of disasters and not only on those arising from natural hazards.

- In addition to social vulnerability, it pays considerable attention to environmental aspects through a strong recognition that the implementation of integrated environmental and natural resource management approaches is needed for disaster reduction
- Disaster risk reduction, more than before, is seen as a policy concern that cuts across many sectors, including health and education

As per the Sendai Framework, in order to reduce disaster risk, there is a need to address existing challenges and prepare for future ones by focusing on monitoring, assessing, and understanding disaster risk and sharing such information. The Sendai Framework notes that it is "urgent and critical to anticipate, plan for and reduce disaster risk" to cope with disaster. It requires the strengthening of disaster risk governance and coordination across various institutions and sectors. It requires the full and meaningful participation of relevant stakeholders at different levels. It is necessary to invest in the economic, social, health, cultural and educational resilience at all levels. It requires investments in research and the use of technology to enhance multi-hazard Early Warning Systems (EWS), preparedness, response, recovery, rehabilitation, and reconstruction.



The four priorities for action under the Sendai Framework are:

1. Understanding disaster risk
2. Strengthening disaster risk governance to manage disaster risk
3. Investing in disaster risk reduction for resilience
4. Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

India is a signatory to the Sendai Framework for a 15-year, voluntary, non-binding agreement which recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government, the private sector and other stakeholders. It aims for the "substantial reduction of disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries." India will make its contribution in achieving the seven global targets set by the Sendai Framework:

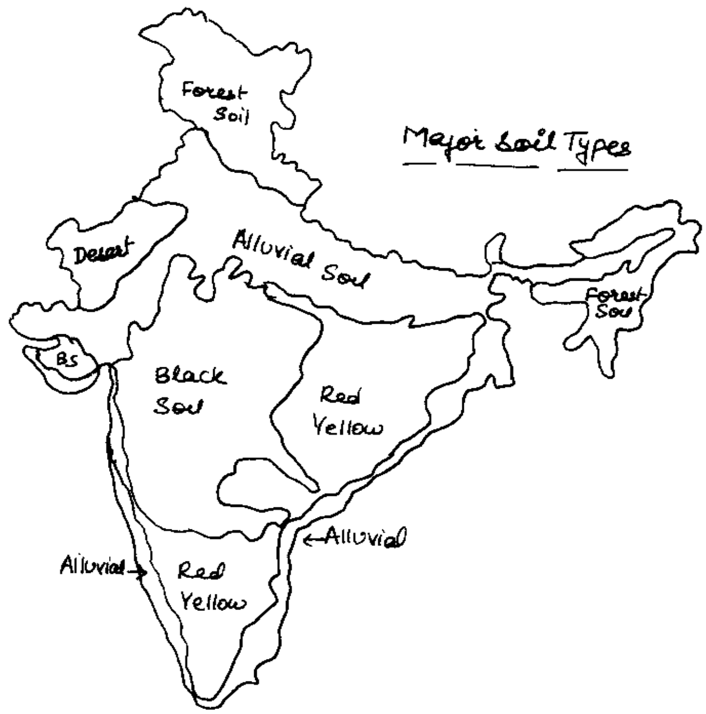
Que. 6 (c) What are the major economic and ecological categories of Indian soil?

Ans. 6 (c) India being large country exhibits variety of soil types. Due to diversity of parent rock material, variation of climatic conditions and soil forming processes, soil character varies from region to region. The soils of peninsular India are mostly zonal soils formed by disintegration and decomposition of rocks in situ. On the other hand soils of plains are azonal soil transported and deposited by rivers. The major classification of soil includes –

(a)Alluvial – developed due to process of deposition of sand, silt and clay in layers. These are found along river courses in low lying tracts. Alluvial soils are classified into newer alluvium (Khader), older alluvium (Bhanger) and pebble sand deposits (Bhaber). Bhanger marks their development only in the regions where flood water do not reach pronouncedly. A few metres below the surface, the bhanger has bed of fine nodules or Kankar. There are other variants regionised like Usar soil in Ganges Ghaghara doab, bhur soil in Ramganga tract, bhat soil in lower Gandak valley Bhaber and terai at the foot of Shivalik. Bhur is sandy in character, bhat is a whitish calcareous soil while bhabar is a sandy soil with a high porosity and low moisture retaining capacity. Although fertility of alluvial soil is dependent on many factors like texture, organic matter and mineral content, these are the best agricultural soils in India. This occupies all the plains of India.

(b)Black soil – is dark color soil due to high content of humus calcium, magnesium carbonates and iron oxides. These are developed from basaltic rocks and are commonly known as regur or black soil. They are prominent over Maharashtra, Malwa, Khahawar, Telengana, Malnads, Piedmont uplands of Tamil Nadu.

(c)Red – is formed by weathering of ancient crystalline and metamorphic rocks. These are found in areas of low rainfall and high temperature. These are less leached than laterite. The colour is due to high iron content. Red soil covers large parts of Tamil Nadu, southern Karnataka, Andhra Pradesh, Madhya Pradesh and Orissa. The soils are poor in phosphorous, nitrogen and lime content.



(d)Laterite – are constituted of ferruginous aluminous elements formed in regions of heavy seasonal rainfall accompanied by high temperature conditions for most part of the year. The top soil is completely leached out leaving a high proportion of iron and aluminium as residue. Laterite soil is poor in phosphorous, potassium lime and nitrogen. The PH ranges from 4.5 to 5.5 and the base exchange capacity is low. The soil is reddish in color due to presence of iron oxides. Laterite soils are found in Orissa, western West Bengal, in some parts of Andhra Pradesh, Meghalaya and Bihar Jharkhand plateau.

(e)Desert soil – are characterized by sandy texture. They are usually adequate in mineral status but poor in organic matter. The pH value is high. These are typical of Rajasthan, parts of Guajarat, Punjab and Haryana where annual rain is less than 40 cm which does not encourage chemical decomposition of crystal elements.

(f)Montane soil - are found in Himalayas and hills of drier regions of peninsula and in parts of Andaman islands. The terai soils of Himalayan foothills are rich in nitrogen and organic matter. In coniferous forest belt of Jammu & Kashmir, Himachal Pradesh, Uttranchal and Sikkim, brown podzol soils are found. Alpine meadow soils are located at further higher altitudes. Further mountain soils having good vegetation cover its rich in organic matter. But their base status varies depending on the degree of leaching.

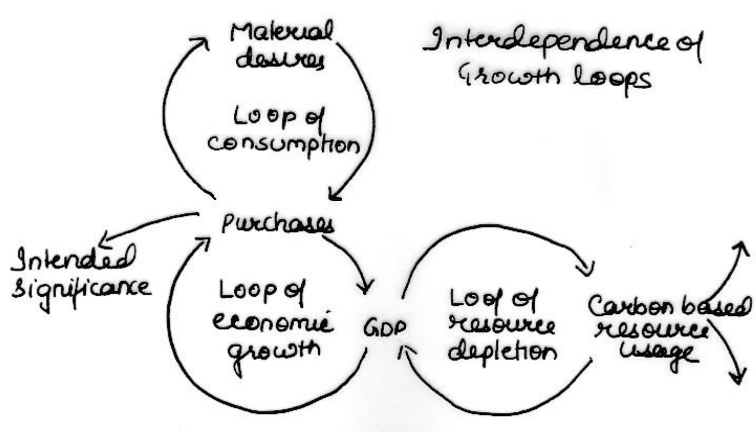
(g)Saline and Alkaline – are found in drier parts of country. Being deficient in undergrounddrainage capillary action during summer brings the concentrated dissolved salts to the surface where they form a white crust.

(h)Peat and Bog – These are found in humid regions as a result of accumulation of a large amount of organic matter in the soil. The soil is deep black is color with a high clay content and is rich in nitrogen adequate in potash, but deficient in phosphorus and are poorly drained.

Que. 7 (a) Suggest the requirement of planning for sustainable development.

Ans. 7 (a) "Sustainable living" encourages people to minimize their use of Earth's resources and reduce the damage of human and environmental interactions**.** For achieving overall economic development, an integration of natural resources, human resources and capital is necessary. The developing countries concentrate on mobilising local resources for sustainable development and regional planning. Natural resources encompass land, water resources, fisheries, mineral resources and so on.

The principal objective of regional planning is to maximise resource development potential by maximising national output. This can be possible only through the optimum utilisation of resources in the short term and sustainable utilisation of the resources in the long term.



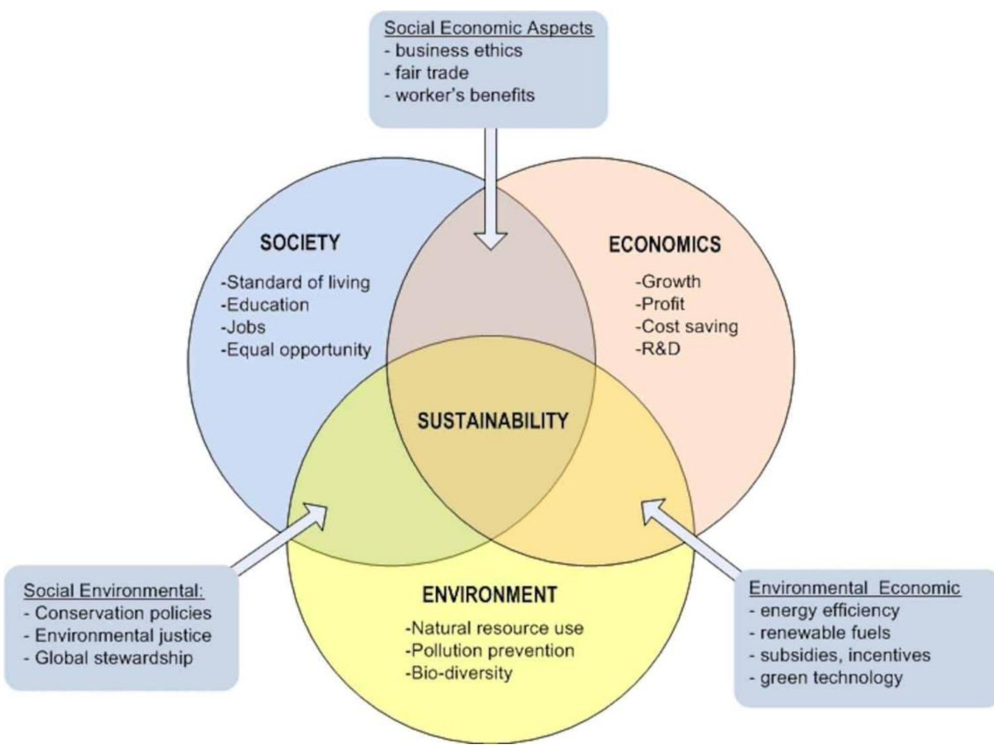
Planning for sustainable development involves the following major principles.

Resources must be exploited in an economical manner. This would help not only to minimise waste of resources but also to convert the waste products into economically viable by-products. Technological upgradation is needed to achieve such a goal.

Society has to be aware enough to conserve renewable resources and also to conserve non-renewable resources.

Multipurpose use of resources can prevent loss of resources. With scientific advancements, newer applications of resources (such as evolving new by-products of coal during the 19th and 20th centuries) have proved to be extremely beneficial for the human civilisation.

Integrated planning is important for the development of economy in a sustainable manner. Examples are found in the case of multi-purpose river valley projects where the same water resource has been used for different purposes—irrigation, hydro-power generation, pisciculture, etc. The multi-level planning in India aims at the planning mechanism being integrated from panchayat level to the Central level for the betterment of society and economy.



Industrial locations should be planned in economically viable regions; e.g., the weight-losing industries such as iron and steel should be located near the source of raw materials for achieving maximum profit and optimum utilisation of resources.

Prevention of environmental hazards such as pollution created by automobiles and industries is important for the developmental aspect of planning.

Management of environment encompasses two approaches

(i) preservative and (ii) conservative. The former deals with the management of the environment without any kind of human interference with nature. But the approach seems to be unrealistic. The second approach emphasises on human adjustments with the physico-biotic environment in relation to techno-behavioural institutional adjustments.

For planners, there are two approaches to resource management:

I. The holistic approach believes that environmental problems can be tackled by solving all the problems together,
II. The monistic approach stresses on narrowly- defined solutions for particular problems.. Jeffers has formulated (1973) a five-stage iterative planning for land use and resource management.

- Identification of common agreement on goals and objective
- Research and development for adequate understanding of the relevant issues.
- Identification and evaluation of alternative modus operandi for fulfillment of the objectives
- Selection and implementation of a specific strategy.
- Monitoring results along with modification of plans according to changing demands and values.

For sustainable planning and development, resources are further categorised as recyclable resources, i.e., a special type of non-renewable resource (e.g., metals) and inexhaustible or flow resources (e.g., sunlight, wind).

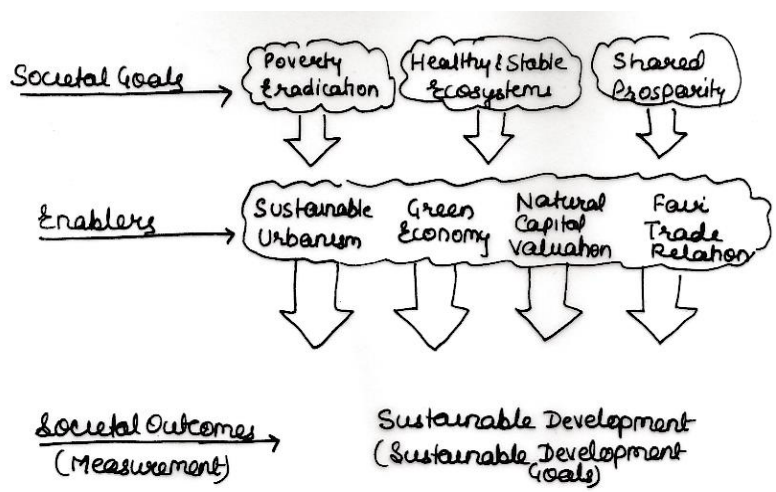
It is extremely important for planners to consider the ecological aspect for our future survival. A concrete database of ecological resources should be prepared by conducting extensive field survey and using remote sensing technology.

Conservation of nature for sustainable development and planning has the following objectives:

- To preserve quality environment that has aesthetic value, and
- To ensure a steady yield of flora and fauna along with renewal of resources.

Man-made constructions such as huge dams, oil pipelines, industries have raised hue and cry all over the world, particularly in the last few decades. Lack of adequate planning in the case of Aswan dam (Egypt) has caused major problems like silting of reservoirs; reduction of plankton in the lower course of River Nile has adversely affected species like sardine, mackerel, lobster etc. Reservoirs and canals ar£ affected heavily by snails" which cause deadly diseases. Reservoirs have increased occurrence of diseases like malaria; they have also increased soil salinity which has led to reduced soil fertility.

On the contrary, the Trans-Alaska project was implemented after adequate planning. Therefore, the pipeline route carefully avoided the seismic active zone of Alaska as well as the delicate marine environment of the Pacific Ocean. Without proper planning the project could have caused disasters like discharge of effluents, thawing of permafrost regions, loss of valuable flora and fauna, etc.



For the development of agriculture, agro- climatic planning has been advocated by experts belonging to various disciplines. The application of chemical fertilisers is gradually being replaced by bio-manures in different parts of the world.

Que. 7 (b) Avail an account of reclaiming methods for salt affected areas.

Ans. 7 (b) Salt affected soils differ from normal soils in respect of soil reaction (pH) and soluble salt content. The ground water found in saline areas is often of poor quality, while fresh water is scarce. Poor rainfall and high temperature of arid and semi-arid regions are very favorable conditions leading to formation of saline and alkali soils.

The factors inhibiting crop/tree growth in alkali soils are:

- A high pH throughout the profile which causes problems of nutrient availability.
- A highly deteriorated soil structure, with poor water transmission characteristics leading to water stagnation and reduced aeration of roots.

A hard calcium carbonate layer at about one metre depth in the profile action as a physical barrier for the vertical penetration of tree roots, although the location of this layer in the profile and its thickness varies in different soils. Often compact sub-surface horizons also restrict root penetration in alkali soils. Saline soils contain an excess of neutral soluble salts, generally chlorides and sulphates of sodium, calcium and magnesium. Saline soils rich in such divalent cat-ions have low ESP and pH and a good physical condition. Owing to the flocculating effect of neutral salts, saline soils are very permeable and can be reclaimed by leaching with good quality water provided the ground water table is deep.

The factors inhibiting crop/tree growth in saline soils include

- The salinity induced high osmotic pressure of soil water
- The toxic effect of specific ions
- Nutritional disorders occur due to competitive uptake of ions.
- A high water table and therefore regular and/or prolonged water logging is associated with such soils.

The reclaiming methods

Leaching of salts: Leaching and draining away of salts by rain and irrigation water can be achieved effectively. The main objective in the reclamations of these soils is to leach the salts below the root zone. Hence, drainage system should be installed, if necessary. This is achieved by flooding and ensuring that water is drained away to lower depths in soil. To make it effective, bunds are raised around plots prepared according to their textural classes and water is applied depending on their water requirement to leach salts. Water needed to leach salts varies according to soil texture. The heavy soil need more water than sandy or light soils.

Scraping: Scraping off surface salts from highly saline patches can be done. However, this is a very tedious job and required lot of labour and energy.

Use of gypsum: If saline soil contain a little amount of sodium, application of gypsum is necessary to displace sodium. This is followed by leaching. In these soils, the exchangeable sodium is so great as to make the soil almost impervious to water. Large quantities of gypsum are applied to replace sodium and leached downward and out of reach of plant roots. Gypsum is applied on the soil surface and mixed by harrowing two to four weeks before sowing "2.5 to 5.0 tonnes per hectare depending on the density of the salts present in the salt affected soil.

Artificial drainage and deep ploughing: In saline soils, with high water table, artificial drainage should be practiced. If there is any hard pan in the sub-soil layer, that may prevent downward movement of water, deep ploughing or chiseling should be done to break such layers and open the soil for free downward movement of water.

Use of mulches: In areas where water resources are limited, application of surface organic mulch shows surface evaporation, salt movement by evaporative water is decreased and net downward movement of salt is increased.

Use of sulphur: In extreme cases, sulphur is used to reduce alkalinity. Ground sulphur is incorporated into the soil several weeks before planting of the crop. The quantity of sulphur required is depending upon the intensity of salt affected soil and climatic conditions. The pH up to 8, the 1.25 to 2.5 tonnes of sulphur and 5 to 7.5 tonnes of organic matter per hectare will be required to reduce the pH to about 6.5.

Application of pyrite: Pyrite is a mineral containing iron and sulphur (FeS2). The pyrite should be grinded into small particles and broadcasted followed by a light irrigation. It takes about 4-6 weeks to oxidize on the surface of soil after which it should be incorporated into the soil. Pyrite is oxidized to sulphate. The oxidation is a chemical and microbiological process. Increasing the ratio of application of pyrite increases the surface available for oxidation and results in an increase in the amount of pyrite oxidized. Top dressing of pyrite increases its oxidation and is more effective.

Application of manure: Salt affected soils are deficient in organic matter and nutrients particularly nitrogen and zinc. Because of high pH, many plant nutrients are fixed up in unavailable forms. Application of farmyard manure results in increasing fertility and improving soil physical conditions. The maintenance of flooded condition for 15-30 days following incorporation of farmyard manure at the rate of 20-25 tonnes/ha reduced exchangeable sodium percentage to a great extent by minimizing the escape of CO2 released during fast initial decomposition besides facilitating the leaching of sodium replaced from the exchange complex.

Use of acidifying fertilizers: The use of some acidifying fertilizers can help to reduce the salts toxicity for growing of the crop plant and trees. For example single superphosphate or ammonium sulphate which increases acidity in soil and maintains fertility of soil impoverished by leaching and cropping are the best source of plant nutrients in salt affected soils.

Green manuring: In alkali soil green manuring of dhaincha has been found to be beneficial along with gypsum in resorting physical condition and enriching the soil in nitrogen and organic matter. In addition to dhaincha, sunhemp can also be grown for reclamation of salt affected soils.

Use of molasses: Molasses are used to reclaim soils at the rate 5 tonnes/ha along with 2.5 to 5 tonnes of press mud. It provides source of energy for micro-organisms and on fermentation, produce organic acids which reduce alkalinity while press mud help in reducing exchangeable sodium.

Growing salt tolerance crops and varieties: Crops and their varieties vary a great deal in their tolerance to salinity and alkalinity conditions. Sesbania aculeate (dhainacha) is a tolerant legume in these soils; rice is tolerant to flooding conditions and has a shallow root system. The selection of crops can be done based on the intensity of the salt affected soils for better utilization of the finite resource (land).

Bio-saline agriculture: As highly saline Vertisols are difficult to reclaim especially under rain-fed situations, bio-saline agriculture forms an alternative to bring these lands under cultivation.

Economic potential of some halophytes can be exploited for saline agriculture on salt affected black soils of Gujarat. It may be concluded that the problems of soil solidicity, salinity and poor quality are likely to increase in the near future due to planned expansion in irrigated area and intensive use of natural resources to meet food, fodder, fibre and timber requirement of the burgening human and livestock populations. Tentative estimate indicates that the salt affected soils will constitute nearly 13 million ha area in the country by 2025. Therefore, there is an urgent need to reclaim the presently salt affected soils, and also to avoid the further deterioration in the soil quality by appropriate management techniques.

Que.7 (c) Define famine. Also outline its effect and remedies.

Ans. 7 (c) Famine is a widespread condition in which a large percentage of people in a country or region have little or no access to adequate food supplies. Many people believe that famines are food shortages caused solely by underproduction. However, in many cases, famine has multiple causes.

The phases includes

Phase 1 None/Minimal Households are able to meet essential food and non-food needs without engaging in atypical and unsustainable strategies to access food and income.

Phase 2 Stressed Households have minimally adequate food consumption but are unable to afford some essential non-food expenditures without engaging in stress-coping strategies.

Phase 3 Crisis Households either: Have food consumption gaps that are reflected by high or above-usual acute malnutrition; or Are marginally able to meet minimum food needs but only by depleting essential livelihood assets or through crisis-coping strategies

Phase 4 Emergency Households either Have large food consumption gaps which are reflected in very high acute malnutrition and excess mortality or Are able to mitigate large food consumption gaps but only by employing emergency livelihood strategies and asset liquidation

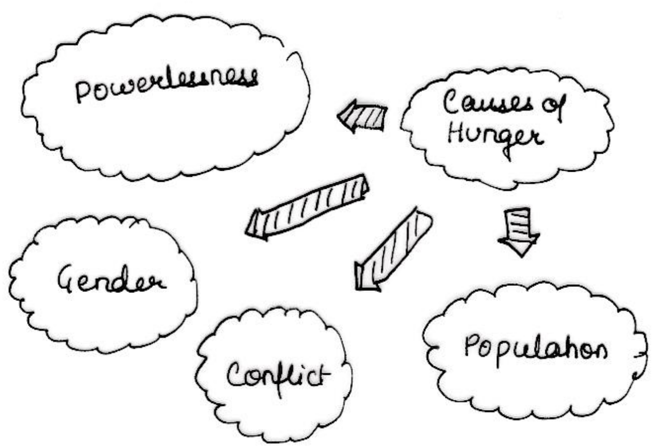
Phase 5 Catastrophe/ Famine Households have an extreme lack of food and/or other basic needs even after full employment of coping strategies. Starvation, death, destitution and extremely critical acute malnutrition levels are evident.

A natural disaster, such as a long period of drought, flooding, extreme cold, typhoons, insect infestations, or plant disease, combined with government decisions on how to respond to the

disaster, can result in a famine. The famine might be initiated by a natural disaster, and a government's inability or unwillingness to deal with the consequences of that event may magnify the effects. This happened in North Korea in the 1990s when government mismanagement of food supplies and an inequitable rationing policy led to a famine that killed over two million people by some estimates.

Human events also lead to famine. A major human cause of famine is warfare. During war, crops are destroyed, either intentionally or as a result of combat. In addition, supply lines and routes are cut off, and food cannot be distributed or is prevented from being distributed by combatants. Forced starvation for political reasons is another cause of famine. In the Soviet Union of the 1930s, for example, millions of peasants died as a result of leader Joseph Stalin's agricultural policies, which required that a quota of grain be supplied to the government before any of the grain could be consumed by those who grew it. Anyone caught violating the policy could be executed.

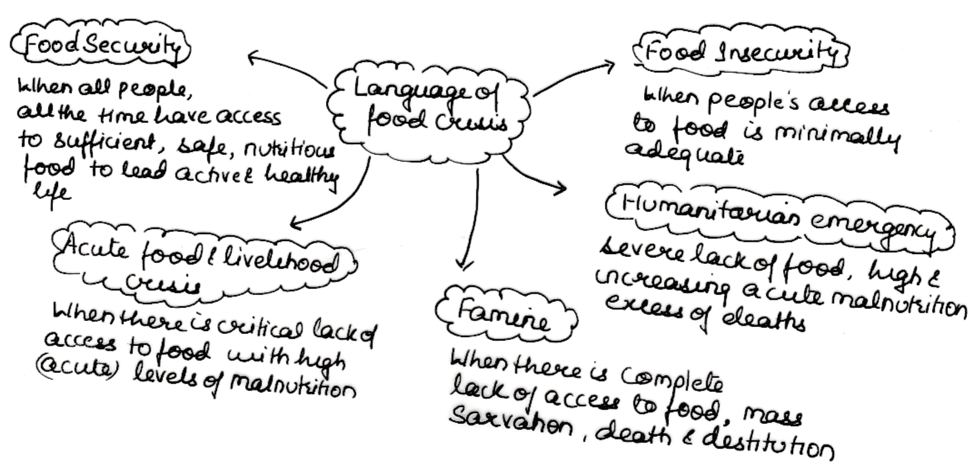
Poverty and hunger exist in a vicious cycle. Families living in poverty usually can't afford nutritious food, leading to undernourishment. In turn, undernourishment makes it difficult for people to earn more money so that they can afford healthy food. Families living in poverty might also sell off their livestock or tools to supplement their income. This buys short-term relief, but



perpetuates a longer-term pattern of hunger and poverty that is often passed down from parents to children. The Democratic Republic of Congo, recognized year over year as one of the world's poorest countries, has a population of 77 million, the majority of whom live below $1.25/day. As of 2017, 7.9 million DRC citizens faced acute hunger. Poverty often goes hand-in-hand with many of the other causes of hunger on this list — read on for more, or see how you can help now.

Food shortages Across Africa, including regions like the Sahel and the Horn of Africa, farming families experience periods before harvests known as "hungry seasons." These are the times of year when food supplies from the previous harvest are exhausted, but the chance to replenish supplies is still some time off. This leaves families forced to skip one (or more) meals each day in the period before the next harvest — which could be months away.

War & conflict War and conflict are also among the leading contributors to world hunger. In South Sudan, civil war has led to mass displacement and abandoned fields. The result is crop failure which, combined with a soaring inflation rate that makes imported food unaffordable, has left 6 million people food-insecure. Likewise, Yemen's ongoing conflict has led to over half the country (approximately 17 million people) in need of urgent action in the absence of ongoing humanitarian food assistance.



Climate change Countries like Zambia enjoy relative peace and political stability. However, they are also plagued by hunger due to climate extremes. Too much, or too little, rainfall can destroy harvests or reduce the amount of animal pasture available. These fluctuations are made worse by the El Niño weather system, and are likely to increase due to changes in climate. Extreme climate patterns also tend to affect the poorest regions of the world the most. The World Bank estimates that climate change has the power to push more than 100 million people into poverty over the next decade.

Poor nutrition Hunger isn't simply a lack of access to food; it's a lack of access to the right nutrients. In order to thrive, humans need a range of foods providing a variety of essential health benefits. Poor families often rely on just one or two staple foods (like corn or wheat), which means they're not getting enough critical macronutrients and vitamins, and may still suffer the effects of hunger.

A lack of nutrition is especially important for pregnant and breastfeeding women and young children: Nutrition support during pregnancy and up to the age of five can help protect children for their entire lives. Proper nutrition reduces the likelihood of disease, poor health, and cognitive impairment. Through the LANN project, communities in countries like Sierra Leone are learning how to identify nutrient-rich wild foods that are safe to eat in order to make the most of their available resources. This is one of the many ways we look for sustainable solutions for malnourished communities.

Poor public policy Systemic problems, like poor infrastructure or low investment in agriculture, often prevent food and water from reaching the world populations that need them the most.

Economy Much like the poverty-hunger cycle, a country's economic resilience has a direct effect on its nutritional resilience. For example, Liberia's overall economic troubles deepened after the Ebola outbreak. Five years later, 50% live below the poverty line.

Food waste According to the World Food Programme, 1/3 of all food produced — over 1.3 billion tons of it — is never consumed. What's more, producing this wasted food also uses other natural resources that, when threatened, have a ripple effect in the countries that are already hit hardest by hunger, poverty, and climate change. Producing this wasted food requires an amount of water equal to the annual flow of Russia's Volga River — and adds 3.3 billion tons of greenhouse gases to the atmosphere.

Gender inequality In its Sustainable Development Goal 2, the UN reveals: "If women farmers had the same access to resources as men, the number of hungry in the world could be reduced by up to 150 million." Female farmers are responsible for growing, harvesting, preparing, and selling the majority of food in poor countries. Women are on the frontlines of the fight against hunger, yet they are frequently underrepresented at the forums where important decisions on policy and resources are made.

A major way to prevent famine is by supporting humanitarian relief efforts. In addition, many groups support the funding of programs to help local communities survive times of drought and other causes of food scarcity.

Que. 8 (a) What are the constraints in Coastal Agriculture? Explain it in Indian context

Ans. 8 (a) The coastal zone represents the transition from terrestrial to marine influences and vice versa. It comprises not only shoreline ecosystems, but also the upland watersheds draining into coastal waters, and the near shore sub-littoral ecosystems influenced by land-based activities. Functionally, it is a broad interface between land and sea that is strongly influenced by both. India has an 7516 km long coastline. Its peninsular region is bounded by the Arabian Sea on the west, the Bay of Bengal on the east and Indian Ocean to its south. It has two distinct major island ecosystems, the Andaman and Nicobar group of Islands in the Bay of Bengal and the Lakshadweep Islands in the Arabian Sea. The coastal ecosystem in India occupies an area of about 10.78 million hectares , and covers a long strip along the east coast (West Bengal, Odisha, Andhra Pradesh, Pudicherry and Tamil Nadu) and west coast (Gujarat, Maharashtra, Karnataka and Kerala). It also occupies considerable area under Lakshadweep and Andaman and Nicobar group of Islands.

Constraints in coastal agriculture Low productivity of this ecosystem is attributed to its unfavourable agro-climatic conditions. Coastal soils encounter several abiotic stresses viz., salinity, acidity, waterlogging and sandy texture. Most of the coastal areas have problematic soils, such as saline, alkaline, acid sulphate, marshy and waterlogged, as they are situated in low-lying areas, mainly along the deltas. Salinity is the main factor responsible for poor yield of crops growing an area of about 3.1 million hectares. The estimate on the extent of acid sulphate soils in the coastal areas reveals that about 0.26 million hectares area in Kerala and the Andaman and Nicobar group of islands are occupied by this type of soil. The presence of acid sulphate soils has also been reported in the coastal areas of Sundarbans, West Bengal. Coastal soils exhibit a great deal of diversity due to difference in parent material, wide variation of climate, physiography, differentially active geomorphic processes, hydrochemical characteristics of shallow underground water and differential inundation by tidal marine/lacustrine waters. Therefore, proper understanding about the nature, properties and prevailing constraints related to diverse group of coastal soils is necessary to adopt better management practices and improve the productivity and quality of such low productive soils.

Management approaches for coastal soils

Leaching the soil The salinity level of salt-affected coastal soils can be reduced by leaching the soils with good quality water. This can be a good option to reclaim the cyclone affected soils of the coastal area also. In the low-lying coastal areas where water table remains shallow for most part of the year and the quality of ground water is poor, installation of sub-soil drainage system is more useful.

Avoidance of summer fallow Most of the coastal areas suffer from excess water in monsoon season with attendant problem of prolonged deep water submergence, leaving an adverse effect on crop growth. Whereas in winter and summer months, the capillary rise of the saline ground water impel the farmers to take only one rice crop in a year during the monsoon season. If good quality water is available, second crop of rice cultivation can be undertaken during the fallow period which will reduce the salinity level, besides increasing the cropping intensity. The high salinity is due to the high evaporation rate from soil during winter and summer months, when ground water is at shallow depth and rich in salt content. In coastal areas, the availability of good quality irrigation water is one of the major problems. However, if sufficient irrigation water of good quality is not available, a crop like chilli, barley, linseed, sugar beet can be grown whose crop canopy will reduce evaporation as well as soil salinity.

Application of soil amendments Application of lime and alkaline flyash in proper combination to the coastal acid sulphate soils is effective for amelioration to some extent. Rice husk bio-char could be used as a substitute for liming materials to improve the quality of acid sulphate soils. This plays an important role in highly permeable coastal sandy soils during dry summer months.

Growing of suitable crops In coastal areas, rice is the most preferable crop, as it is highly salt tolerant and can be grown under submerged condition. Rice cultivation promotes the leaching of salts from coastal saline soils. Adoption of rice crop in acid sulphate soils of coastal areas increases the pH of soil and thus reduces the iron and aluminium toxicity. Selection of suitable rice variety depending upon the salinity level and depth of water regime is highly appreciable

Nutrient management Most of the coastal soils are deficient in nitrogen due to heavy loss through volatilization, leaching and run-off. Phosphorus deficiency is also a common phenomenon in coastal acid sulphate or acid saline soils. Use of nitrogenous fertilizers is very much essential to obtain higher yield of crop in coastal saline soils. Application of rock phosphate as phosphorus source is highly beneficial for coastal acid saline soils (locally known as kari or kayal or karappadom in Kerala). Long term fertilizer experiment showed significant response of rice crop due to application of nitrogenous fertilizers on coastal saline soils of West Bengal under rice-fallow cropping system.

Rice-Fish based agro-ecology Rainfed lowlands with water stagnation and flooding occupy 41 per cent (17.3mha) of the rice area in the country, and 52 per cent (14.9 mha) of the rice area in eastern India. The productivity of this mega system is very low because of mono-crop of rice. Among the farming system options available in rainfed low land ecologies, rice-fish farming system is one of the best acceptable choices considering the resources, food habits and socio-economic cultures of the country in general and eastern India in particular. The water stored in the deep part of the system is utilized for life saving irrigation. Rice-fish farming venture is a better bargain than a single rainfed low land rice-cultivation, under the risk of vagaries of climate.

Components of rice-fish farming system Crop husbandry: In the centre of the pond area, rice is grown in the Kharif season; followed by vegetables like brinjal, gourds, chilli etc. in the summer season. Fruits like banana and papaya are grown on the dykes of the pond. In the deep area of the pond rice-rice crop sequence may be followed. Rice varieties capable of growing vigorously in hypoxic environment,that is oxygen deficient conditions alleviate the constraints of poor seedling stand establishment and also accrue the weed suppressing advantage of early flooding. To supplement the nitrogen requirement, Azolla is grown along with paddy.

Fish species which thrive in shallow water, tolerate high turbidity, temperature and grow fast are selected. The fishes like catla ,rohu mrigal , common carp can be best suited for rice-fish-culture. The stocking density is maintained at 5,000 to 6,000 fingerlings per hectare

Water hyacinth is grown in a portion of the canal, which provides shade and shelter for the fish, besides being an excellent feed to the fishes. It is grown as an added commodity in a rice-fish farm. Practically, whole plant of water hyacinth can be consumed (tubers, stalk and leaves) by the fishes. It is also utilized as food by the ducks. The fishes are fed with rice-bran or rice polish and mustard cake/ groundnut cake or soybean meal in dough-like balls at 2-3 per cent of the average body weight of the fish as supplementary feed to help them grow to a bigger marketable size.

Que. 8 (b) Discuss the significance of bio diversity and fundamentals of sustainability.

Ans. 8 (b) The term biodiversity (from "biological diversity") refers to the variety of life on Earth at all its levels, from genes to ecosystems, and can encompass the evolutionary, ecological, and cultural processes that sustain life. Ecosystems and biodiversity provide four types of services to the world

- **Provisioning Services** are the material benefits people get from ecosystems for e.g. supply of food, water, fibers, wood and fuels.
- **Regulating Services** are the benefits obtained from the regulation of ecosystem processes e.g. the regulation of air quality and soil fertility, control of floods or crop pollination.
- **Supporting Services** are necessary for the production of all other ecosystem services, for e.g. by providing plants and animals with living spaces, allowing for diversity of species, and maintaining genetic diversity.
- **Cultural Services** are non-material benefits people gain from ecosystems, for e.g. aesthetic and engineering inspiration, cultural identity and spiritual well-being.

Biospheres refers to the narrow zone of the earth in which all life forms exist. It is because this is the zone in which all the three essentials things which are required for sustenance of life are found in a right mixture. They are land (lithosphere), air (atmosphere) and water (hydrosphere). In other words, this narrow zone is a place where lithosphere, atmosphere and hydrosphere meet. Within this framework, those characterized by broadly similar geography and climate, as well as communities of plant and animal life can be divided for convenience into different bio geographical realms.

These occur on different continents. Within these, smaller bio geographical units can be identified on the basis of structural differences and functional aspects into distinctive recognizable ecosystems, which give a distinctive character to a landscape or waterscape. Their easily visible and identifiable characteristics can be described at different scales such as those of a country, a state, a district or even an individual valley, hill range, river or lake.

The simplest of these ecosystems to understand is a pond. It can be used as a model to understand the nature of any other ecosystem and to appreciate the changes over time that is seen in any ecosystem. The structural features of a pond include its size, depth and the quality of its water. The periphery, the shallow part and the deep part of the pond, each provide specific conditions for different plant and animal communities. Functionally, a variety of cycles such as the amount of water within the pond at different times of the year, the quantity of nutrients flowing into the pond from the surrounding terrestrial ecosystem, all affect the 'nature' of the pond.

The ecosystem functions through several biogeochemical cycles and energy transfer mechanisms. Both these aspects of the ecosystem interact with each other through several functional aspects to form Nature's ecosystems. Plants, herbivores and carnivores can be seen to form food chains. All these chains are joined together to form a 'web of life' on which man depends. Each of these use energy that comes from the sun and powers the ecosystem.

Principles of Ecosystem Function

The preceding examination of how ecosystems function reveals that three common denominators underlie them all:

- recycling of nutrients,
- using sunlight as a basic energy source, and
- Populations are such that overgrazing does not occur.

In turn, these common features reveal basic principles underlying the sustainability of ecosystems.

Nutrient Cycling

Looking at the various inputs and outputs of producers, consumers, detritus feeders, and decomposers, you should be impressed by how they fit together. The products and byproducts of each group are the food and/or essential nutrients for the other. Specifically, the organic material and oxygen produced by green plants are the food and oxygen required by consumers and other heterotrophs. In turn, the carbon dioxide and other wastes generated when heterotrophs break down their food are exactly the nutrients needed by green plants. Such recycling is fundamental, for two reasons: (a) It prevents wastes, which would cause problems, from accumulating; (b) It assures that the ecosystem will not run out of essential elements. Thus, we uncover the ***first basic principle of ecosystem sustainability*****:**

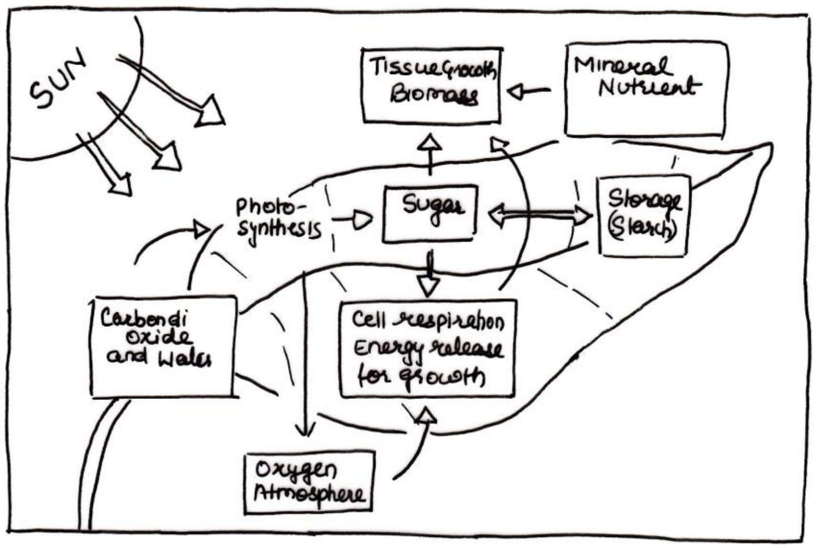
For sustainability, ecosystems dispose of wastes and replenish nutrients by recycling all elements.

Running on Solar Energy

We have seen that no system can run without an input of energy, and living systems are no exception. For all major ecosystems, both terrestrial and aquatic, the initial source of energy is sunlight absorbed by green plants through the process of photosynthesis. (The only exceptions are ecosystems near the ocean floor or in dark caves, where the producers are bacteria that derive energy from the oxidation of hydrogen sulfide in those locations. These bacteria use that energy to make organic compounds, in a manner similar to that of higher plants. The process is called chemosynthesis, because it runs on chemical energy rather than light).

Using sunlight as the basic energy source is fundamental to sustainability for two reasons: it is both nonpolluting and non depletable.

Nonpolluting – Light from the Sun is a form of pure energy; it contains no substance that can pollute the environment. All the matter and pollution involved in the production of light energy are conveniently left behind on the Sun some 93 million miles (150 million kilometers) away in space.



Non depletable – The Sun's energy output is constant. How much or how little of this energy is used on Earth will not influence, much less deplete, the Sun's output. For all practical purposes, the sun is an everlasting source of energy. True, astronomers tell us that the Sun will burn out in another 3-5 billion years, but we need to put this figure in perspective. One thousand is only 0.0001 percent of a billion. Thus, even the passing of millennia is hardly noticeable on this time scale.

Hence, we uncover the ***second basic principle of ecosystem sustainability***:

For sustainability, ecosystems use sunlight as their source of energy.

From the preceding discussion, you should be impressed with the importance of chemical nutrients and light as the major prerequisites for the functioning of every ecosystem. Yet, rainfall and temperature (climate) are the primary limiting factors determining different terrestrial biomes. Basically, this is because every region that is above water receives abundant light, and most soils contain a modicum of nutrients or retain their nutrients through recycling. Therefore, light and nutrients are generally not limiting factors on land. But the situation is different in aquatic and marine environments, where light and nutrients dominate as the determining factors.

Prevention of Overgrazing

In the concept of the food or biomass pyramid, a consumer cannot gain an amount of weight equal to what it eats because first, 60-90 percent of what is consumed is broken down for energy and second, another portion passes through without being digested. These two facts by themselves would result in the declining biomass at each higher trophic level – the biomass pyramid observed. However, there is a third reason for the observed decline. It is the following.

In a grazing situation, it is readily apparent that if the animals eat the grass faster than the grass can re-grow, sooner or later, the grass will be destroyed, and all the animals will starve. This situation is known as **overgrazing**. The same holds true in the case of carnivores and their prey. Basically, a sustainable situation demands that, on average, consumption cannot exceed production. It follows, then, that a large portion of the producer must remain intact to maintain that production. This portion, or population, that is not consumed, and which must remain intact to assure continued production, is called the **standing biomass**. In natural ecosystems, which are sustainable, we observe that consumers eat no more than a small proportion of the total biomass available; most is left as standing biomass. We can readily see that this is another feature that is fundamental to sustainability. Hence, here is the ***third basic principle of ecosystem sustainability***:

For sustainability, the size of consumer populations is maintained so that overgrazing or other overuse does not occur.

For not, it is sufficient to appreciate that such regulation is mandatory for sustainability. Recognizing principles of ecosystem sustainability, many attempts to make artificial ecosystems have been initiated worldwide.

UN Decade on Ecosystem Restoration aims at building a common understanding among involved stakeholders of the objectives, ensuring active participation of each member in a coherent way and discussing the way forward for realizing the Decade's objectives.

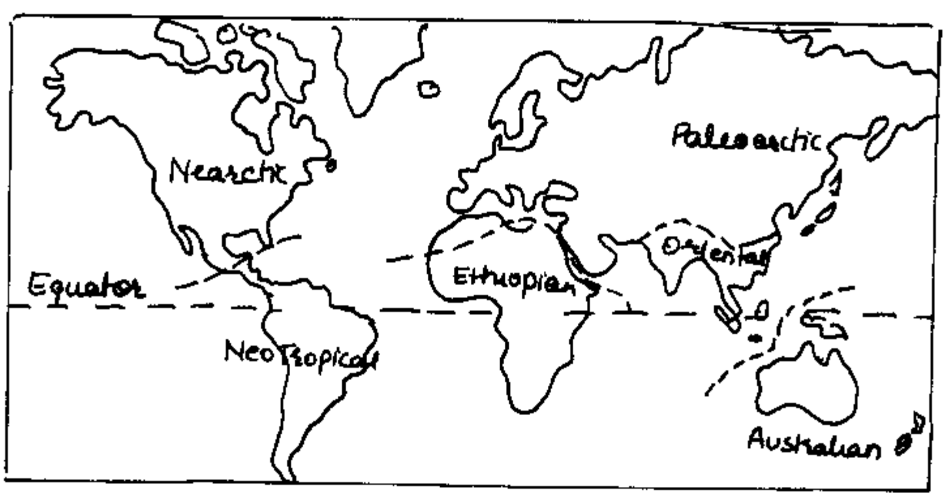
- Raise awareness of the importance of healthy ecosystems for livelihoods in the NENA region and inform about the costs that the region and its people will incur if no action is taken.

- Inform all relevant stakeholders of the UN Decade about the global appeal and opportunity for action by all; and define roles and responsibilities of each partner in achieving the Decade's goals.
- Discuss linkages between the UN Decade and the existing international conventions and agreements such as CBD, UNCCD, UNFCCC as well as its contribution for achieving the SDGs.
- Deliberate on policy and technical constrains facing implementation of the Decade in the region as well as opportunities

Que. 8 (c) Give an account of world distribution of land animals. How many types of animal dispersals are identified?

Ans. 8 (c) Zoo geography deals with the geographic distribution of animals. The world is divided into a number of zoo-geographic or faunal regions. According to **Wallace** (1876), the following zoo-geographic regions of the world may be observed

(i)**Palaerctic region:** This largest region includes whole of Europe, northern China, Japan, Soviet Russia, northern part of Africa and Persia, etc. It is subdivided into Europeans, Mediterranean, Siberian and Manchurian sub regions. Fauna is represented by 135 families of terrestrial vertebrates (33 mammals, 68 of birds, 24 of reptiles, 10 of amphibians and fishes).



ii)**Ethiopian region:** This includes whole of Africa and Arabia, Madagascar and Mauritius. The fauna is much varied, resented by about 161 families of terres trial vertebrates; of which 30 are endemic to this region which include such mammals as aye-aye, golden moles, mole rates, jumping hares, African flying squirrels,giraffes etc. this region is divided into east African, west African, south African and Malagasy sub-regions.

iii) **Oriental region**: This region includes all the tropical parts of Asia, like India, Sri Lanka,south China, Malaysia and Malayan islands located to the western side of Wallace's line, i.e. Java, Sumatra, Philippines, Borneo, Bali, etc. Climatic conditions of this region are much varied being desert in the north of Indian sub-region, tropical in southern portion of India and Sri Lanka, and temperate in Bhutan and Yang-tse-kiang. Major part of the region is occupied by luxuriant forest vegetation. The terrestrial verte brates are represented by about 153 families of which 10 are peculiar to the region, which include four mammals, one bird and five reptiles.

Oriental region is divided into the following four sub regions:

- **Indian sub region:** It includes whole of India from the Himalayan slopes to Cape Comorin.
- **Ceylonese sub region**: It comprises the island of Sri Lanka, whose physical characteristics are more or less similar to those of southern mountains of India.
- **Indo-Chinese region:** It includes China, south of Palaearctic boundary, Burma, Thailand and islands of Andaman, Formosa and Hainan.
- **Indo-Malayan sub region:** It includes the Malayan Peninsula and islands of Malayan Archipelago, i.e. Borneo, Java, Sumatra, Nicobar, etc.

(iv) Australian region: This includes the whole of Australian, New Zealand, New Guinea and adjoining islands, particularly those of Pacific Ocean. The oriental and Australian regions are separated from each other by an imaginary line, **Wallace's line**, that is supposed to run between the islands of Bali and Lombok. In various parts, the climate is of temperate as well as tropical type. The fauna is represented by 134 families of terrestrial vertebrates of which 30 are specific to the region including 8 families or mammals, 17 of birds, 3 of reptiles and 2 of amphibians. Among the mammals, all belong to Monotremta and marsupialia, placental ones being altogether absent.

(v) Neotropical region: It comprises southern Mexico, Central and South America, West Indies and Galapagos islands. It is a tropical region with luxuriant forests. The fauna is represented By 155 families of terrestrial vertebrates of which 39 are peculiar to the region. These include 10 mammals, 23 birds, 2 reptiles and 4 amphibians. This region is divided into Chilean, Brazilian, Mexican and Artillian sub regions.

(vi) Neoarctic region: It comprises Greenland and North America up to the centre of Mexico. In the west, there are many large lakes and island seas. The terrestrial vertebrates are about 120, or which 26 are mammals, 59 birds, 21 reptiles and amphibians. Of these, 5 are peculiar, such as Haplodontidae and prong-buck among mammals the wren-tits among birds. Anillidae among reptiles and the Sirededidae among amphibians. This region is divided into Californian, Rocky Mountain, Alleghany and Canadian sub regions.

Dispersal of Animals Dispersal of animals may be defined as the spreading of animals from the places of their origin to other areas. Dispersal is a **three-stage process,** encompassing

- decision making in terms of departure,
- displacement and
- Settlement.

The social dominance hypothesis predicts emigration of individuals in an inferior physiological state

Factors of Animal Dispersal The spread and dispersal of animals is controlled by two factors:

1. **Physical environment:** Distribution of land and water and topography affect the dispersal of animals to a great extent. Terrestrial animals cannot swim, as such; water poses a great barrier to their dispersal. Saline oceanic water is harmful for fresh water animals. High mountains, widespread deserts, swamps, deep valleys, etc. also obstruct the dispersal of animals. Unfavorable climate and distance factor also affect the dispersal of animals in a great way.

2. **Innate ability:** Qualities of animals e.g. creeping, crawling, hopping, leaping, climbing, digging, borrowing, swimming, flying, etc. enable animals to move and migrate. These qualities of animals determine the type nature and rate of dispersal and migration. When animals become mobile and

move out from their places motivated and stimulated by their innate qualities, the resultant dispersal is called “active dispersal’.

Mesosaurs (a Permain reptile), Glossopteris (Permain plant) and Cynognathus (a Late Triassic reptile) originated in South America, from where Cynognathus and Mesosaurs migrated to Africa, while Glossopteris plants migrated to Africa, Antarctica, India and Australia. Lystrosaurs (Late Triassic reptile) was originated in Africa from where it was dispersed to India and Australia.

Dear, taiga, sheep, bison, musk ox, mastodon, mammoths and man migrated from Asia to North America via Bering Bridge, while beavers, opossum, raccoon, horse, etc. migrated from North America to Asia (via the same bridge). Raccoons, cats, horses, tapirs, llamas, camels, etc. migrated from North America to South America via Central American Bridge, whereas capybaras, porcupines, armadillos, glyptodonts, ground sloths etc. were dispersed from South America to North America via Central American Bridge, Butterflies, moths, beetles, grasshoppers, locusts, bugs etc. were dispersed from Africa to Europe and Asia, whereas these animals were transported to South America by ships.

Dispersal may be of the following types:

- **Gradual dispersal:** It involves longer period of time and very slow rate of migration. However, such dispersal covers large areas and results in widespread distribution of animals over time.
- **Rapid dispersal.** It involves mass exodus of animals from one area to another. Such dispersal may not be a permanent one as they may not be allowed by man or local environmental conditions to settle down in new habitats. Such dispersal involves certain animals only, e.g. locusts, lemmings, butterflies, moths, dragonflies, etc.
- **Seasonal dispersal:** It involves the migration of those animals which leave their habitat due to seasonal extreme weather conditions every year and migrate to areas of favourable weather conditions. These migratory animals and birds return to their native places when conditions become favourable. Migration of Arctic birds during winter to sub-tropical and tropical areas and the return to their native places next summer season proves this fact. Some of the Greenland wheatears birds fly directly to Spain covering a distance of 3200 km. Similarly, Blackpoll Warbler (a sparrow like small bird) flies from New England (USA) during winter to

Venezuela (South America). Arctic terns cover the longest distance (over 35,000 km) each year. Like Volcanic eruptions, recurrent floods, forest fires, prolonged droughts, etc.

- **Forced dispersal:** It occurs when sudden events force the animals to leave their native places. In such conditions, scarcity of food leads to famine, and causes their migration. Serious forest fires in Siberia in 1915 caused many animals to migrate.
- **Anthropogenic dispersal:** Man has been a major factor in the dispersal of animals. He has introduced diversifications in the regional fauna and has caused several ecological problems. For example, the introduction of deers and rabbits in New Zealand by the Europeans caused large scale destruction of natural vegetation. It led to accelerated soil erosion.

Sometimes the animal dispersal is effected by external carriers; it is called 'passive dispersal'. Passive dispersal occurs when animals are carried by man or by various means of transport (man made as well as natural). Such carriers are of four types:

Eolian Carriers: e.g. air masses, air currents and winds, which transport micro-organisms from one place to another without the willingness of the organisms.

Aquatic Carriers: e.g. sea waves, tidal currents, and oceanic currents which can carry larger animals to distant places.

Organism Carriers: Symbiotic animals (those dependent on each other and live together) also transport animals to distant places. It happens when small animals are attached and stuck to the bodies of the carrier animals and thus these are transported to various destinations. Birds also help in such dispersal. Parasitic organisms, such as virus are hidden in the stomach or mixed with blood, spatum and stool of animals, reach various destinations. Worms living in the stomach of man are also carried away to far off places when overseas journeys are under taken.

Anthropogenic Carriers: These are the most powerful and effective means of passive dispersal and migration of animals. It is caused by man deliberately or accidentally. **Dispersal of animals is not always positive. It becomes unsuccessful when the animals reaching new habitats are unable to adapt to new environmental conditions and ultimately perish.**

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