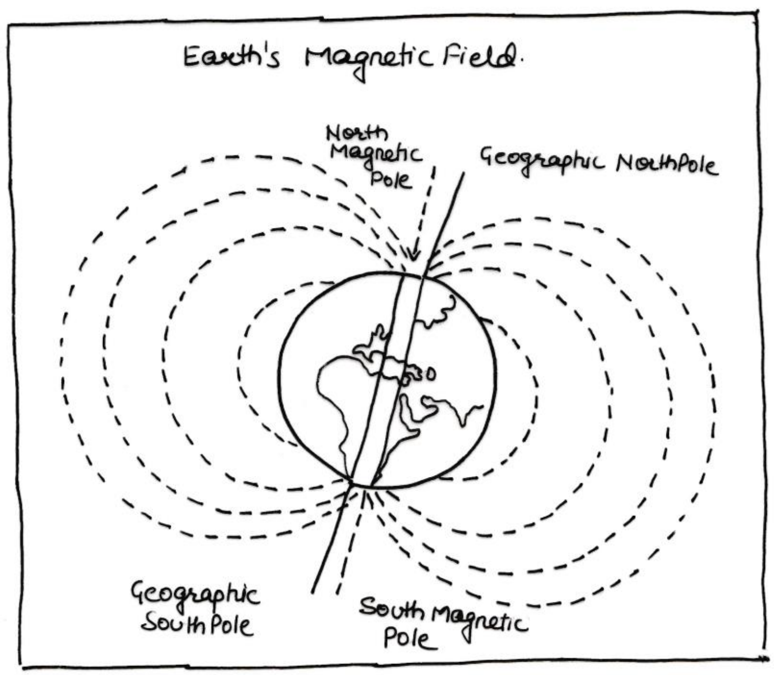
## MODEL ANSWER - 9

**Ques. 1 (a) What are fundamentals of geomagnetism?**

**Ans. 1 (a)** The magnetic properties of the iron-rich mineral magnetite, or lodestone, were known to the Ancient Greeks, but the magnetic compass was not invented until the 13th century when the Chinese floated lodestone on wood and found that it caused the wood to rotate to a fixed position. The use of a compass in navigation and path finding lies in the fact that a magnetized needle that is free to rotate about a vertical axis always comes to rest with one end pointing in the direction of the north magnetic pole. The reason why a compass needle consistently points north-south in this fashion was first explained by the 17th century British physicist William Gilbert, who suggested that the Earth itself acted as a huge magnet, the force of which controlled the orientation of smaller ones.

Although the exact relationship is still a matter of intense debate, scientists now think that this magnetism is related to the motion of a liquid layer deep within the Earth's interior. This layer is rich in iron and spins like a dynamo under the influence of the Earth's rotation. The spinning dynamo, in turn, generates the planet's magnetic field. This field behaves as if a simple bar magnet were aligned north-south at the Earth's center, producing lines of magnetic force which emerge from the southern hemisphere and loop through space to return in the northern hemisphere. Therefore the lines of magnetic force are parallel to the Earth's surface at the equator but plunge ever more steeply as the poles are approached, pointing up out of the ground in the southern hemisphere and down into the ground in the northern hemisphere.




The orientation of a compass needle pivoted on its center of gravity is controlled by these invisible lines of magnetic force. The lines cause the compass needle to point north but also cause the needle to tilt, the north end tilting downward in the northern hemisphere and upward in the southern hemisphere. So a compass reading really has two components - a horizontal component, or swing, used in navigation and path finding; and a vertical component or tilt, known as the magnetic inclination. Because the amount of inclination progressively increases with distance from the equator, and the direction of tilt is different in the northern and southern hemispheres, the inclination of a compass needle can be used to determine latitude.

The study and measurements of the Earth's magnetic field from ancient rocks is called paleo magnetism. When the history of the Earth's magnetic field was first examined in this way, the results were startling. Rather than pointing to the present day magnetic poles as expected, the tiny magnetic compass needles in ancient basalt lavas were found to point in many different directions.

**Apparent Polar Wander**

When modern basalt lava flows, like those of Hawaii, are examined paleo magnetically, their tiny magnetite compass needles are found to point toward the present day magnetic poles. But this is not the case for ancient basalt lavas. Magnetized rock samples taken from basalts all over North America, for example, were found to point in the same direction providing the basalts were the same age, but the direction was not north-south. Moreover, magnetized samples from basalts of different age were found to point in different directions, suggesting that the Earth's magnetic poles had moved with time. Yet harder to explain, basalts of the same age but from different continents gave different positions for the same magnetic pole. Only the geologically most recent basalts gave calculated "north pole" positions that coincided with the true position of the North Pole. If the continents were fixed, this data suggested that the Earth had several north and south poles at the same time.

In order to obtain a systematic view of these puzzling magnetic patterns, pole positions were calculated for rocks from North America and Europe for the last 300 million years.

The line connecting the changing positions of either pole suggested by successively older basalt samples from a given continent is called a polar wander curve, and traces the pole's apparent movement.

A corresponding analysis of the European data produced similar results. European basalts of the same age define the same "north pole", but basalts of different ages have different "north poles" whose positions can be connected to define a polar wander curve for Europe. However, this pole wander curve has a different path from of North America. If the continents had fixed positions, this would be very difficult to explain.

But the position of the magnetic poles is thought to be geographically fixed by the Earth's axis rotation. If so, how could the poles "wander" or change their positions. They don't wander and there can't be several of them at once. There are only two realistic options. Either the magnetic poles have moved in some unknown manner, or the continents have moved. If the continents moved, the magnetic records frozen into ancient basalts when they erupted on continents millions of years ago would become reoriented by the movement. As the positions of the magnetic poles are constrained by the Earth's rotational axis, it is most unlikely that they have moved to the extent suggested by the data. By eliminating the first option we are left either the second, that is, the movement of the continents. Furthermore, when the continents are reassembled into a Pangea "fit" like the one proposed by Wegner, the two polar wander paths coincide. This suggests that the two continents were once joined and that their polar wander oaths diverged with the opening of the North Atlantic Ocean.

**Paleomagnetic Reversals**

A key piece of the puzzle was provided by an even more startling paleomagnetic discovery. Magnetized samples of basalts from the same locality were repeatedly found in which the north and south poles had apparently been interchanged. That is, the north magnetic pole suddenly swapped position with the south magnetic pole so that the tiny compass needles produced in basalt lavas erupted at the time pointed south rather than north. To test these rival possibilities, Allan Cox of Standard University and Brent Dallrymple of the U.S Geological Survey set about collecting magnetized samples from all over the world in order to compare their mineral content, their direction of magnetization, and their age. If, they argued, rocks were reversely magnetized because they contained a certain mineral, then all reversely magnetized samples would contain that mineral. If, on the other hand, the Earth's magnetic field had reversed, then samples from all over the world would record the magnetic reversal at precisely the same time. Amazingly, their study showed that it was the Earth's magnetic field that periodically reversed itself during an event known as a magnetic polarity reversal.

**Que. 1 (b) Discuss the characteristics of precipitation regimes of world.**
**Ans. 1 (b)** Globally, rain is the main source of fresh water for plants and animals rainfall is essential for life across Earth's landscapes. In addition to moving tremendous amounts of water through Earth's atmosphere, rain clouds also move tremendous amounts of energy. When water evaporates from the surface and rises as vapor into the atmosphere, it carries heat from the sun-warmed surface with it. Later, when the water vapor condenses to form cloud droplets and rain, the heat is released into the atmosphere. **This heating is a major part of Earth's energy budget and climate.**

The most obvious pattern in the total rainfall maps is seasonal change. A band of heavy rain moves north and south of the Equator seasonally. In fact, about two-thirds of all rain falls along or near the equator, and countries in those latitudes often have several months of near-daily rain followed by months of dryness as the rain band moves north and south. The Asian monsoon brings rain to China, Southeast Asia, and India between April and September. From October through May, South America goes through a rainy season, but even parts of the Amazon Rainforest goes a few months each year without significant rain.

The most important geographic aspect of atmospheric moisture is the spatial distribution of precipitation. The broad-scale zonal pattern is based on latitude, but many other factors are involved and the overall pattern is complex. A major cartographic device used on maps that illustrates worldwide. precipitation distribution is the **isohyet**, a line joining points of equal quantities of precipitation.

**Average Annual Precipitation**

- The amount of precipitation on any part of Earth's surface is determined by

- the nature of the air mass involved and
- the degree to which that air is uplifted.
- The humidity, temperature, and stability of the air mass are mostly dependent on where the air originated (over land or water, in high or low latitudes) and on the trajectory, it has followed.
- The amount of uplifting, and whether or not that uplifting takes place, are determined largely by zonal pressure patterns, topographic barriers, and storms and other atmospheric disturbances.

The most conspicuous feature of the worldwide annual precipitation pattern is that the tropical latitudes contain most of the wettest areas. The warm trade winds are capable of carrying enormous amounts of moisture, and where they are forced to rise, very heavy rainfall is usually produced. Equatorial regions particularly reflect these conditions, as warm, moist, unstable air is uplifted in the ITC zone, where warm ocean water easily vapourizes. Considerable precipitation also results where trade winds are forced to rise by topographic obstacles. As the trades are easterly winds, it is the eastern coasts of tropical landmasses – for example, the east coast of Central America, northeastern South America, and Madagascar – where this orographic effect is most pronounced. Where the normal trade-wind pattern is modified by monsoons, the onshore trade-wind flow may reverse direction. Thus, the wet areas on the western coast of southeastern Asia, India, and what is called the Guinea Coast of West Africa are caused by the onshore flow of southwesterly winds that are nothing more than trade winds diverted from a ‘normal’ pattern by the South Asian and West African monsoons.

The only other regions of high annual precipitation shown on the world map are narrow zones along the western coasts of North and South America between 40° and 60° of latitude. These areas reflect a combination of frequent onshore westerly airflow, considerable storminess, and mountain barriers running perpendicular to the direction of the prevailing westerly winds. The presence of these north-south mountain ranges near the coast restricts the precipitation to a relatively small area and creates a pronounced rain shadow effect to the east of the ranges.

***The principal regions of sparse annual precipitation on the world map are found in three types of locations:***

1. Dry lands are most prominent on the western sides of continents in subtropical latitudes (centered at 25° or 30°). High-pressure conditions dominate at these latitudes, particularly on the western sides of continents, which are closer to the normal positions of the subtropical high-pressure cells. High pressure means sinking air, which is not conducive to condensation and precipitation. These dry zones are most extensive in North Africa and Australia, primarily because of the blocking effect of landmasses or highlands to the east. (The presence of such landmasses prevents moisture from coming in from that direction).
2. Dry regions in the midlatitudes are most extensive in central and southwestern Asia, but they also occur in western North America and southeastern South America. In each case, the dryness is due to lack of access for moist air masses. In the Asian situation, this lack of access is essentially a function

of distance from any ocean where onshore airflow might occur. In North and South America, there are rain shadow situations in regions of predominantly westerly airflow.

3. In the high latitudes, there is not much precipitation anywhere. Water surfaces are scarce and cold, and so little opportunity exists for moisture to evaporate into the air. As a result, polar air masses have absolute humidities and precipitation is slight. These regions are referred to accurately as 'cold deserts'.
4. One further generalization on precipitation distribution is the contrast between continental margins and interiors. Because coastal regions are much closer to moisture sources, they usually receive more precipitation than interior regions.

**Seasonal Precipitation Patterns**

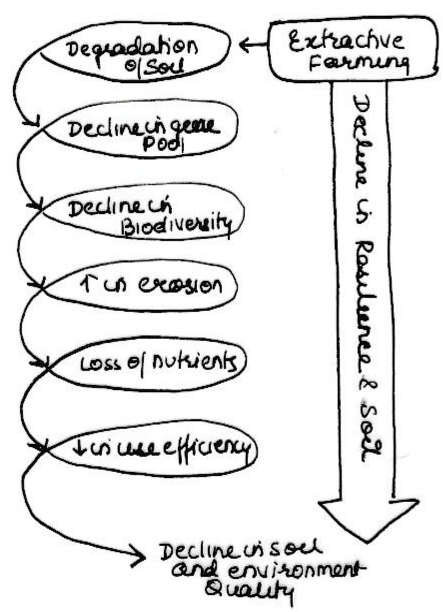
A geographic understanding of climate requires knowledge of seasonal as well as annual precipitation patterns. Over most of the globe, the amount of precipitation received in summer is considerably different from the amount received in winter. This variation is most pronounced over continental interiors, where strong summer heating at the surface induces greater instability and the potential for greater convective activity. Thus in interior areas most of the year's precipitation occurs during summer months, and winter is generally a time of anticyclonic conditions with diverging airflow.

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

**Ans. 1(c)** 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., CO2 and CH4) 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 (d) Avail detailed account on global attempts to abate marine pollution.**

**Ans. 1(d)** Ocean pollution — also called marine pollution — is a mixture of both chemical contamination and trash. The act of ocean pollution occurs when chemicals and trash are either washed, blown or intentionally dumped into the ocean. There are many causes of ocean pollution, but most (80%) of the pollution in our oceans originates on land and is caused by humans. Here are some of the major causes of marine pollution:

**Nonpoint source pollution (runoff)**

Nonpoint source pollution is the accumulation of pollution from small sources that can't be exactly pinpointed. Examples include the pollution created by individual cars, boats, farms and construction sites. Nonpoint source pollution typically becomes ocean pollution via runoff, which occurs when rain or snow moves pollutants from the ground into the ocean. For instance, after a heavy rainstorm, water flows off roads into the ocean, taking oil left on streets from cars with it. But wind can transfer dirt and other debris from nonpoint sources and deposit these pollutants on the ocean's surface.

**Point source pollution discharge**

Manufacturing plants in many areas of the world release toxic waste into the ocean, including mercury. While it has been banned in the USA, sewage also contributes to ocean pollution. Meanwhile, plastic waste poses a particularly tough challenge; according to the Ocean Conservancy, eight million metric tons of plastic go into our oceans every year.

**Oil spills** Ships are major contributors to ocean pollution, especially when crude oil spills occur. Crude oil lasts for years in the ocean and is difficult to clean up. You can find a history of oil spills on the NOAA site, but the largest one in recent history was, by far, the 2010 Deepwater Horizon well blowout in the Gulf of Mexico, which spilled roughly 134 million gallons of oil into the ocean.

**Littering** Atmospheric pollution — a type of ocean pollution where objects are carried by the wind to the ocean — is often caused by littering. It includes single-use plastics (such as plastic bags) and styrofoam containers which can take hundreds of years to biodegrade. It is estimated that roughly 1 trillion plastic bags are used worldwide per year.

**Ocean mining** Deep-sea ocean mining causes ocean pollution and ecosystem disruption at the lowest levels of the ocean. Drilling for substances such as cobalt, zinc, silver, gold and copper creates harmful sulfide deposits deep in the ocean.

**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.

**Effects of ocean pollution**

Ocean pollution has many consequences that directly and indirectly affect marine life, as well as humans. Here are some of the most common effects of ocean pollution:

**Harmful to marine species** Sea animals are frequent victims of ocean pollution. Oil spills, for instance, will ensnare and suffocate marine animals by permeating their gills. When the oil gets into seabird feathers, they may not be able to fly or feed their young. Animals that aren't killed by crude oil may suffer from cancer, behavioral changes and become unable to reproduce. Marine animals also mistake small plastic debris for food or become entangled in or strangled by plastic bags and discarded fishing nets. Animals most vulnerable to harm from plastic debris in the ocean include dolphins, fish, sharks, turtles, seabirds and crabs.

**Depletion of oxygen in seawater** As excess debris in the ocean slowly degrades over many years, it uses oxygen to do so, resulting in less oxygen in the ocean. Low levels of oxygen in the ocean lead to the death of ocean animals such as penguins, dolphins, whales and sharks. Excess nitrogen and phosphorus in seawater also cause oxygen depletion. When a great deal of oxygen depletion occurs in an area of the ocean, it can become a dead zone (see below) where very little marine life can survive.

**A threat to human health** Pollutants in the ocean make their way back to humans. Small organisms ingest toxins and are eaten by larger predators, many of which are seafood that we eventually eat. When the toxins in contaminated animals get deposited in human tissue, it can lead to long-term health conditions, cancer and birth defects. For example, phytoplankton will absorb methylmercury (bacteria-converted mercury carried down to the ocean's surface). This makes its way up the food chain when zooplankton eat the phytoplankton, then small fish eat the zooplankton, then bigger fish eat the smaller fish. By the time you reach a fish the size of a swordfish, they can contain a very high mercury load (in fact, swordfish contain one of the highest mercury loads).

While the exact amount of pollution in the ocean is difficult to measure, one recent study estimates that the world's oceans are polluted by roughly 171 trillion plastic particles that, if gathered, would weigh roughly 2.3 million tons. These microplastics (tiny plastic particles .2 inches or smaller) find their way into marine ecosystems and our water.

**The Great Pacific Garbage Patch** is a collection of litter — primarily microplastics — in the North Pacific Ocean, and is actually composed of two separate large patches, the Western Garbage Patch (found near Japan) and the Eastern Garbage Patch (found between Hawaii and California). The GPGP is the biggest, but not the only, garbage patch; the Atlantic and Indian Oceans are home to trash vortexes, and smaller bodies of water are also developing them.

**Dead zones are areas** of water where sea life cannot survive due to reduced oxygen levels. Dead zones result from nutrient pollution — a type of pollution created when runoff introduces excess nutrients like nitrogen and phosphorus — which encourages the growth of algae blooms. These algae blooms consume oxygen and block sunlight to oxygen-producing underwater plants.

**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.***

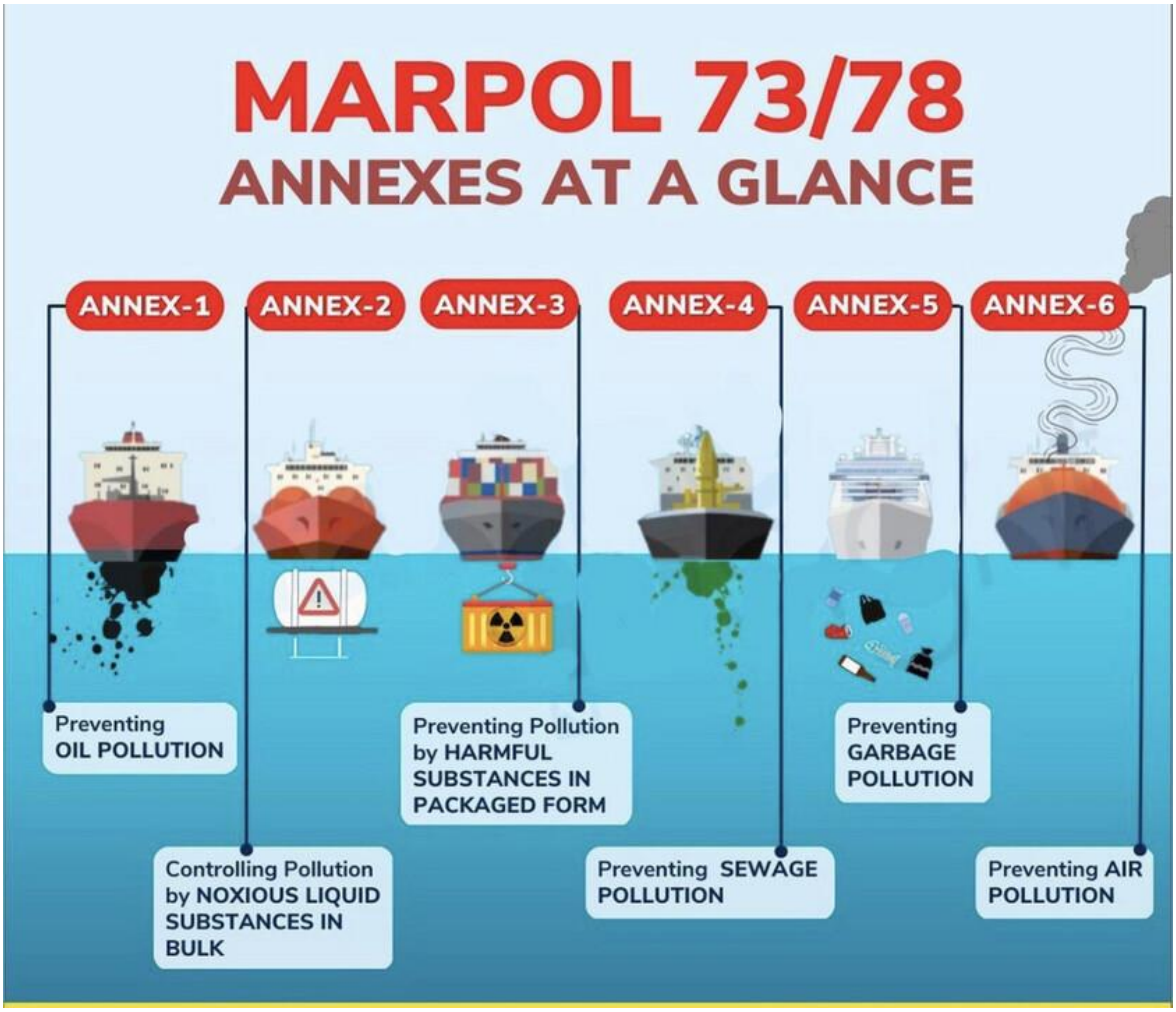
**International Convention for the Regulation of Whaling**

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.

**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. 1 (e) What are unconformities and its kinds?**

**Ans. 1 (e)** Unconformities are gaps in the geologic record that may indicate episodes of crustal deformation, erosion, and sea level variations. They are a feature of stratified rocks, and are therefore usually found in sediments (but may also occur in stratified volcanics). They are surfaces between two rock bodies that constitute a substantial break (hiatus) in the geologic record (sometimes people say inaccurately that "time" is missing). Unconformities represent times when deposition stopped, an interval of erosion removed some of the previously deposited rock, and finally deposition was resumed**.**

An unconformity are contact between two rock units. Unconformities are typically buried erosional surfaces that can represent a break in the geologic record of hundreds of millions of years or more. It called an unconformity because the ages of the layers of rock that are abutting each other are discontinuous. An expected age of layer or layers of rock is/are missing due to the erosion; and, some period in geologic time is not represented.

**Disconformity**

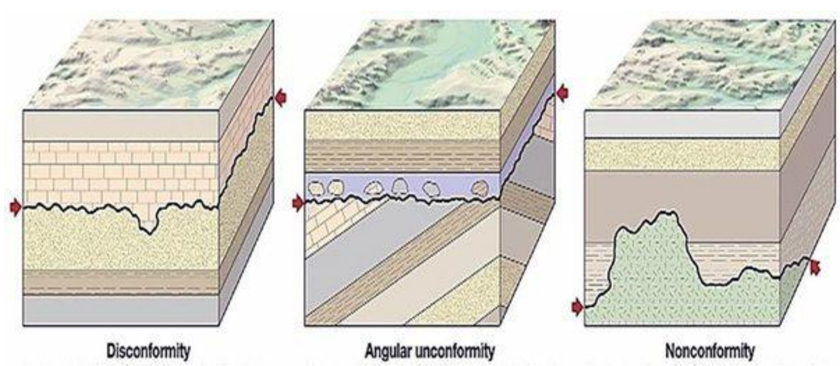
Disconformities are usually erosional contacts that are parallel to the bedding planes of the upper and lower rock units. Since disconformities are hard to recognize in a layered sedimentary rock sequence, they are often discovered when the fossils in the upper and lower rock units are studied. A gap in the fossil record indicates a gap in the depositional record, and the length of time the disconformity represents can be calculated. Disconformities are usually a result of erosion but can occasionally represent periods of nondeposition.

**Nonconformity**

A nonconformity is the contact that separates a younger sedimentary rock unit from an igneous intrusive rock or metamorphic rock unit. A nonconformity suggests that a period of long-term uplift, weathering, and erosion occurred to expose the older, deeper rock at the surface before it was finally buried by the younger rocks above it. Nonconformity is the old erosional surface on the underlying rock.

**Angular Unconformity**

An angular unconformity is the contact that separates a younger, gently dipping rock unit from older underlying rocks that are tilted or deformed layered rock. The contact is more obvious than a disconformity because the rock units are not parallel and at first appear cross-cutting. Angular unconformities generally represent a longer time hiatus than do disconformities because the underlying rock had usually been metamorphosed, uplifted, and eroded before the upper rock unit was deposited.



**Buttress Unconformity**

A buttress unconformity (also called onlap unconformity) occurs where beds of the younger sequence were deposited in a region of significant predepositional topography. Imagine a shallow sea in which there are islands composed of older bedrock. When sedimentation occurs in this sea, the new horizontal layers of strata terminate at the margins of the island. Eventually, as the sea rises, the islands are buried by sediment. But along the margins of the island, the sedimentary layers appear to be truncated by the unconformities. Rocks below the unconformities may or may not parallel the unconformities, depending on the pre-unconformity structure. Note that a buttress unconformity differs from an angular unconformity in that the younger layers are truncated at the unconformities surface.

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A regression occurs when a coastline migrates towards the sea when the coast falls to sea level (or lake level). Sea-level changes may result from regional uplifts or global sea-level changes, such as the formation or melting of continental glaciers. Regardless of the reason for the change of sea level, when the sea level falls, sediments erode from exposed soils. When the sea level rises, sediments are typically deposited in shallow continental shelves or coastal plains, such as in low, swampy areas, in quiet water environments.

**Que 2 (a)What is Metamorphism? Identify grade and Types of Metamorphism.**

**Ans 2 (a)** The mineralogical and structural adjustment of solid rocks to physical and chemical conditions that have been imposed at depths below the near surface zones of weathering and diagenesis and which differ from conditions under which the rocks in question originated.

The word "Metamorphism" comes from the Greek: meta = after, morph = form, so metamorphism means the after form. In geology this refers to the changes in mineral assemblage and texture that result from subjecting a rock to conditions such pressures, temperatures, and chemical environments different from those under which the rock originally formed.

Note that Diagenesis is also a change in form that occurs in sedimentary rocks. In geology, however, we restrict diagenetic processes to those which occur at temperatures below 200oC and pressures below about 300 MPa (MPa stands for Mega Pascals), this is equivalent to about 3 kilobars of pressure (1kb = 100 MPa).

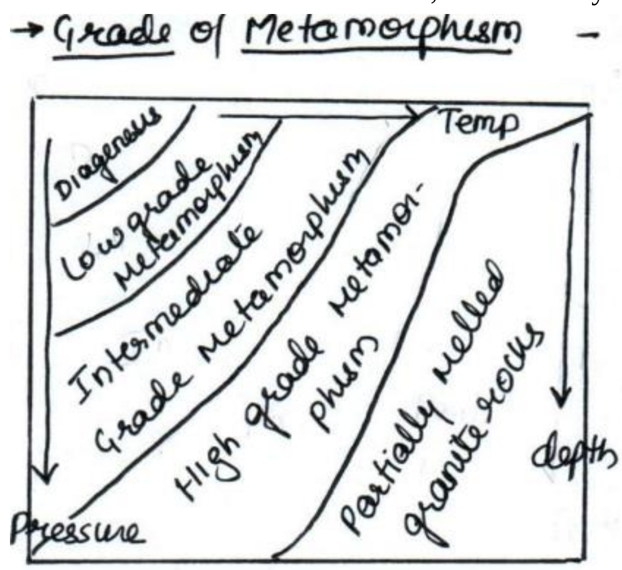
Metamorphism, therefore occurs at temperatures and pressures higher than 200oC and 300 MPa. Rocks can be subjected to these higher temperatures and pressures as they are buried deeper in the Earth. Such burial usually takes place as a result of tectonic processes such as continental collisions or subduction.

The upper limit of metamorphism occurs at the pressure and temperature where melting of the rock in question begins. Once melting begins, the process changes to an igneous process rather than a metamorphic process.

**Grade of Metamorphism**

As the temperature and/or pressure increases on a body of rock we say the rock undergoes prograde metamorphism or that the grade of metamorphism increases. Metamorphic grade is a general term for describing the relative temperature and pressure conditions under which metamorphic rocks form.

**Low-grade metamorphism** takes place at temperatures between about 200 to 320oC, and relatively low pressure. Low grade metamorphic rocks are generally characterized by an abundance of hydrous minerals. With increasing grade of metamorphism, the hydrous minerals begin to react with other minerals and/or break down to less hydrous minerals.



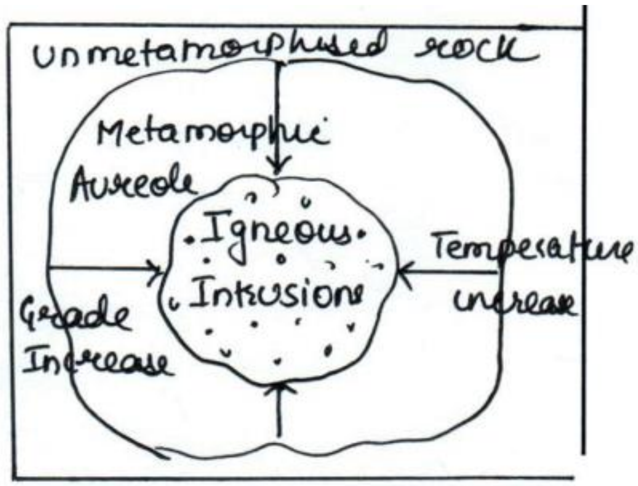

**High-grade metamorphism** takes place at temperatures greater than 320oC and relatively high pressure. As grade of metamorphism increases, hydrous minerals become less hydrous, by losing $H_2O$, and non-hydrous minerals become more common.

**Types of Metamorphism**

**Contact Metamorphism**

Contact metamorphism occurs adjacent to igneous intrusions and results from high temperatures associated with the igneous intrusion.

Since only a small area surrounding the intrusion is heated by the magma, metamorphism is restricted to the zone surrounding the intrusion, called a metamorphic or contact aureole. Outside of the contact aureole, the rocks are not affected by the intrusive event. The grade of metamorphism increases in all directions toward the intrusion. Because the temperature contrast between the surrounding rock and the intruded magma is larger at shallow levels in the crust where pressure is low, contact metamorphism is often referred to as high temperature, low pressure metamorphism. The rock produced is often a fine-grained rock that shows no foliation, called a hornfels.




**Regional Metamorphism**

Regional metamorphism occurs over large areas and generally does not show any relationship to igneous bodies. Most regional metamorphism is accompanied by deformation under non-hydrostatic or differential stress conditions. Thus, regional metamorphism usually results in forming metamorphic rocks that are strongly foliated, such as slates, schists, and gniesses. The differential stress usually results from tectonic forces that produce compressional stresses in the rocks, such as when two continental masses collide. Thus, regionally metamorphosed rocks occur in the cores of fold/thrust mountain belts or in eroded mountain ranges. Compressive stresses result in folding of rock and thickening of the crust, which tends to push rocks to deeper levels where they are subjected to higher temperatures and pressures.

**Cataclastic Metamorphism**

Cataclastic metamorphism occurs as a result of mechanical deformation, like when two bodies of rock slide past one another along a fault zone. Heat is generated by the friction of sliding along such a shear zone, and the rocks tend to be mechanically deformed, being crushed and pulverized, due to the shearing. Cataclastic metamorphism is not very common and is restricted to a narrow zone along which the shearing occurred.

**Hydrothermal Metamorphism**

Rocks that are altered at high temperatures and moderate pressures by hydrothermal fluids are hydrothermally metamorphosed. This is common in basaltic rocks that generally lack hydrous minerals. The hydrothermal metamorphism results in alteration to such Mg-Fe rich hydrous minerals as talc, chlorite, serpentine, actinolite, tremolite, zeolites, and clay minerals. Rich ore deposits are often formed as a result of hydrothermal metamorphism.

**Burial Metamorphism**

When sedimentary rocks are buried to depths of several kilometers, temperatures greater than 300oC may develop in the absence of differential stress. New minerals grow, but the rock does not appear to be metamorphosed. The main minerals produced are often the Zeolites. Burial metamorphism overlaps, to some extent, with diagenesis, and grades into regional metamorphism as temperature and pressure increase.

**Shock Metamorphism (Impact Metamorphism)**

When an extraterrestrial body, such as a meteorite or comet impacts with the Earth or if there is a very large volcanic explosion, ultrahigh pressures can be generated in the impacted rock. These ultrahigh pressures can produce minerals that are only stable at very high pressure, such as the SiO2 polymorphs coesite and stishovite. In addition they can produce textures known as shock lamellae in mineral grains, and such textures as shatter cones in the impacted rock.

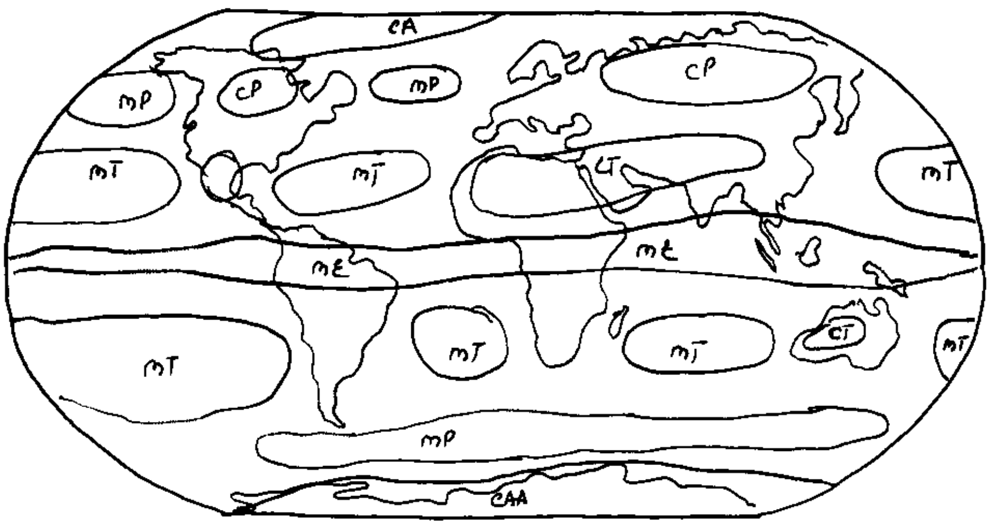
**Que. 2 (b) Examine spatial synoptic classification system proposed by Bergeron? With any example justify its Movement and Modification.**

**Ans 2(b)** The Bergeron classification is the most widely accepted form of air mass classification. Air mass classification involves three letters.

- The first letter describes its moisture properties, with c used for continental air masses (dry) and m for maritime air masses (moist).
- The second letter describes the thermal characteristic of its source region: T for tropical, P for polar, A for Arctic or Antarctic, M for monsoon, E for equatorial, and S for superior air (dry air formed by significant downward motion in the atmosphere).
- The third letter is used to designate the stability of the atmosphere. If the air mass is colder than the ground below it, it is labeled k. If the air mass is warmer than the ground below it, it is labeled w. While air mass identification was originally used in weather forecasting during the 1950s, climatologists began to establish synoptic climatologies based on this idea in 1973.

Based upon the Bergeron classification scheme is the **Spatial Synoptic Classification system** (SSC). There are six categories within the SSC scheme: Dry Polar (similar to continental polar), Dry Moderate (similar to maritime superior), Dry Tropical (similar to continental tropical), Moist Polar (similar to maritime polar), Moist Moderate (a hybrid between maritime polar and maritime tropical), and Moist Tropical (similar to maritime tropical, maritime monsoon, or maritime equatorial).

Air masses are classified on the basis of **source region**. The latitude of the source region correlates directly with the temperature of the air mass, and the nature of the surface strongly influences the humidity content of the air mass. Thus a low-latitude air mass is warm or hot; a high-latitude one is cool or cold. If the air mass develops over a continental surface, it is likely to be dry; if it originates over an ocean, it is usually moist.




**Movement and Modification**

Some air masses remain in their source region for long periods, even indefinitely. In such cases, the weather associated with the air mass persists with little variation. Our interest, however, is in masses that leave their source region and move into other regions, particularly into the midlatitudes.

When an air mass departs from its source region, its structure beings to change, owing in part to thermal modification (Heating or cooling from below), in part to dynamic modification (uplift, subsidence, convergence, turbulence), and perhaps also in part to addition or subtraction of moisture.

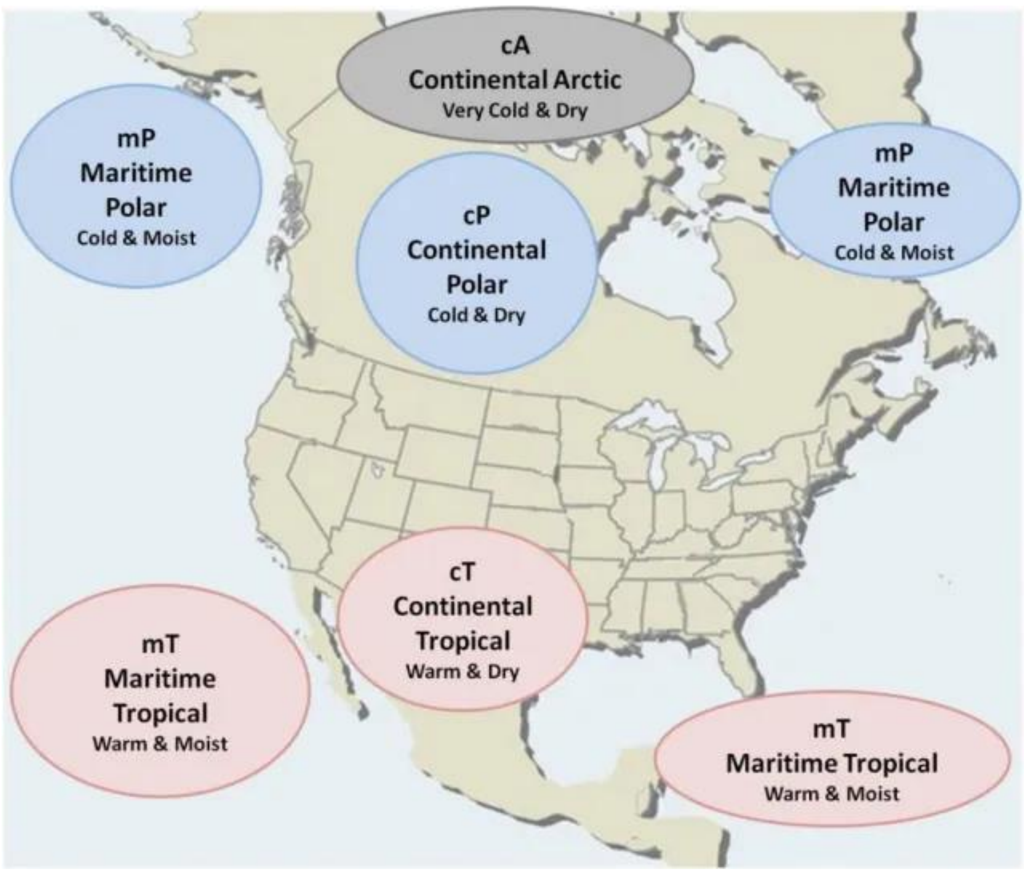
Once it leaves its source area, an air mass modified the weather of the regions into which it moves: it takes source-region characteristics into other regions. A midwinter outburst of continental polar (cP) air from northern Canada sweeps down across the central part of North America. With a source-region temperature of -46° C) around great Bear Lake, the air mass has warmed to 34° C by the time it reaches Winnipeg, Manitoba, and it continues to warm as it moves southward.

Throughout its southward course the air mass becomes warmer, but it also brings some of the coldest weather that each of these places will receive all winter. Thus the air mass is modified, but it also modified the weather in all regions it passes through. (In summer, cP air is much less well developed and prominent, but occasionally it provides cooling relief to portions of eastern and central North America).

Temperature, of course, is only one of the characteristics modified by a moving air mass. There are also modifications in humidity and stability.

**Movement and Modification of North American Air Masses**

The North American continent is a prominent area of air mass interaction. The lack of mountains trending east to west permits polar air to sweep southward and tropical air to flow northward unhindered by terrain, particularly over the eastern two-thirds of the continent. Major north-south trending mountain ranges in the western part of the continent, however, impede the movement of the Pacific air masses, causing significant modification of their characteristics.

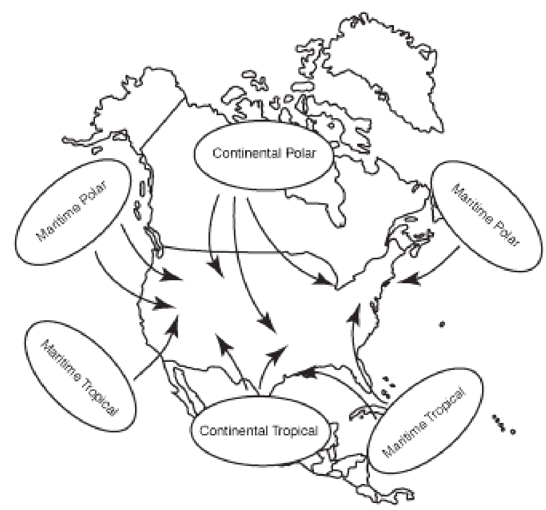



**Continental polar air masses** develops in central and northern Canada, and Arctic (A) air masses originate farther north. These two masses are similar to each other, except that the latter is even colder and drier than the former. They are dominant features in winter with their cold, dry, stable nature.

**Maritime polar (mP)** air that affects North America normally originates as cold, dry, cP air and then moves off the land. Once over water, this air either stagnates or else moves slowly over the North Pacific or North Atlantic, acquiring its mP characteristics only in its low-altitude portion. Consequently, the lower layers are cool, moist, and relatively unstable, whereas conditions of higher altitudes in the air mass may be cold, dry, and stable. Pacific mP air normally brings widespread cloudiness and heavy precipitation to the mountainous coastal regions, but it is often severely modified in crossing in the western ranges. By the time it reaches the interior of the continent, it has moderate temperatures and clear skies. In summer, the ocean is colder than the land, and so Pacific mP air produces fog and low stratus clouds along the coast but takes no distinctive weather conditions to the interior.

Air masses that develop over the North Atlantic are also cool, moist, and unstable. Except for occasional incursions into the mid-Atlantic coastal region, however, Atlantic mP air does not affect North America because the prevailing circulation is westerly.

**Maritime tropical (mT)** air from the Atlantic/Caribbean/Gulf of Mexico is warm, moist, and unstable. It strongly influences weather and climate east of the Rockies in the United States, southern Canada, and much of Mexico, serving as the principal precipitation source in this broad region. It is more prevalent and extensive in summer than in winter, bringing periods of uncomfortable humid heat.




**Pacific mT** air originates over water in areas of anti-cyclonic subsidence, and so it is cooler, drier, and more stable than Atlantic mT air. The influence of the former is felt only in the southwestern United States and north-western Mexico, where in winter this air produces some coastal fog and occasional moderate orographic rainfall if forced to ascend mountain slopes. It is also the source of some summer rains in the southwestern interior.

**Continental tropical (cT)** air is relatively unimportant in North America because its source region is not extensive and consists of varied terrain. There is no winter air mass genesis in this northern Mexico/south-western U.S. source region, but in summer, hot, very dry, unstable cT air develops. It surges into the southern Great Plains area on occasion, bringing heat waves and drought conditions. Equatorial (E) air affects North America only in association with hurricanes. It is similar to mT air except that E air provides an even more copious source of rain than does mT air because of high humidity and much instability.

**Que. 2 (c) What are multiple drivers of the North Atlantic warming hole? Also define its likely influence.**

**Ans 2(c)** The cold temperature anomaly which is developing in southern Greenland due to melting polar ice is expected to increase over the next few decades. As this cold anomaly, also known as the **North Atlantic Warming Hole** (NAWH), becomes more pronounced it will have a significant effect on the Atlantic jet-stream. At least this is what a team of researchers from the University of Columbia (USA) has predicted following a series of simulation tests. By taking the evolution of the NAWH into consideration, researchers believe future climactic changes could be better understood.

Although **Sea-surface temperatures** (SST) are generally predicted to increase in years to come, there are some very rare regions which will see the inverse effect. This is particularly the case for the North Atlantic Warming Hole which is situated to the south of Greenland.

The development of the NAWH is believed to be due to a slowdown in ocean circulation in which warm waters from the tropics are carried northwards into the North Atlantic ocean. The increase of fresh water coming from melting Arctic sea ice and polar ice caps into the sub-polar gyre is thought to be the cause if these changes in circulation patterns.

Over the course of 21st century, the cooling pattern of Sea surface temperatures is predicted to increase and become more distinct in this area in terms of internal ocean variability. In other words as Sea surface temperatures tend to increase elsewhere around the world, the NAWH is expected to become colder.

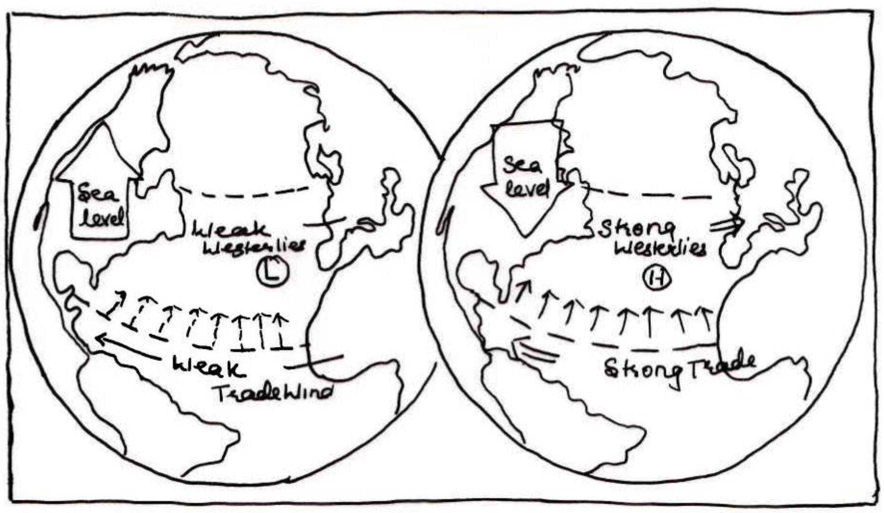
A team of researchers studied the impact of this anomaly on atmospheric circulation in a paper published in the Journal of Climate. Following the results of three simulation tests, the study's authors underline the importance of the NAWH in future climate projections due to its affect on the jet stream. It was noticed that this region of the ocean is a really important place for forcing the jet stream that goes across the North Atlantic Ocean,.

High altitude, west to east winds also known as the jet stream are influenced by temperature differences between the cold Arctic air and hot air from the tropics. As a result the potential impact of climate change on the jet-stream is exceedingly important for understanding weather patterns and storms.

It is generally understood that the jet stream will see a pole ward shift and an eastward elongation with the effects of climate change. However Right now, it's sort of a tug of war between impacts of the tropics and impacts of the arctic. So those two things are competing to shift where the jet is located.

However researchers wanted to see in what ways the North Atlantic Warming Hole could have an effect on the jet stream. Following a series of simulation tests, the researchers noted how the warming hole had an important impact on midlatitude atmospheric circulation changes in the model's future climate simulations. They noted how the NAWH seemed to be shifting even more to the north and elongating even further. It should be noted that the European continent is particularly exposed to these dynamic changes to the jet-stream.

**Major factor to take into account**




Researchers have found that the North Atlantic jet stream in climate simulations of the future is largely affected by the North Atlantic warming hole.

The North Atlantic warming hole is the sub polar gyre of the North Atlantic ocean, an area of reduced warming.

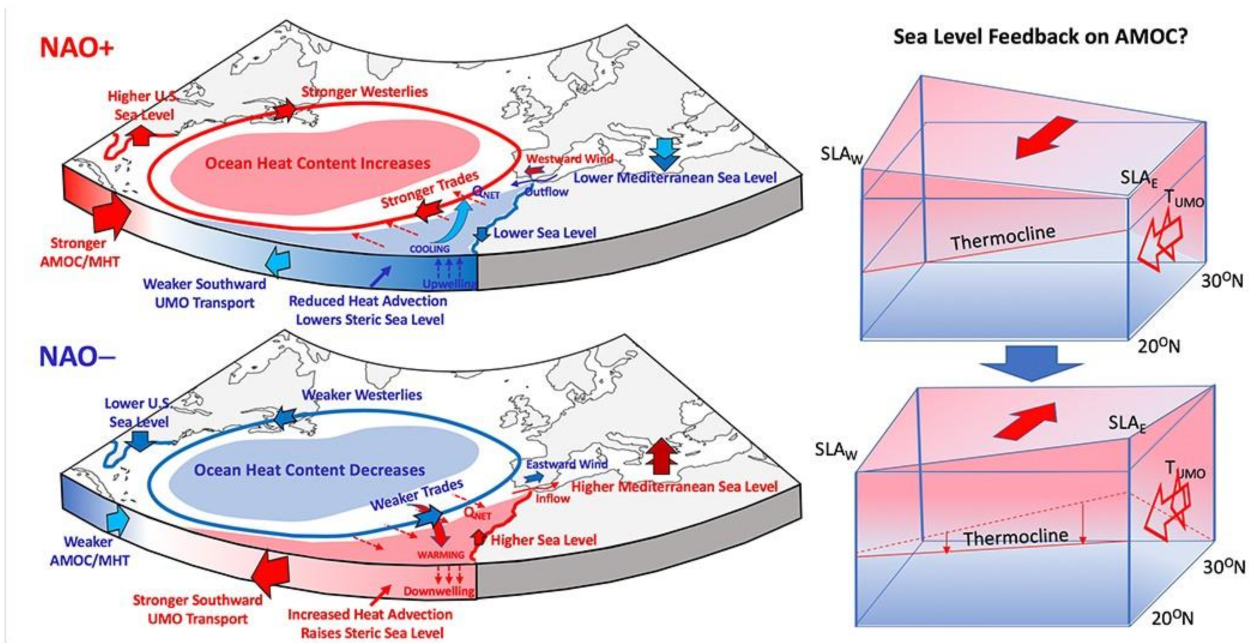
**Lack Of Warming**

One of the projected consequences of the global climate change is the increase in the sea surface temperatures. However, colder sea-surface temperatures were documented in both global climate-model projections and observations within an area of rotating ocean currents just south of Greenland. The results of the study were published in the Journal of Climate. It's called a hole because there is a lack of warming.

It is  found that this region of the ocean is a really important place for forcing the jet stream that goes across the North Atlantic Ocean.

**Melting Arctic Ice**

The inundation of fresh water coming from melting Arctic sea ice is originally thought to be the cause of the slowdown of the Atlantic Meridional Overturning Circulation. Apparently, the development of the North Atlantic warming hole is a major factor.




The Atlantic Meridional Overturning Circulation is a large system of ocean currents that carry warm water from the tropics northwards into the North Atlantic. Preliminary research suggests that the more fresh water enters the ocean, the more it leads to surface cooling and changes in circulation patterns.the changes in SST patterns could have a major contribution on atmospheric circulation and the North Atlantic storm track in the future.

**Effects**

Currently, scientists are concerned about the changes in storm tracks and weather patterns based on the relationship between jet streams and climate change. Jet streams are responsible for driving weather patterns and transporting air masses on the planet.

Although it is expected that  a poleward shift and eastward elongation of the jet streams, there is a present tug-of-war between impacts of the arctic and impacts of the tropics.

The North Atlantic Ocean has a defined eddy-driven jet, produced by baroclinic eddy activity in the midlatitudes, that is typically separate from the subtropical jet, produced due to angular momentum transport from the tropics. The enhanced baroclinicity associated with gradients in SST is a source of baroclinic wave activity for the North Atlantic storm track, particularly along the western edge of the Atlantic Ocean and the subpolar front.The studies showed that North Atlantic SST gradients located poleward of the subtropical jet produce a poleward shift and enhancement of the eddy-driven jet acting to further separate it from the subtropical jet. However, when these gradients are located close to or equatorward of the subtropical jet they can act to enhance the subtropical jet and shift the storm track equatorward. The NAWH is located just poleward of the subpolar front, acting to increase the SST gradient already present in this region, and thus may be expected to strengthen the eddy-driven jet.

The leading mechanisms through which these jets are expected to change as a tug of war between thermodynamic impacts, such as the increased latent heat release due to tropical convection causing an enhanced temperature gradient aloft, and increased polar temperatures at lower levels from Arctic amplification leading to a decrease in temperature gradients at lower levels. In the North Atlantic, projected changes in the winter jet position are modest with a potential poleward shift or eastward extension and differences among climate model simulations are large.

**Que. 3 (a) Define geosyncline, outline the types and explain how it is used to explain fold orogeny?**

**Ans. 3 (a)** The geosynclines concept was first developed by the American geologists James Hall and James Dwight Dana in the mid-19th century during the classic studies of the Appalachian Mountains. Dana was first to use the term geosynclinal in reference to a gradually deepening and filling basin resulting from his concept of crustal contraction due to a cooling and contracting Earth. The geosynclinal hypothesis was further developed in the late 19th century and early 20th century and at that time was widely accepted as an explanation for the origin of most mountain ranges until its replacement by the subduction zone and continental collision orogenies of plate tectonics in the 1960s. Although the usage varied over the following 100 years, a geosyncline is still basically a large linear deepening basin along a continental margin which becomes deformed and then uplifted in parts as a mountainous region

Geosynclines are divided into **miogeosynclines and eugeosynclines,** depending on the types of discernible rock strata of the mountain system.

A miogeosyncline develops along a continental margin on continental crust and is composed of sediments with limestone, sandstones and shale. The occurrences of limestone and well-sorted quartzite, sandstones indicate a shallow-water formation, and such rocks form in the inner segment of a geosyncline. The eugeosynclines consist of different sequences of lithologies more typical of deep marine environments.

Eugeosynclinal rocks include thick sequences of greywacke, cherts, slates, tuffs and submarine lavas. The eugeosynclinal deposits are typically more deformed, metamorphosed, and intruded by small to large igneous plutons. The eugeosynclines often contain exotic flysch and mélange sediments.

An **orthogeosyncline** is a linear geosynclinal belt lying between continental and oceanic terranes, and having internal volcanic belts (eugeosynclinal) and external nonvolcanic belts (miogeosynclinal).Also known as geosynclinal couple or primary geosyncline. A miogeosyncline is the nonvolcanic portion of an orthogeosyncline, located adjacent a craton. A zeugogeosyncline is a geosyncline in a craton or stable area within which is also an uplifted area, receiving clastic sediments, also known as yoked basin.

A **parageosyncline** is an epeirogenic geosynclinal basin located within a craton area. A exogeosyncline is a parageosyncline that lies along the cratonal border and obtains its clastic sediments from erosion of the adjacent orthogeosynclinal belt outside the craton. Also known as delta geosyncline; foredeep; or transverse basin.

***Several types of "mobile" geosynclinal zones have also been recognized and named.*** Among the more common of these are the **taphrogeosyncline**, a depressed block of the Earth's crust that is bounded by one or more high-angle faults and that serves as a site of sediment accumulation; and the **paraliageosyncline,** a deep geosyncline that passes into coastal plains along continental margins.

The geosyncline hypothesis is an obsolete concept involving vertical crustal movement that has been replaced by plate tectonics to explain crustal movement and geologic features.

If the idea of geosynclines is due to Hall and Dana, the theory of their develop-ment is really due to Haug'. He defined geosynclines as long and deep water bodies. According to Haug 'geosynclines are relatively deep water areas and they are much longer than they are wide'. He drew the palaeogeographical maps of the world and depicted long and narrow oceanic tracts to demonstrate the facts that these water tracts were subsequently folded into mountain ranges.

He further postulated that the positions of the present-day mountains were previ-ously occupied by oceanic tracts i.e. geosynclines. Geosynclines existed as mobile zones of water be-tween rigid masses.He identified 5 major rigid masses during Mesozoic era e.g.:

***North Atlantic Mass,***

***Sino-Siberian Mass,***

***Africa-Brazil Mass,***

***Australia-India-Madagascar Mass, and***

***Pacific Mass***.

He located 4 geosynclines between these ancient rigid masses e.g.:

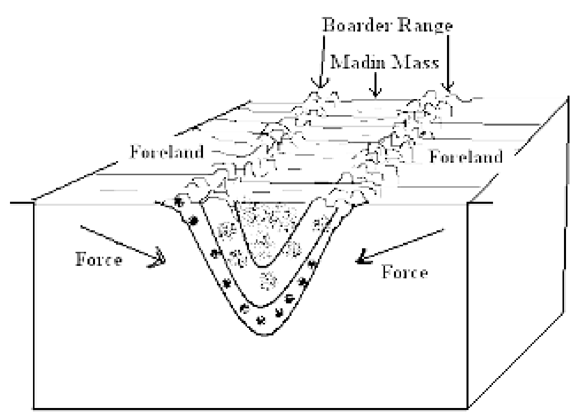
***Rockies geosyncline, Ural geosyncline, Tethys geosyncline, and Circum- Pacific geosyncline.***

According to Haug there are systematic sedi-mentation in the geosynclines. The littoral margins of the geosynclines are affected by transgressional and regressional phases of the seas. The marginal areas of the geosynclines have shallow water wherein larger sediments are deposited whereas finer sediments are deposited in central parts of the geosynclines. The sediments are squeezed and folded into mountain ranges due to compressive forces coming from the margins of the geosynclines.

He has further remarked that it is not always necessary that all the geosynclines may pass through the complete cycle of the processes of sedi-mentation, subsidence, compression and folding of sediments. Sometimes, no mountains are formed from the geosynclines inspite of continuous sedimentation for long duration of geological time.

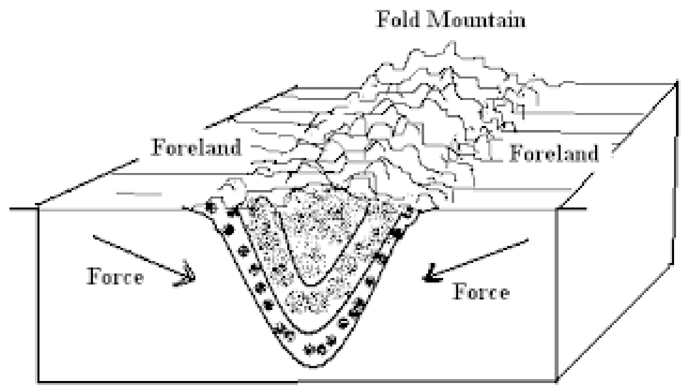
Kober was a German geologist. He attempted to explain the **origin of mountain on the basis of his geosynclines theory.** A geosyncline may be defined as “a thick, rapidly accumulating body or sediment formed within a long, narrow, subsiding belt of the sea which is usually parallel to a plate margin”. we may say a geosyncline is a “very large linear depression or down-warping of the earth’s crust, filled (especially in the central zone) with a deep layer of sediments derived from the two land masses on each side and deposited on the floor of the depression at approximately the same rate as it slowly, continuously subsided during a long period of geological time”. He also attempted to elaborate the formation of mountains, their geological history and their evaluation and development. The theory is the result of his study of the western Alps. According to him folded mountain are the result of the upliftment of sediment that deposited in geosynclines located between two forelands. According to Kober, to form a mountain there are three main stages.

**Lithogenesis:** This stage is characterized by the creation, sedimentation and subsidence of geosynclines. The geosynclines are formed due to contraction caused by the cooling process of the earth. The forelands (kratogens) which border geosynclines succumbed to the forces of denudation. Due to this process, there was constant wearing a way of rocks and boulders from forelands and deposition of the eroded material on the beds of geosynclines. This led to the subsidence of geosynclines. The twin processes of sediment deposition and the resultant subsidence led to further sediment deposition and increasing thickness of sediments.




**Orogenesis:** In this stage, the geosynclinals sediments are squeezed and folded into mountain ranges. There is a convergence of the forelands towards each other due to the force of the contraction of the earth. The enormous compressive forces produced by these moving forelands produce squeezing, contraction and folding of sediments deposited on the geosynclinal bed.

The parallel mountain ranges found on both sides of the geosyncline have been termed by Kober as randketten meaning marginal ranges. Kober viewed the folding of geosynclinal sediments to be dependent upon the intensity or degree of the compressive forces. If the compressive forces is normal and moderate intensity they produce marginal ranges on two sides of the geosyncline leaving the middle part unaffected.




**Glyptogenesis:** This stage of mountain-building is characterised by a gradual ascent of mountain ranges and the ongoing denudation processes by natural agents. . As a result gradual lowering of the height of mountains started.

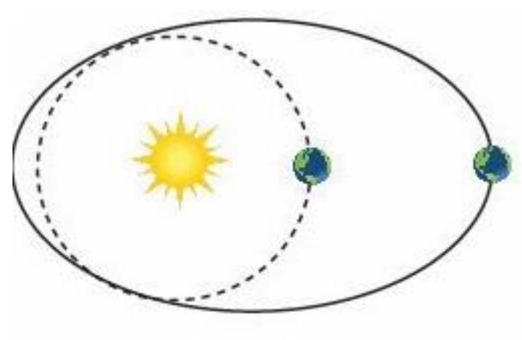
**Que.3 (b) Discuss the Milancovitch Cycles. Do define its effect on climate change.**

**Ans.3 (b)** Serbian scientist Milutin Milankovitch hypothesized the long-term, collective effects of changes in Earth's position relative to the Sun are a strong driver of Earth's long-term climate, and are responsible for triggering the beginning and end of glaciation periods (Ice Ages).

Specifically, he examined how variations in three types of Earth orbital movements affect how much solar radiation (known as insolation) reaches the top of Earth's atmosphere as well as where the insolation reaches. These cyclical orbital movements, which became known as the Milankovitch cycles, cause variations of up to 25 percent in the amount of incoming insolation at Earth's mid-latitudes (the areas of our planet located between about 30 and 60 degrees north and south of the equator).

**The Milankovitch cycles include:**

- The shape of Earth's orbit, known as eccentricity;
- The angle Earth's axis is tilted with respect to Earth's orbital plane, known as obliquity;
- The direction Earth's axis of rotation is pointed, known as precession.


Eccentricity

**Eccentricity** – Earth's annual pilgrimage around the Sun isn't perfectly circular, but it's pretty close. Over time, the pull of gravity from our solar system's two largest gas giant planets, Jupiter and Saturn, causes the shape of Earth's orbit to vary from nearly circular to slightly elliptical. Eccentricity measures how much the shape of Earth's orbit departs from a perfect circle. These variations affect the distance between Earth and the Sun.

Eccentricity is the reason why our seasons are slightly different lengths, with summers in the Northern Hemisphere currently about 4.5 days longer than winters, and springs about three days longer than autumns. As eccentricity decreases, the length of our seasons gradually evens out.

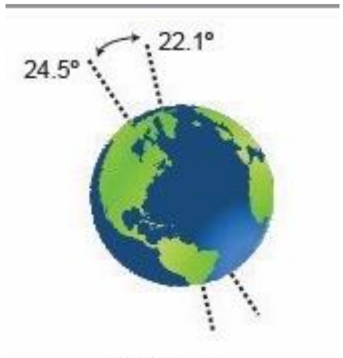
The difference in the distance between Earth's closest approach to the Sun (known as perihelion), which occurs on or about January 3 each year, and its farthest departure from the Sun (known as aphelion) on or about July 4, is currently about 5.1 million kilometers (about 3.2 million miles), a variation of 3.4 percent. That means each January, about 6.8 percent more incoming solar radiation reaches Earth than it does each July.

When Earth's orbit is at its most elliptic, about 23 percent more incoming solar radiation reaches Earth at our planet's closest approach to the Sun each year than does at its farthest departure from the Sun. Currently, Earth's eccentricity is near its least elliptic (most circular) and is very slowly decreasing, in a cycle that spans about 100,000 years.

The total change in global annual insolation due to the eccentricity cycle is very small. Because variations in Earth's eccentricity are fairly small, they're a relatively minor factor in annual seasonal climate variations.

**Obliquity –** The angle Earth's axis of rotation is tilted as it travels around the Sun is known as obliquity. Obliquity is why Earth has seasons. Over the last million years, it has varied between 22.1 and 24.5 degrees with respect to Earth's orbital plane. The greater Earth's axial tilt angle, the more extreme our seasons are, as each hemisphere receives more solar radiation during its summer, when the hemisphere is tilted toward the Sun, and less during winter, when it is tilted away. Larger tilt angles favor periods of deglaciation (the melting and retreat of glaciers and ice sheets). These effects aren't uniform globally -- higher latitudes receive a larger change in total solar radiation than areas closer to the equator.

Earth's axis is currently tilted 23.4 degrees, or about half way between its extremes, and this angle is very slowly decreasing in a cycle that spans about 41,000 years. It was last at its maximum tilt about 10,700 years ago and will reach its minimum tilt about 9,800 years from now. As obliquity decreases, it gradually helps make our seasons milder, resulting in increasingly warmer winters, and cooler summers that gradually, over time, allow snow and ice at high latitudes to build up into large ice sheets. As ice cover increases, it reflects more of the Sun's energy back into space, promoting even further cooling.



Obliquity

**Precession –** As Earth rotates, it wobbles slightly upon its axis, like a slightly off-center spinning toy top. This wobble is due to tidal forces caused by the gravitational influences of the Sun and Moon that cause Earth to bulge at the equator, affecting its rotation. The trend in the direction of this wobble relative to the fixed positions of stars is known as axial precession. The cycle of axial precession spans about 25,771.5 years.

Axial precession makes seasonal contrasts more extreme in one hemisphere and less extreme in the other. Currently perihelion occurs during winter in the Northern Hemisphere and in summer in the Southern Hemisphere. This makes Southern Hemisphere summers hotter and moderates Northern Hemisphere seasonal variations. But in about 13,000 years, axial precession will cause these conditions to flip, with the Northern Hemisphere seeing more extremes in solar radiation and the Southern Hemisphere experiencing more moderate seasonal variations.

Precession does affect seasonal timing relative to Earth's closest/farthest points around the Sun. However, the modern calendar system ties itself to the seasons, and so, for example, the Northern Hemisphere winter will never occur in July. Today Earth’s North Stars are Polaris and Polaris Australis, but a couple of thousand years ago, they were Kochab and Pherkad.

There’s also apsidal precession. Not only does Earth’s axis wobble, but Earth’s entire orbital ellipse also wobbles irregularly, primarily due to its interactions with Jupiter and Saturn. The cycle of apsidal precession spans about 112,000 years. Apsidal precession changes the orientation of Earth’s orbit relative to the elliptical plane.The combined effects of axial and apsidal precession result in an overall precession cycle spanning about 23,000 years on average.

***The small changes set in motion by Milankovitch cycles operate separately and together to influence Earth’s climate over very long timespans,*** leading to larger changes in our climate over tens of thousands to hundreds of thousands of years. Milankovitch combined the cycles to create a comprehensive mathematical model for calculating differences in solar radiation at various Earth latitudes along with corresponding surface temperatures. The model is sort of like a climate time machine: it can be run backward and forward to examine past and future climate conditions.

Milankovitch assumed changes in radiation at some latitudes and in some seasons are more important than others to the growth and retreat of ice sheets. In addition, it was his belief that obliquity was the most important of the three cycles for climate, because it affects the amount of insolation in Earth’s northern high-latitude regions during summer (the relative role of precession versus obliquity is still a matter of scientific study).

He calculated that Ice Ages occur approximately every 41,000 years. Subsequent research confirms that they did occur at 41,000-year intervals between one and three million years ago. But about 800,000 years ago, the cycle of Ice Ages lengthened to 100,000 years, matching Earth’s eccentricity cycle. While various theories have been proposed to explain this transition, scientists do not yet have a clear answer.

Milankovitch’s work was supported by other researchers of his time, and he authored numerous publications on his hypothesis. But it wasn’t until about 10 years after his death in 1958 that the global science community began to take serious notice of his theory. In 1976, a study in the journal Science by

Hays et al. using deep-sea sediment cores found that Milankovitch cycles correspond with periods of major climate change over the past 450,000 years, with Ice Ages occurring when Earth was undergoing different stages of orbital variation.

Several other projects and studies have also upheld the validity of Milankovitch's work, including research using data from ice cores in Greenland and Antarctica that has provided strong evidence of Milankovitch cycles going back many hundreds of thousands of years.

**Que .3(c) Discuss the concept of biodiversity. Also distinguish between detrimental and beneficial interactions.**

**Ans.3 (c)** The term biodiversity was first coined by the entomologist E.O. Wilson in 1986. A neologism from biology and diversity, it refers to the variety of life on the planet. There is no single standard definition for biodiversity.

- Biodiversity may be defined as the totality of different organisms, the genes they contain, and the ecosystems they form.
- The Convention on Biological Diversity defines biodiversity as the variability among living organisms from all sources including, among other things, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

Biodiversity may be considered at three levels: genetic diversity, species diversity, and ecosystem diversity

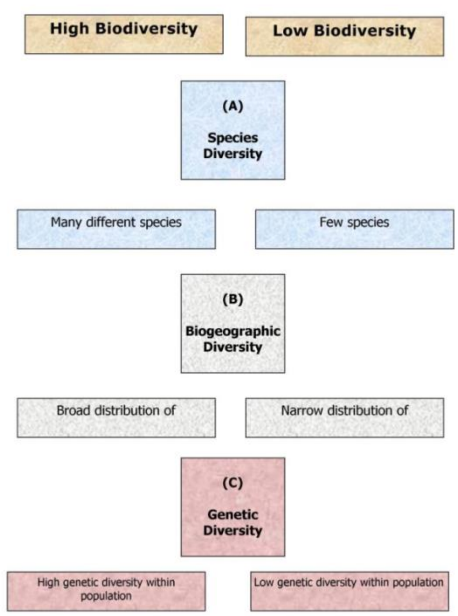
**Species diversity** refers to the variety of living species within a geographic area. A species may be defined as a group of organisms which are able to interbreed freely under natural conditions to produce viable offspring. Species diversity may be measured using the following characteristics:

- Species richness - the number of species within a particular sample area.(in combination with)
- Species evenness - this refers to the evenness in number of individuals of each species in the area

Relative abundance of species of various categories - (the categories might include size classes, tropic levels, taxonomic groups, or morphological types). For example, an area with a greater number of closely related species is not as diverse as the same area with the same number of species which are not closely related. An illustration of this point would be an island with two species of birds and one species of lizard – this island would be more diverse than an area with three species of birds and no lizards.

Therefore, species diversity can be assessed in terms of the number of species or the range of different types of species an area contains. The species level is generally regarded as the most appropriate for considering the diversity between organisms. This is not because species diversity is more important than the other two types, but because:

- **Species diversity is easier to work with-**Species are relatively easy to identify by eye in the field, whereas genetic diversity (see below) requires laboratories, time and resources to identify, and ecosystem diversity (see below) needs many complex measurements to be taken over a long period of time.
- **Species are also easier to conceptualize and have been the basis of much of the evolutionary and ecological research that biodiversity draws on-**Species are well known and are distinct units of diversity. Each species can be considered to have a particular "role" in the ecosystem, so the addition or loss of single species may have consequences for the system as a whole. Conservation efforts often begin with the recognition that a species is endangered in some way, and a change in the number of species in an ecosystem is a readily obtainable and easily understandable measure of how healthy the ecosystem is.




**Genetic diversity** refers to the differences in genetic make-up between distinct species, as well as the genetic variations within a single species. This is the least visible and, arguably, least studied level of biological diversity.

Genetic diversity is the variety present at the level of genes. Genes, made of DNA, are the building blocks that determine how an organism will develop and what its traits and abilities will be. This level of diversity can differ by alleles (different variants of the same gene, such as blue or brown eyes), by entire genes (which determine traits, such as the ability to metabolize a particular substance), or by units larger than genes such as chromosomal structure.

The amount of diversity at the genetic level is important because it represents the raw material for evolution and adaptation. More genetic diversity in a species or population means a greater ability for some of the individuals in it to adapt to changes in the environment. Less diversity leads to uniformity, which is a problem in the long term, as it is unlikely that any individual in the population would be able to adapt to changing conditions.

**Ecosystem diversity** encompasses the broad differences between ecosystem types, and the diversity of habitats and ecosystem processes within each ecosystem type.

Ecosystem diversity deals with species distributions and community patterns, the role and function of key species, and combines species functions and interactions. The term "ecosystem" here represents all levels greater than species: associations, communities, ecosystems, and the like.

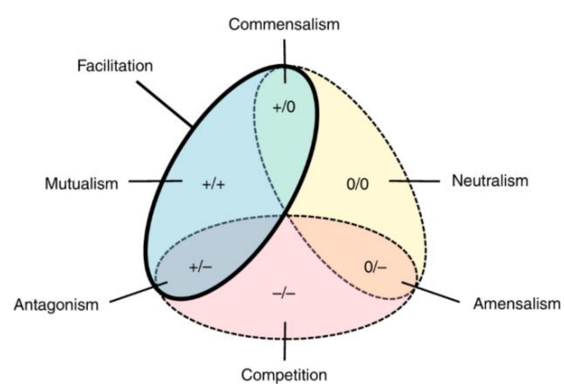
Another aspect to this level of diversity is biogeographic diversity which refers to the distribution of species within habitats or ecosystems and **links**.

**Mutualism** When the two different population species interact in such a manner that it is beneficial to each other, then this form of interaction is called mutualism. Lichens are a classic example of mutualism in between fungi and algae. Even plants and animals show good mutualism.

Plants need some agents for pollination and seed dispersal. And these agents are the animals. Animals, in turn, are rewarded with the nectar or the fruits of the plants. But, even in mutualism, there are some cheater species, which may not reward the other species. This leads to co-evolution of the species.

**Competition** When the closely related species fight for limited resources, there is a competition between the species. These types of interactions are called competition. This fight for resources can occur between diverse groups of the population also.

Competition can occur even when there is an unlimited supply of resources. Here, it depends on the superiority of one species over the other. In the presence of one population species, the other population species may not use the resources effectively. But if the dominant species is removed, then the other species will use the resources to their full capacity.




**Predation** This interaction is a very important one as it ensures that there is stability in the ecosystem. The two main populations interacting in predation are the predators and the prey.

Without the predators, the prey population will go out of control. The species diversity in a community is also maintained by the predators. They reduce the intensity of the competition between prey species. The prey species have also evolved several mechanisms to lessen the impact of predation.

**Parasitism** This is an interaction of populations where a parasitic mode of nutrition is clearly seen, with one species being completely dependent on the other host species for all its meals/ nutrient requirements. Parasitism is clearly seen in many taxonomic groups, right from plants to higher vertebrates.

**Commensalism**

In this kind of integration, one species population benefits from the other species population. But the other species population does not benefit nor is it harmed in any way. If you have been to rural areas, you have seen many birds perching on cattle.

Here the cattle do not benefit anything nor cause any harm. But as the cattle moves, they stir up the small insects hiding in the grass. It is these insects that the birds feed on, thereby benefiting to large extent.

**Que .4 (a) What are coastal processes and features? Explain them in light of types of shoreline.**

**Ans .4 (a)** The coastal zone is that part of the land surface influenced by marine processes. It extends from the landward limit of tides, waves, and windblown coastal dunes, and seaward to the point at which waves interact significantly with the seabed. The coastal zone is a dynamic part of the Earth's surface where both marine and atmospheric processes produce rocky coasts, as well as beaches and dunes, barriers and tidal inlets, and shape deltas. The atmospheric processes include temperature, precipitation, and winds, while the major marine processes are waves and tides, together with water temperature and salinity. The coast also supports rich ecosystems, including salt marshes, mangroves, seagrass, and coral reefs. The diverse coastal ecology is favored by the shallow waters, abundant sunlight, terrestrial and marine nutrients, tidal and wave flushing, and a range of habitat types.

**Waves** provide about half the energy to do work at the coast. Ocean waves are generated by wind blowing over the ocean surface. The stronger the wind, the longer it blows and the longer the fetch, or stretch of ocean over which it blows, the larger the waves. The world's greatest wave factories are in the zone of sub-polar lows centered on 40–60° N and S latitudes, the so-called roaring 40's and screaming 60's. The strong westerly winds produce the world's biggest waves which initially head west, and are deflected equatorward by the Coriolis effect, arriving from the northwest in the northern hemisphere and southwest in the southern hemisphere. Other major wave climates are the easterly waves produced by the expansive but moderate velocity northeast and southeast Trade winds — and lesser seasonal waves produced by the monsoons and even the polar easterlies, together with occasional hurricanes that can produce massive waves as well as storm surges.

As wind velocity increases, the period or time between waves, and wave length, increases, and the amount of energy transferred to the waves increases exponentially. Note how as wind velocity doubles from 37 to 75 km/hr the amount of energy increases exponentially. Very strong winds are therefore required to generate the biggest waves.

When waves are being generated they are called a sea and consist of short, steep, high, slower waves, which tend to topple over and break, and have a broad spectrum of direction. Once the wind stops blowing, and/or the waves leave the area of generation, they quickly transform into swell — lower, longer, faster and uniform in direction. Swell waves can theoretically travel around the world with minimal loss of energy, while in reality they eventually break on some distant shore.

**Tides** are produced by the gravitational pull of the Moon and Sun acting on a rotating Earth. This pull produces a very slight bulge in the ocean, which we know as tide. The tides and the currents they generate are responsible for about 50% of the marine energy delivered to the coast. The major impact of tides is to shift the shoreline between high and low tide, and to generate tidal currents either parallel to the coast, or at tidal inlets and estuaries, currents flowing into the inlets.

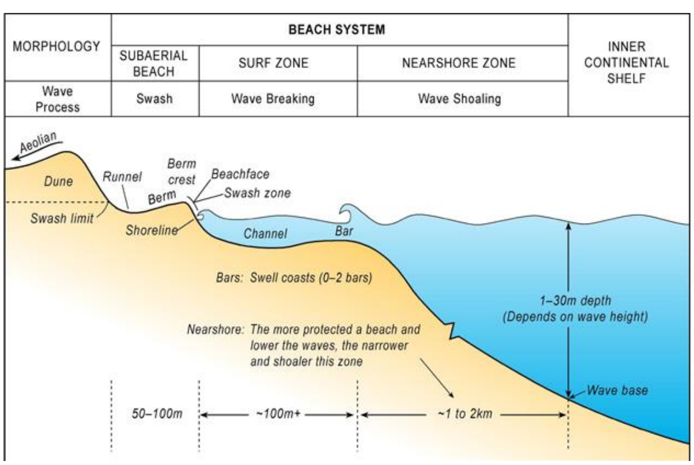
**Wind and currents.** Winds blowing over the oceans are responsible for generating ocean waves. Nearer the coast they can generate local seas — they can move the ocean surface and generate locally wind driven currents which in places can result in upwelling and downwelling. Finally, when blowing over the beach, they can transport sand inland to build coastal sand dunes.

**Fluvial-deltaic systems.** Fluvial systems deliver sediment to the coast where it is deposited in estuaries and deltas. Depending on their location, deltas are also acted on by waves, tides, and other currents, and shaped to suit the prevailing processes. Sediment can also be moved longshore to supply beach and barrier systems.

**Sea level determines** the position of the shoreline. During the last glacial maxima (ice age) 18,000 years ago, sea level was 120 m below present, and the continental shelves were exposed. It then rose, reaching present sea level around 6,000 years ago, after which it was relatively stable. Now, with climate change, it is beginning to rise again, and may rise as much as 1 m over the next 100 years, triggering shoreline retreat, inundation, and erosion.

**Beaches are wave-deposited accumulations** of sediment located at the shoreline. They require a base to reside on, usually the bedrock geology, waves to shape them, sediment to form them, and most are also affected by tides. The beach extends from wave base where waves begin to feel bottom and shoal, across the near shore zone, though the surf zone to the upper limit of wave swash. In the coastal zone ocean waves are transformed by shoaling, breaking, and swash. In doing so they interact with the seabed, and determine the beach morphology or shape, a process called beach morpho dynamics.

All beaches consist of sediment, which can range in size from sand up to cobbles and boulders. The finer sand result in very low gradient (~1°) beaches while cobbles may be stacked as steep as 20°. Most beaches with fine to medium sand have a swash zone gradient between 1–8°.




In the mid latitudes most beaches are composed of siliceous or quartz sand grains derived from erosion. In the topics, coral reef detritus and shells known as 'carbonate sediment' tend to dominate, while in higher latitudes physical weathering produces coarse rock fragments and gravel.

Sediments may therefore be derived from the land and delivered via rivers, glaciers and shoreline erosion, and from marine organisms in the sea. Once at the shore they are moved onshore by wave, tide, and wind driven currents to form beaches. A positive sediment supply produces beach accretion while when negative beaches erode.

At the beach the three zones of wave transformation (shoaling, breaking, and swash) produce three morphologically distinct sub-systems. The shoaling wave zone builds a low gradient (~1°) concave upward profile, smooth in outline, with small wave-generated ripples and generally onshore sediment movement. As they shoal they interact with the seabed, slowing down and increasing in steepness and height.

The surf zone is the most dynamic part of the beach and extends from the breaker zone to the shore. Waves break when the water depth is approximately 1.5 times the wave height. They can break as a spilling breaker on low gradient slopes, a plunging wave on moderate gradients, or a surging wave on steep slopes. In breaking, waves transform their potential energy to kinetic energy, which is initially manifest as the broken wave of translation, or wave bore, which moves shoreward as broken white water. At the shoreline the currents can be deflected longshore and water may return seaward as a rip current.

Surf zone currents can transport sediment onshore, longshore and offshore and build the (sand) bars and troughs that occupy the surf zone. The number and location of the bars is a product of infra gravity waves, a low frequency (greater 30 sec period) wave produced by sets of higher and lower waves and which is enhanced by wave breaking across the surf zone. The longer the infra gravity wave period the more widely spaced the bar(s). Another form of infragravity wave called edge waves also influence the longshore spacing of rip currents and channels, which are typically 200–300 m apart on ocean beaches. Rip currents are narrow, seaward moving currents that move seaward though the surf zone, often in a deeper rip channel. They are a mechanism for returning the water back out to sea, and a conduit to transport seaward eroded beach sediment during high seas. They are also a major hazard to beach goers and responsible for most beach rescues and drowning.

When the broken wave reaches the base of the wet beach it collapses and runs up the beach face as swash or uprush in the swash zone. The uprush stops toward the top of the slope, some percolates into the beach, the remainder flows back down the beach as backwash. Both actions produce a relatively steep seaward sloping swash zone or beach face, which can range from 1 to 20°. As sediment is deposited in the swash zone it can build a berm, a near horizontal to slightly landward-dipping sand surface, the area where most people sit when they go to the beach. The swash zone may also contain beach cusps, spaced about every 20 to 30 m and produced by another form of edge wave.

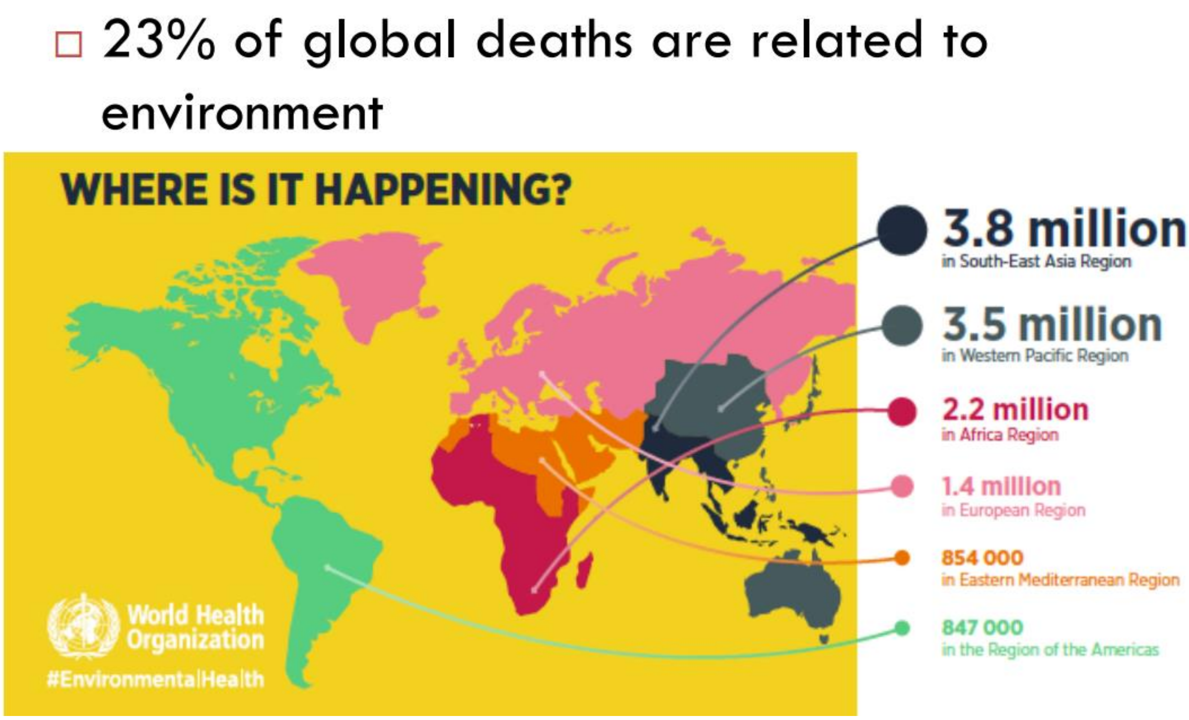
**Que. 4 (b) Define environmental hazard. Also suggest the ways to mitigate it.**

**Ans .4 (b)** Environmental health is a field that focuses on how the natural and human-built surroundings as well as behaviors affect human well-being. The field is concerned with preventing disease, death, and disability by reducing exposure to environmental hazards and promoting behavioral change. Environmental hazards are threats to human health and well-being.

**Traditional versus Modern Environmental Hazards**

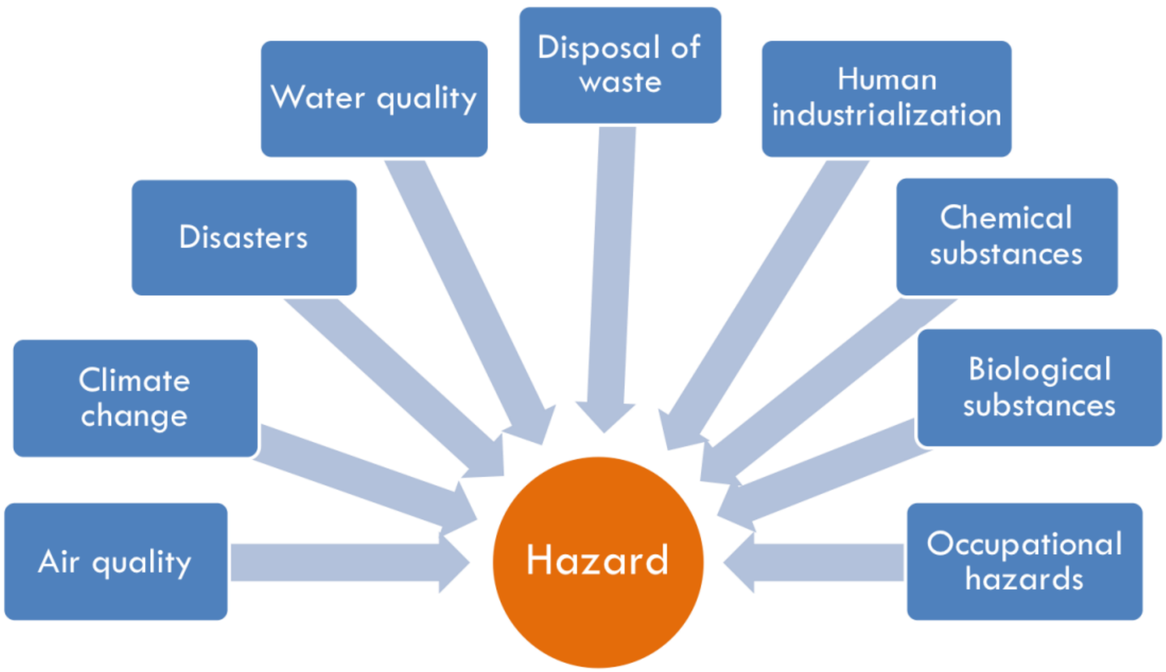
Environmental hazards can be classified as traditional or modern. Traditional hazards are related to poverty and mostly affect low-income people and those in developing countries. Modern hazards, caused by technological development, prevail in industrialized countries where exposure to traditional hazards is low.

The impact of traditional hazards exceeds that of modern hazards by 10 times in Africa, five times in Asian countries (except for China), and 2.5 times in Latin America and the Middle East. Water-related diseases caused by inadequate water supply and sanitation impose an especially large health burden in Africa, Asia, and the Pacific region.




**Biological, Chemical, and Physical Environmental Hazards**

Environmental hazards can also be classified into three interrelated categories (biological, chemical, and physical) based on the properties of their causes. These categories are not mutually exclusive with traditional versus modern hazards. For example, indoor air pollution is both a traditional and chemical hazard. Different hazards can interact and exacerbate one another. For example, a flood is primarily a physical hazard, but it can lead to the spread of waterborne disease (a biological hazard). Similarly, air pollution (a chemical hazard) can damage respiratory tissue, making the body more vulnerable to a respiratory infection (a biological hazard). Infectious diseases (biological hazards) can also weaken the immune system, making an individual more vulnerable to chemical hazards.




**Biological Hazards**

For most of human history, biological hazards were the most significant factor in health. Biological hazards are infectious (communicable) diseases caused by pathogens (disease-causing organisms or infectious particles) such as bacteria, fungi, parasitic worms, protozoa, viruses, and prions. Bacteria are single-celled organisms with small, simple cells. Parasitic worms are animals from several phyla (groups) that siphon nutrients from their hosts. Viruses are infectious particles with genetic information surrounded by a protein coat, but they are not technically considered organisms in part because they do not consist fo cells. COVID-19, influenza, measles, the common cold, ebola viral disease (Ebola hemorrhagic fever), and human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) are all caused by viruses. While the proportion of deaths caused by in infectious diseases has overall decreased (with a higher proportion of deaths caused by non communicable diseases such as cancer and cardiovascular disease). These deaths occurred at the highest rates in developing countries and many were in children. Malnutrition, unclean water, poor sanitary conditions and lack of proper medical care all play roles in transmission and high death rates from infectious diseases Compounding the problems of infectious diseases are factors such as antibiotic-resistant pathogens, pesticide-resistant disease vectors, and overpopulation.

**Chemical Hazards**

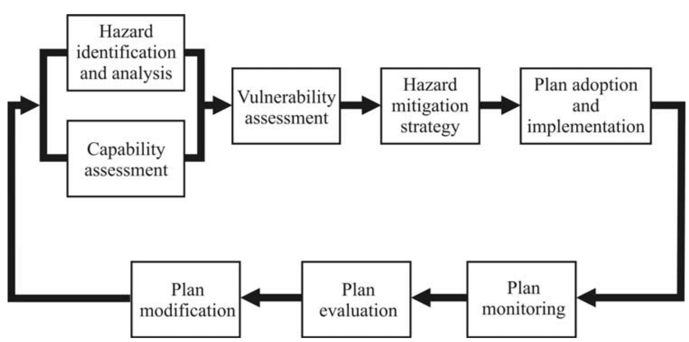
Chemical hazards are toxic substances, which cause damage to living organisms. Air pollutants (such as secondhand smoke or carbon monoxide), heavy metals, and pesticides are a few examples. We can be exposed to these contaminants from a variety of residential, commercial, and industrial sources. Sometimes harmful environmental contaminants occur biologically, such as those from mold or a toxic algae bloom. Toxins can be classified based on their origin, purpose, chemical structure and properties, or effects.

**Physical Hazards**

Physical hazards are additional forces that can imperil humans. Physical hazards may arise naturally such as natural disasters (earthquakes, wildfires, landslides, etc.) or extreme weather. Others may arise from human structures or activities (traffic accident, building collapse, injury from mechanical equipment, strain on the body from repeated movements, etc.) Some physical hazards, such as explosions or radiation, can arise from natural or human sources.

Radiation is energy given off by matter in the form of rays or high-speed particles, and some types of radiation present a physical hazard. Some familiar forms of radiation are infrared radiation (heat), visible light, ultraviolet (UV) light, radio waves, and microwaves. We are exposed to radiation every day from natural sources. For example, the sun exposes us to UV radiation.

The purpose of **hazard mitigation** is to protect people and structures, and minimize the costs of disaster response and recovery. Hazard mitigation can take many forms: capital projects, policies, education, and environmental protection.




**Proactive mitigation** leads to more cost-effective projects. By contrast, reactive mitigation, tends to lead to severe damage and often more costly fixes; it simply costs too much to address the effects of disasters only after they happen. A surprising amount of damage can be prevented if we can anticipate where and how disasters occur, and take steps to prevent those damages.The planning process is as important as the plan itself because it creates a framework for governments to reduce the negative impacts from future disasters on lives, property, and the economy.

**Hazard Mitigation Breaks the Cycle**

When recurrent disasters, such as riverine flooding, take place, repeated damage and reconstruction can occur. This reconstruction becomes more expensive as the years go by. Hazard mitigation breaks this expensive cycle of repetitive damage and increasing reconstruction costs by taking a long-term view of rebuilding and recovering from disasters.

**Hazard mitigation actions are commonly broken into four different categories:**

- Local Plans and Regulations – These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.
- Structure and Infrastructure Project– These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- Natural Systems Protection– These are actions that minimize damage and losses, and also preserve or restore the functions of natural systems.
- Education and Awareness Programs – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

**Common mitigation actions that are taken include:**

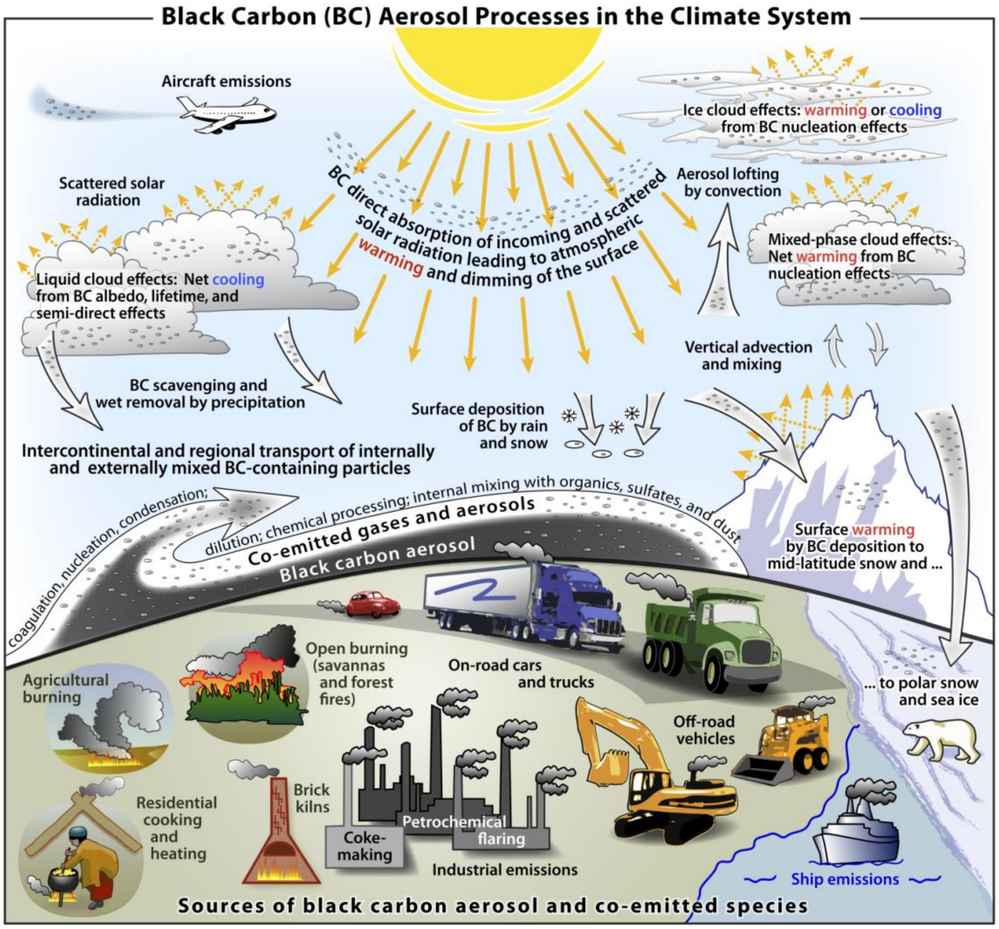
- Enforcement of building codes, floodplain management codes, and environmental regulations
- Public safety measures such as continual maintenance of roadways, culverts, and dams
- Acquisition or relocation of structures, such as purchasing buildings located in a floodplain
- Acquisition of hazard prone lands in their undeveloped state to ensure they remain so
- Retrofitting structures and design of new construction such as elevating a home or building
- Protecting critical facilities and infrastructure from future hazard events
- Mitigation, disaster recovery, and Continuity of Operations planning
- Development and distribution of outreach materials related to hazard mitigation
- Deployment of warning systems
- Drainage system upgrades

**Que. 4 (c) Elaborate on black carbon caused climate change.**
**Ans .4 (c)** The understanding about black carbon has come a long way since the nebulous beginning in the seventies, when all the world understood was suspended particulate matter (SPM) – a local pollutant from incomplete combustion, indicted for pollution from fires and vehicles. The composition of black carbon varies by the type of fuel used, the combustion process, and emission control technologies or practices. Black carbon particles vary in size and can be much smaller than PM2.5 and as small as PM0.1. These last up to minutes, hours and one week or little more in the atmosphere depending on the combustion process and size.

- Black carbon and warming: Black carbon can absorb heat and warm up the surrounding atmosphere. Scientists calculate the potential of a gas to cause global warming in terms of 'radiative forcing'. Radiative forcing is the difference of sunlight absorbed by the Earth and energy radiated back to space in watts per square meter of the Earth's surface. More incoming energy is more warming.
- More outgoing energy is negative forcing that cools. Black carbon has the shortest life – between 3-8 days. And there is uncertainty regarding its potential of causing climate change. The uncertainty in the emission metrics such as Global Warming Potential (GWP) and Global Temperature change Potential (GTP) of Black Carbon is wide reflecting the current challenges related to understanding and quantifying the various effects of black carbon on climate systems in different regions of the world.
- However, the science of black carbon has improved over the years and so has the understanding on its impacts on climate. The latest IPCC report AR6 has taken note of the recent research and is more explicit in its discussion on black carbon than it was ever before. For instance, AR5 has doubled the estimate of warming (Global mean radiative forcing) of black carbon aerosol from fossil fuels and bio fuels from its previous report.

**The Damaging Effects of Black Carbon**

- Air pollution, both outdoors and indoors, causes millions of premature deaths each year. The deaths are mainly caused by the inhalation of particulate matter. Black carbon, a component of particulate matter, is especially dangerous to human health because of its tiny size. But black carbon not only has impacts on human health, it also affects visibility, harms ecosystems, reduces agricultural productivity and exacerbates global warming.




- The breathing in of particulate matter (composed of black carbon, sulfate, nitrates, ammonia, sodium chloride, mineral dust and water) that measures 10 microns or less in diameter (PM10), poses the greatest health risks because the particles can find their way deep into lungs and the bloodstream, and cause cardiovascular and respiratory disease, and premature death. Formed by the incomplete burning of fossil fuels, bio fuels and biomass, black carbon, has a diameter of less than 2½ microns (PM2.5).
- Because black carbon absorbs solar energy, it warms the atmosphere. When it falls to earth with precipitation, it darkens the surface of snow and ice, reducing their albedo (the reflecting power of a surface), warming the snow, and hastening melting.
- Black carbon, like all particles in the atmosphere, also affects the reflectivity, stability and duration of clouds and alters precipitation. Depending on how much soot is in the air and where black carbon sits in the atmosphere, it has different effects. If it absorbs heat at the level where clouds are forming, they will evaporate. When it lies above lower stratocumulus clouds that block the sun, it stabilizes them and thus has a cooling effect. Because black carbon interacts with other components of particulate matter, such as sulfates and nitrates that reflect sunlight and cool the atmosphere, scientists do not know exactly how much black carbon itself directly contributes to global warming.

- Snow covered regions are the most vulnerable to the warming effects of black carbon, and any particles reaching them are of concern if they are darker than snow, because they can reduce reflectivity and speed melting. Glaciers are melting in the Andes, the Rocky Mountains, the Canadian Rockies, the Alps, the Himalayas and around the world. As glaciers melt and retreat, the ice melt that during the dry season feeds the rivers that supply irrigation systems will dwindle. The glaciers of the Himalayas and the Tibetan Plateau sustain the rivers of China and India and are critical to the fresh water and food supplies of these two countries.
- As arctic ice continues to melt, there will be more shipping in the region, making it more likely that black carbon emissions from ships burning heavy fuel will increase in the future.
- According to the Committee on the Marine Transportation System, shipping in U.S. waters of the arctic could increase five-fold by 2025.
- The process is intensified because as snow melts and refreezes, the melt water sticks grains of snow together. As snow grains get bigger, more solar radiation is absorbed, increasing melting and exposing more darkening. This process, however, is invisible to our eye—the light reflecting off the snow may look the same, however the absorption and darkening is occurring in the near infrared band, which the human eye can't perceive. Curbing black carbon emissions is one of the most effective strategies for slowing climate change because of their short life in the atmosphere. The climate will respond quickly to reductions of black carbon, especially in regions like the arctic and Asia where the warming and melting of snow and ice could be slowed and changes in precipitation patterns reversed.
- At the Paris climate talks in December, the Climate and Clean Air Coalition comprised of government and industry groups, agreed on plans to tackle the emissions of “short-lived climate pollutants” which include black carbon, HFCs, methane and ground-level ozone. The Green Freight Action Plan aims to increase awareness about black carbon emissions, develop methods to track and report black carbon emissions and spur the adoption of technologies and best practices to reduce them.
- A side event at the climate conference focused on the Arctic Council's initiatives to curb black carbon and methane emissions, mainly arising from cooking, heating, transportation including shipping, and the flaring of methane that leaks from oil and gas wells in the region.
- It highlighted efforts to deal with sources of black carbon, reduce emissions from wood burning for heating and convert diesel transport. The Arctic Council's states (countries with territory in the arctic—Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) and Arctic Council Observers are estimated to be responsible for around 50 percent of manmade global emissions of black carbon and methane.
- The tricky aspect of developing strategies to reduce black carbon emissions is that when things burn, they generate not only black carbon but also pollutants such as sulfur dioxide and nitrogen dioxide that have cooling effects. Knowing the relative amounts of these pollutants in each source is key. For example, diesel engines produce mostly black carbon, as does coal combustion, but wildfires and open biomass burning also generate organic carbon that creates a haze that cools the atmosphere.

- To be most effective, strategies aimed at curbing climate change must take into consideration the particular mix of pollutants produced by each source. Sources that emit more black carbon than other pollutants are the best targets for action.

**Que. 5 (a) What is meant by biological wealth? Identify its role in equitable development.**

**Ans. 5 (a)** Of all the wealth that is present on the planet Earth, there are **three simple categories** that wealth can be grouped into**. Material riches** can be grouped into the first category and those things that are **culturally** meaningful comprise the second group. The first two groupings of wealth come in forms that are readily understood. They can also be quantified rather easily. The main reason for this easy understanding of material and cultural wealth is because of their omnipresence in our daily lives. The third one is **biological wealth**/ Ecosystem Values.

Biological wealth are measures of how important ecosystem services are to people what they are worth. Economists measure the value of ecosystem services to people by estimating the amount people are willing to pay to preserve or enhance the services. However, this is not always straightforward, for a variety of reasons.

Economists classify biological wealth into several types. The two main categories are use values and non-use, or **passive use values**. Whereas **use values** are based on actual use of the environment, non-use values are values that are not associated with actual use, or even an option to use, an ecosystem or its services.

Thus, use value is defined as the value derived from the actual use of a good or service, such as hunting, fishing. Use values may also include indirect uses. For example, an natural wilderness area provides direct use values to the people who visit the area.

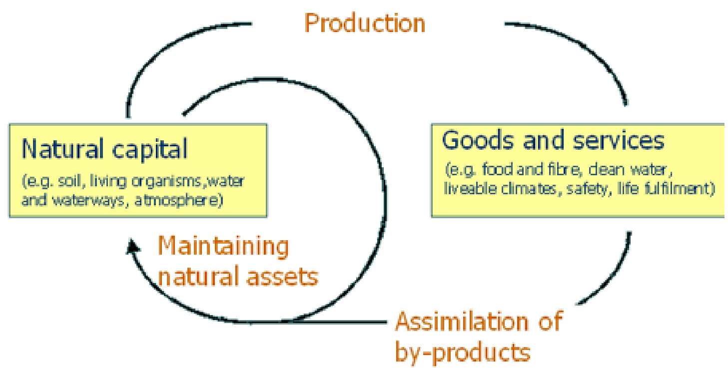
Non-use values, also referred to as ¡¦passive use¡¦ values, are values that are not associated with actual use, or even the option to use a good or service. Existence value is the non-use value that people place on simply knowing that something exists, even if they will never see it or use it. For example, a person might be willing to pay to protect the Alaskan wilderness area, even though he or she never expects or even wants to go there, but simply because he or she values the fact that it exists.

Ecosystem valuation can be a difficult and controversial task, and economists have often been criticized for trying to put a pricetag on nature. However, agencies in charge of protecting and managing natural resources must often make difficult spending decisions that involve tradeoffs in allocating resources. These types of decisions are economic decisions, and thus are based, either explicitly or implicitly, on society are values. Therefore, economic valuation can be useful, by providing a way to justify and set priorities for programs, policies, or actions that protect or restore ecosystems and their services .

**Ecosystem Functions and Services**

Ecosystem functions are the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem; in other words, what the ecosystem does. Some examples of ecosystem functions are provision of wildlife habitat, carbon cycling, or the trapping of nutrients. Thus, ecosystems, such as wetlands, forests, or estuaries, can be characterized by the processes, or functions, that occur within them.

Ecosystem services are the beneficial outcomes, for the natural environment or people, that result from ecosystem functions. Some examples of ecosystem services are support of the food chain, harvesting of animals or plants, and the provision of clean water or scenic views. In order for an ecosystem to provide services to humans, some interaction with, or at least some appreciation by, humans is required. Thus, functions of ecosystems are value-neutral, while their services have value to society.




**Decisions about ecosystem management** are complicated by the fact that various types of market failure are are associated with natural resources and the environment. Market failures occur when markets do not reflect the full social costs or benefits of a good. For example, the price of gasoline does not fully reflect the costs, in terms of pollution, that are imposed on society by burning gasoline. Market failures related to ecosystems include the facts that: (i) many ecosystems provide services that are public goods; (ii) many ecosystem services are affected by externalities; and (iii) property rights related to ecosystems and their services are often not clearly defined.

- Ecosystem services are often public goods, which means that they may be enjoyed by any number of people without affecting other peoples enjoyment. For example, an aesthetic view is a pure public good. No matter how many people enjoy the view, others can also enjoy it. Other services may be quasi-public goods, where at a certain level of use, others enjoyment may be diminished. For example, a public recreation area may be open to everyone. However, crowding can decrease people enjoyment of the area. The problem with public goods is that, although people value them, no one person has an incentive to pay to maintain the good. Thus, collective action is required in order to produce the most beneficial quantity.

- Ecosystem services may be affected by externalities, or uncompensated side effects of human actions. For example, if a stream is polluted by runoff from agricultural land, the people downstream experience a negative externality. The problem with negative externalities is that the people (or ecosystems) they are imposed upon are generally not compensated for the damages they suffer.

- Finally, if property rights for natural resources are not clearly defined, they may be overused, because there is no incentive to conserve them. For example, unregulated fisheries are an open-access resource anyone who wants to harvest fish can do so. Because no one person or group owns the resource, open access can lead to severe over-harvesting and potentially severe declines in fish abundance over time.

Biological wealth valuation can help resource managers deal with the effects of market failures, by measuring their costs to society, in terms of lost economic benefits. The costs to society can then be imposed, in various ways, on those who are responsible, or can be used to determine the value of actions to reduce or eliminate environmental impacts. For example, in the case of the crowded public recreation area, benefits to the public could be increased by reducing the crowding. This might be done by expanding the area or by limiting the number of visitors. The costs of implementing different options can be compared to the increased economic benefits of reduced crowding.

In the case of a stream polluted by agricultural runoff, the benefits from eliminating the pollution can be compared to costs of actions to reduce the runoff, or can be used to determine the appropriate fines or taxes to be levied on those who are responsible. In the case of open-access fisheries, the benefits from reducing overfishing can be compared to regulatory costs or costs to the commercial fishing industry if access is restricted.

Often overlooked is what some could argue is the planets' most valuable wealth. Biological wealth is less well understood because it is not at the forefront of our everyday lives and thought. A key component to solving the current global problem of biodiversity loss is to study the underlying facts that make biological wealth so important.

**Que .5 (b) Examine resource and population relations in light of Ackerman's Population - Resource Regions.**

**Ans. 5 (b)** Collection of people at a time of a place if more than thirty then such size of collection of people considered as 'population'. On the other hand, 'resource' means some things that has utility to human beings. Therefore, foods, tables, chairs, books or many others have some utility and that is why these things are resources.

The population-resource relationship over any region keep on changing. With increasing world population, the major and basic resources such food, shelter and home have becoming scare. In any given resources base what should be the population size? It is an important issue debated since second half of nineteen century. Here, we shall discuss and understand the different types of population-resources relation of the world.

**Optimum population** has been defined as that size of population enabling per capita output of the maximum orders accompanied by the highest possible standards of living under a given set of economic and technological conditions. Therefore, optimum population lies between two extremes, i.e., overpopulation and under-population, although the size of optimum population is not sacrosanct.

It is a theoretically perfect situation difficult to estimate or define. The Penguin Dictionary of Geography characterises optimum population as a situation when the number of individuals can be accommodated in an area to the maximum advantage of each individual.

Thus, optimum population yields highest quality of life, which means each person has access to adequate food, water, energy and air of highest quality, adequate medical care, recreational facilities and cultural outlets. In other words, optimum population permits the highest per capita output; therefore, the marginal productivity exceeds the average productivity whereby the rates of growth of total production are the highest.

**Under-Population** is recognized when there are more resources in an area (for example, food, energy and minerals) than can be used by the people living there. Hence, the maximum human potential of that area is not realized as the resources are not fully exploited. Countries like.

Canada and Australia can export the surplus of food, energy, and mineral resources, have high incomes, good living conditions and level of technology and immigration.

Some rural areas close to major cities in advanced countries such as the UK are underpopulated due to outward migration. In the UK, the Southwest Wales and the highlands of Scotland are less densely populated compared to the rest of the country. This has also happened in older declining industrial areas and the outward movement or migration has been due to lower wages and unemployment. This phenomenon results in a decline in a population. With fewer people, there is a decrease in demands for services. The lower level of services therefore sometimes encourages further outward migration.

**Various attempts have been made to address population decline that are as follows:**

i. Improving communication networks and transport facilities makes remote places more accessible. This strategy was used in developing countries like Nigeria and Tanzania where modern railway networks were established, but these attempts were not very successful.

ii. Establishment of new capital cities, new towns, or development growth points. For example, Brazil has a population imbalance between the coastal parts from east and south and the rest of the country. Brasilia, the new capital was created in the 1960s in the country's geographical center to attract people into the North and Center-West regions, but this had limited effect, as most of these unpopulated areas are occupied by large forests and swamps.

iii. Regional development programs. In Brazil, the interior improvement of transport networks and development of secondary growth points and rural development has all been enhanced to attract more people and discourage out-migration. The standard of living in such regions is expected to gradually improve due to improved resource utilization.

iv. Ponytails policies providing tax incentives paid maternity leaves, day care, or other benefits to families to bear more children. Such policies have been tried, with mixed success, in Western Europe in recent years.

**Overpopulation** is a condition when an organism's numbers exceed the carrying capacity of its ecological niche. In common parlance, the term usually refers to the relationship between the human population and its environment, the Earth.

Overpopulation is not simply a function of the size or density of the population. Overpopulation can be determined using the ratio of population to available resources. If a given environment has a population of ten, but there is food or drinking water enough for only nine, then that environment is overpopulated; if the population is 100 individuals but there is food, shelter or water enough for 200, then it is not. Overpopulation can result from an increase in births, a decline in mortality rates due to medical advances, from an increase in immigration, a decrease in emigration, or from an unsustainable use and depletion of resources. It is possible for very sparsely-populated areas to be "overpopulated", as the area in question may have a very meager or non-existent capability to sustain human life (e.g. the middle of the Sahara Desert or Antarctica)

Some of the overpopulated regions of the world are India, Petén region of Guatemala, Bangladesh, Madagascar, Australia, Nigeria, Ethiopia, Sudan, Niger, Haiti, United States, Arizona, California, Uganda, and Zimbabwe.

**Ackerman’s Population - Resource Regions**

Edward A. Ackerman (1911-1973) has used three basic criteria for devising the world’s regional scheme of population /resource ratio, which are:

- **Population factor,**
- **Resource factor and**
- **Technology factor.**

Among these three variables used in this scheme, the most critical is the magnitude and quality of available technology. Ackerman while using the three factors of population, resource and technology, emphasized more on technology. He suggested a five-fold classification of the world into population/resource regions on the basis of population resource ratios and the availability of technology:

1. **United States Type:** About one sixth of the world's people live in technology-source areas with low population/resource ratios, as in much of North America, Australia and New Zealand and the erstwhile Soviet Union.

2. **European Type:** One sixth live in technology-source areas with high population/resource ratios, where industrialization and technology have permitted an expansion of resources through international trade. Most of Europe and Japan fall in this category.

3. **Egyptian Type:** Roughly one-half live-in areas which are technology deficient with high population/resource ratios, as in India, Pakistan and China. This type epitomizes some of the most severe population problems.

4. **Brazilian Type:** One sixth live in technology- deficient areas with low population/resource ratios, as in much of Latin America, Africa and South-East Asia, where resources sometimes remain unused because of the problems of developing difficult environments.

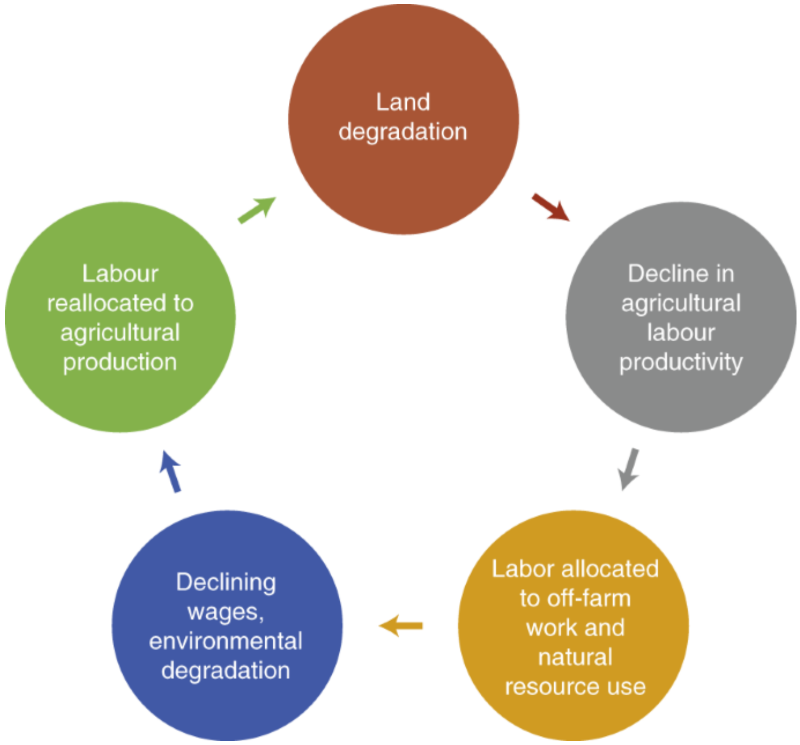
5. **Arctic- Desert Type:** The largely uninhabited ice caps, tundra's and deserts are mostly technology-deficient and offer little food-producing potential at the moment.

6. This classification is a useful general guide but offers little help for more specific cases of pressure of population on resources, which is extremely difficult to define in quantitative terms due to the dynamism of the variables involved: population, resource, technology and the economic expectations and attainments of the people.

**Que . 5(c) Analyse the changes in land use pattern, its effect and management approach in world.**

**Ans. 5 (c)** The total area of ice-free land on Earth is estimated at 13 billion hectares. Of this, about 46% is currently being used for agriculture and forestry; almost 7% is considered urban, peri-urban or modified by human infrastructure. Estimates indicate that up to 25% of all land is currently highly degraded, 36% is slightly or moderately degraded but in stable condition, while only 10% is improving. In the last two centuries, humans have converted or modified 70% of the world's grasslands, 50% of the savannah, 45% of the temperate deciduous forest, and 27% of the tropical forest biome primarily for farming and grazing activities.

Land is a major overarching theme connecting the three Rio Conventions covering climate change (UNFCCC), biodiversity (CBD), and desertification and land degradation (UNCCD). Land management plays a key role in attaining their goals and targets. Furthermore, a large number of the Sustainable Development Goals have strong links to land and land management, and tradeoffs between sustainability ambitions often materialise on land.

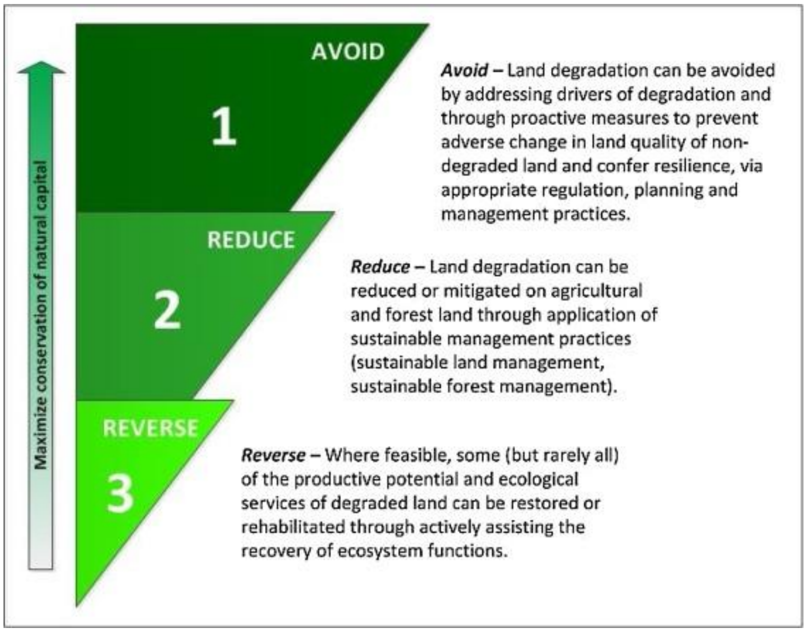



The pressure on land is projected to increase in Sub-Saharan Africa. Larger and more affluent populations will drive an increase in demand for food and fibre, with projections ranging from 25% to 75%, depending on the scenario being considered. SubSaharan Africa and South Asia are the regions that will bear the brunt of population growth and, together with South America, are expected to see the fastest increase in pressure on land resources. All three scenarios expect the most significant regional expansion of agricultural land to take place in Sub-Saharan Africa, taking over savannahs and tropical forests, in particular.

The amount of land available to expand agriculture is becoming more and more limited and expansion increasingly takes place on marginal lands. In several regions, the best lands are already in use and expansion will increasingly take place on marginal lands which include less fertile soils, steep slopes and less-favourable climatic conditions, resulting in lower yields. Land for agriculture is especially scarce, or, expected to become so, in the Middle East and Northern Africa, South Asia, China, and Japan and Oceania. The projected expansion of agriculture in tropical areas is especially worrisome since soils there are, generally, more prone to erosion and nutrient depletion when not managed carefully.

Future agricultural land use depends greatly on efficiency increases. Over the past decades, the largest contribution to the rise in food production has come from efficiency increases in agriculture, in both yields and conversion steps in the livestock sector. Although to varying degrees, the three scenarios assume enhanced efficiency will continue to play a dominant role in future production increases. However, the opportunities for future efficiency improvements differ markedly.

Land degradation is both a cause and a consequence of climate change. Land degradation and climate change form feedback loops whereby intensive production increases emissions while the loss of soil and vegetation significantly reduces carbon sequestration (carbon sinks). The result is more carbon in the atmosphere feeding an energetic cycle of land degradation, biodiversity loss and climate change. To date, a great many of the synergies between land and climate have been negative. However, a vicious cycle can be turned into a virtuous one by reinforcing the positive elements of the relationship, helping to manage emissions on the one hand and adapting to climate impacts on the other. Adopting and scaling up sustainable land management practices would deliver important benefits not only for climate stability but for the farmer, the consumer and the environment.




Today, the global losses as a result of land degradation are estimated to be USD 6.3-10.6 trillion per year. Approximately 52% of the land used for agriculture worldwide is moderately or severely affected by soil degradation while 50 million people will face displacement in the next 50 years as a result of desertification and land degradation. Land degradation represents one of the biggest human challenges of our time and yet too many people are still unaware that the cost of inaction is far greater than the cost of taking action.

As the environmental realities of the 21st century become clear, we must recognize the stark fact that our global lands are fixed in quantity although not in quality. This simple fact is a compelling argument for us to become agents of change and begin managing our land in a manner that reflects its central importance to our future survival on this planet. Land and land resources (i.e., soil, water and biodiversity) underwrite the ability to grow, prosper, and sustain our very existence. An important dimension of future land use decisions is the effect that land management, rehabilitation and restoration will have on our ability to adapt to and mitigate climate change. This presents a unique opportunity to transform policies (e.g., legislation, regulation, subsidies) that provide incentives and drive investment towards more sustainable, climate-smart land use management and planning.

Indeed, the land use sector is quite unique with respect to mitigating climate change as it affords us opportunities to both avoid/reduce emissions and sequester carbon. There is a growing recognition that limiting global warming to 2° C above pre-industrial levels can only be realized if the mitigation potential of the land use sector is exploited in a more systematic and comprehensive manner. This largely untapped mitigation potential offers clear pathways of action that also contribute to multiple Sustainable Development Goals (SDGs) and targets, such as achieving Land Degradation Neutrality (LDN) .

Striving to achieve the LDN target translates into meaningful climate action by: 1) protecting our natural carbon sinks like forests, grasslands and wetlands, 2) adopting and scaling up sustainable land management practices that reduce emissions, increase productivity and prevent further land use change, and 3) restoring degraded ecosystems for improved resilience and long-term carbon storage. These three pathways of action need not be expensive or complex.

An increased appreciation for the mitigation potential of the land use sector would allow many developing countries to act quickly in halting and reversing land degradation, thus contributing to real climate action, poverty reduction and sustainable development. Climate-smart land management practices nearly always come with adaptation co-benefits. Their more efficient use of resources and inputs can ensure greater food and water security while land rehabilitation and restoration helps build community resilience and sequesters carbon.

**Que. 5 (d) Write note on Anderson's classification of Ecological systems.**

**Ans. 5 (d)** In classifying the world's agriculture, a four-level frame was recognized by Anderson (1970), namely ecological, subsistence, commercial and collective agricultural systems. At the ecological or near-ecological level, natives utilize natural plants and breed animals by primitive methods. At the subsistence level, which may be subdivided into the least primitive and intensive subsistence sub-types, the agricultural produce is raised primarily for consumption at home and very little is traded.

**Ecological or Near-Ecological Systems**

**Nomadic Herding**Nomadic herding is, at present, concentrated mainly in Saharan Africa, Eastern Africa, interior of Southern Africa, and the southwestern and interior parts of Asia. Unlike commercial grain farming or commercial grazing, nomadic herding is, therefore, an ancient activity, and may also be called an aboriginal form of livestock raising. It is the simplest form of pastoralism in which herds and flocks graze chiefly on natural vegetation. It is mainly confined to the sparsely populated dry regions of the old world. Such vast tracts of the earth are too dry to produce crops but are suitable for rearing or grazing livestock of different kinds. On the whole, it is just a subsistence form of exploiting dry regions in which the use of land is extensive, as several hectares are required to feed one animal.

**Shifting Cultivation** Shifting cultivation is said to be as old as the history of agriculture itself. Its origin, however, could be traced back to about 7,000/8,000 BC, when man made an attempt to switch to food production from food gathering activities. Infertile soils in the humid lowlands of low latitudes are chiefly responsible for farming of a temporary or shifting character. This type of farming is a primitive form of the utilization of the poor soils of tropical rain forests and bush areas. On the whole, shifting cultivation has long been recognized as the most widespread agricultural system of the tropics encountered in Amazonia *Selva*, the Congo Basin and Southeast Asia.

When brought under cultivation, laterite soils turn infertile because they leach and erode rapidly with the removal of natural vegetation which exposes them to the sun and rain. After two or three years of producing subsistence crops of land cleared by the *slash-and-burn* technique, the primitive people are forced to move into the adjacent forest. After some years (5 to 12) the tilled arable fields get still further removed from the settlement, and hence the tribe moves to a new site in the deep forest so as to come closer to the tilled fields.

Shifting cultivation is carried on chiefly in regions with a tropical forest climate. It is widely spread in it and along its borders. The tropical regions of the Americas, central Africa, and southeastern Asia (including Indonesia) may be identified as the home of shifting cultivation.

In shifting cultivation, the farmer selects a patch of forest, in which he fells a few trees with crude hand tools, leaving only the larger and economically useful plants untouched. He clears the undergrowth with a short one-edged sword having a slightly curved blade (cutlass), and burns the residue. Crops are sown in the clearing or *swidden* with little preparation. *Swidden* cultivation is practiced in areas which are cleared during the brief dry season (December and January). The burning process takes two or three days resulting in only the partial destruction of the cleared vegetation, much of which still lies on the surface when the crops are planted.

Despite a large number of papers on different aspects of shifting cultivation, such as ecological and anthropological investigations, topical and geographical or regional coverage is very small. It was only in the fifties and sixties that it began to receive attention from students of *swidden* cultivation, who conducted their studies, more actively in the tropics of Southeast Asia and Africa than in the tropical regions of North and South America. The fundamental difficulty faced by researchers in the geographical investigation of *swidden* cultivation is the length of stay required in the field to determine a complete agricultural cycle, from the initial clearance through cultivation and fallowing to recultivation of the same site. Such a cycle is commonly completed in ten years or more; as yet no detailed study of a complete cycle at any one site appears to have been made in any part of the world.

The crops receive only cursory attention during the growth period. After the first harvest, they are sown again for a year or two, and thereafter the land is left fallow. Colonization by natural vegetation is allowed while another patch of land is cleared for cultivation. Ideally the first clearing is not used for cultivating crops again until it has been under a natural fallow for some years and the soil fertility restored. Thus, the most striking features of shifting cultivation are:

- its scattered rather than concentrated distribution, and small patches of tilled land commonly surrounded and separated by sufficiently broad stretches of forest;

- rotation of fields rather than crops as short periods of cropping alternating with sufficiently long periods of natural fallow;

- a common method of slash-and-burn so as to clear the natural vegetation; and
- fertility of the land being maintained by allowing the natural vegetation to regenerate.

**Rudimentary Sedentary Tillage**In many parts of the world, agrarian communities practice *subsistence cultivation* to some extent, that is, cultivation of crops for consumption by the family itself. In other words, subsistence farming is the cultivation of crops and the raising of animals to feed the farmer and his family members. It is normally practiced in environments not very suitable for commercial livestock rearing and crop production. There are some regions in the world where cultivators operate within a completely subsistence economy although such groups exist in regions isolated from the commercial world by topographical and vegetational barriers.

Though shifting cultivation is a typical feature of the tropical rainforests, in scattered areas many families and even groups who till the same piece of land year after year are being settled in one single area. They practice rudimentary sedentary tillage mostly in the tropical rainforests. They remain permanently sedentary unless some unforeseen calamity sets them wandering. Shifting cultivators tend to rely on a more primitive and less reliable system of agriculture than their sedentary counterparts.

**Intensive Subsistence Tillage (With Paddy Dominance)**In tropical monsoon areas the frost-free year round growing season, and the prevalence of numerous agro-climatic conditions are highly favorable to the maturing of two or three paddy crops in an agricultural year from the same *paddies*. Rice is the most distinctive and important staple food of the intensive subsistence tillage areas. The principal types of farmland are the irrigated deltas, flood plains, coastal plains, and terraced mountain slopes. These are mainly devoted to rice. The multiple cropping of rice with the most intensive methods is a common feature. In extreme cases three crops of rice can be grown successfully each year on the same field. Two crops of rice a year are the rule where potential agro-climatic conditions in a slightly modified form persist.

**Intensive Subsistence Tillage (Without Paddy Dominance)**Areas which border the regions of paddy dominance are not devoted to intensive paddy cultivation on account of lack of moisture, a short growing season, and the prevalence of other unfavourable physical conditions for *paddies*. These handicaps have led cultivators to drastically modify the farming system. As such, the farmers are forced to produce several drought-resistant or drought-escaping cereals in place of rice. Most of these are low-value low-yielding foodgrains. Continental location has led to climatic hazards, particularly with regard to rainfall concentration, which at times is scanty and unreliable, and the short growing period for rice. Wherever fertile soils are available, wheat, barley, sorghum, bulrush millet, etc. are the staple foodgrains. Besides these, tobacco, sugar cane, vegetables, various oilseeds such as rape, mustard and linseed and certain legumes, e.g. peas, broad beans and gram or chick pea are also produced. Draught animals, particularly cattle, are fairly common, bullocks and water buffaloes are used for heavy work, while in the high altitudes mules or asses are used for transporting agriculture produce. Certain other animals, such as swine, poultry, and goats are also domesticated with little space and food requirements.

**Que. 5 (e) Avail an account of factors regulating nucleated settlement.**

**Ans. 5 (e)** The bulk of the world's rural population lives in hamlets and villages, not dispersed across the countryside. Most people have ancestral origins that go back to a village community. Not only is the small nucleated community the traditional settlement form in most countries, it is a cultural characteristic that has had a powerful influence on the development of many societies the factors that help account for the agglomeration of people in the rural landscape. Eight factors that contribute to the development of nucleated settlement can be identified.

The first is a *harsh environment*. Groups of people may be better able to cope than individual families with the uncooperative or unpleasant realities of a harsh environment. In a very cold land, such as Siberia, communal living might better enable people to deal with the severe winters, whereas solitary life in such an environment would be more risky. In a rainforest, the communal efforts of tribal life might better deal with the rainforest vegetation and poor soils than the individual efforts of the isolated family. Terrain is another environmental factor that may contribute to the aggregation of people. In areas of rugged terrain, people usually settle in the small valleys and hollows: the limited extent of this more favorable land encourages the concentration of settlement. Water is also an environmental factor significant in affecting settlement patterns. Both too little water (dry lands) and too much water (flood-prone lands) may be influential in concentrating people into local areas having optimal water availability.

*Defense*, the second factor historically has been a major reason for the agglomeration of settlement and continues to be important in areas of cultural instability and conflict. The use of defensive locations for rural settlement is perhaps nowhere better demonstrated than in the United Kingdom.

*Religion* is the next factor. Some of the earliest permanent settlements were established, totally or in part, to serve religious purposes. In the nineteenth and twentieth centuries thousands of farm villages were formed by organized religious groups in various parts of the world. Many were founded by religious cult leaders and their followers.

Dispersed settlement cannot provide the *social advantages* of village life. In a nucleated settlement it is easier to provide education services and health care. It is also easier to organize social clubs and cooperative societies in villages. For the village dweller loneliness is not the problem that it can become for the isolated farmer.

Certain *land tenure* systems and methods of organizing labor lend themselves more than others to a nucleated pattern. Medieval European farming, with its emphasis on communal field labor, clearly favored nucleation. Certain modern farming systems, such as some of those established for ideological reasons in the Soviet Union, China, and Israel, have required nucleated settlement and communal labor.

*Agrarian reform*, as we have seen, is large-scale government-sponsored change in the institutional setting of rural society and agriculture. It involves not only land reform (changing the land tenure), but also the establishment of rural settlement patterns and government support for agricultural and social programs.

The enormous economic and social gap between wealthy landowners on the one hand and struggling masses of small farmers and landless workers on the other has been one factor that has caused the governments of some less developed countries to initiate agrarian reform measures.

The movement of people from one place to another and their resettlement in new farm villages may also be the result of *colonization*, the seventh factor. The term is not used here in the sense of pursuing a policy of colonialism; instead, it refers to the organized settlement of a new area, usually as a result of a government program implemented in a more or less isolated part of the country. The availability of public land has prompted many developing countries to adopt population relocation schemes bearing such labels as land colonization, resettlement, transmigration, or land development. They have been presented by proponents (primarily government officials) as potentially tidy solutions to a number of problems, including curbing unemployment, providing land for the landless, reducing population pressures in the core area, and increasing agricultural production. Whatever the settlement pattern used, colonization schemes are costly undertakings.
The final factor is *urbanization*. In developed countries, as urban centers grow, nearby villages often grow into towns and nearby hamlets may grow into villages. It is not unusual, as well, for new hamlets to spring up as a result of counter-urbanization.

**Problems of Nucleated Settlements**
Many people, especially those accustomed to life in urban centers, associate a variety of problems with nucleated rural settlements. These problems diminish the attraction of villages and undoubtedly inhibit their prospects for growth. *The vast majority can be grouped into three categories:* (1) isolation, (2) limited goods and services, and (3) lack of freedom.

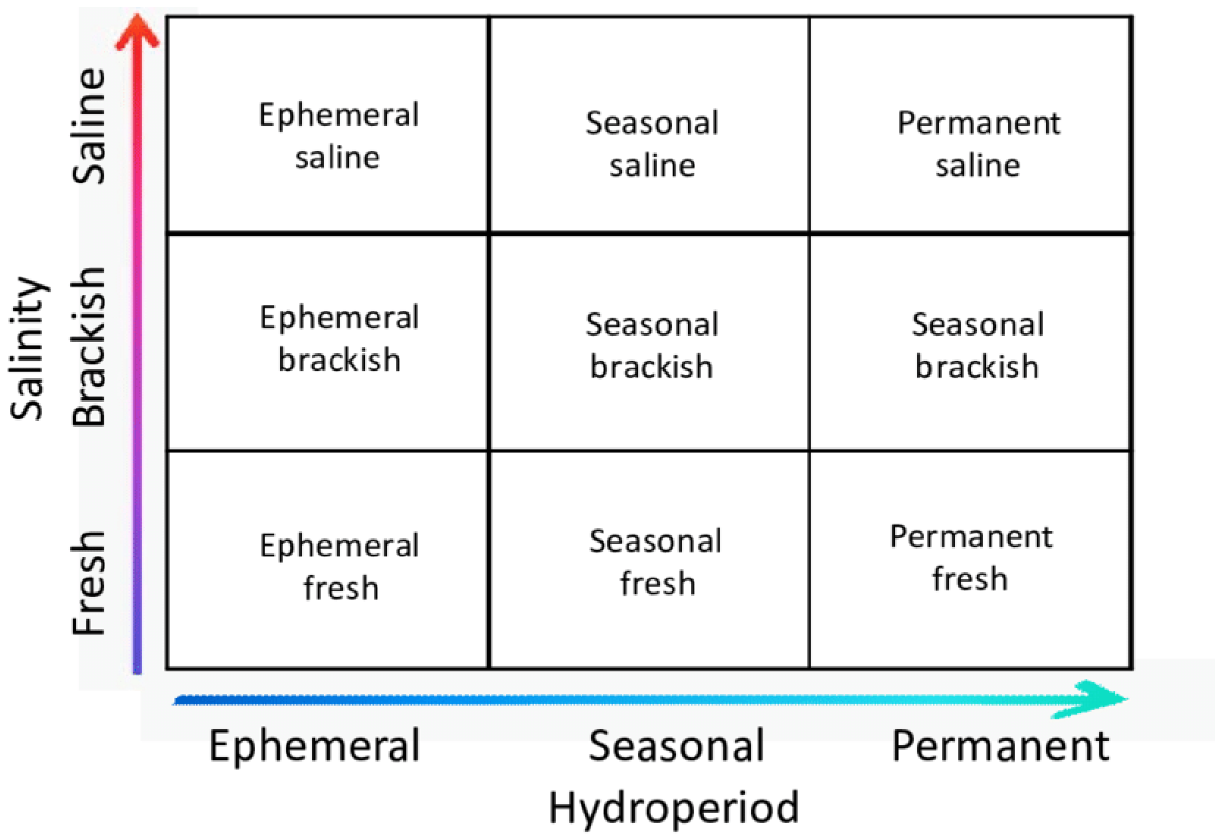
Villages often are viewed as remote and isolated places of small size in the “boondocks”. Instead, the small size of villages is a disadvantage to those who prefer the cultural offerings and excitement of the city. Also, because of their small size, villages present limited opportunities for social contacts. However, villages are not as isolated as dispersed farmsteads; villagers tend to characterize the inhabitants of dispersed farmsteads as living in the boondocks.

Villages are not able to offer nearly as many goods and services as urban places, and people who prefer urban life may consider this to be a disadvantage of smaller-than-urban places. However, people who live on dispersed farmsteads may be able to obtain most of the goods and services they need in the nearest village and may not think of the village as being disadvantaged.

Lack of personal freedom may be viewed as a problem in villages by both dispersed populations and urban dwellers. People who live on the land usually enjoy their independence and their freedom to do whatever they like on their own land: it would “cramp their style,” some believe, to live in a nucleated settlement. Those who favor urban living may also feed that freedoms are limited in villages. Among the masses of humanity who make up a city, one can find a certain amount of anonymity, freedom from social pressure, and tolerance of a wide variety of views and lifestyles. In a village, everyone might know everyone else, and there might be social pressure to conform to the local mores. Those often are perceived disadvantages of village life, even though such stereotyping is unfair, no doubt, to many villages.

**Que .6 (a) What are wetlands? Identify the conservation strategies applied for them**

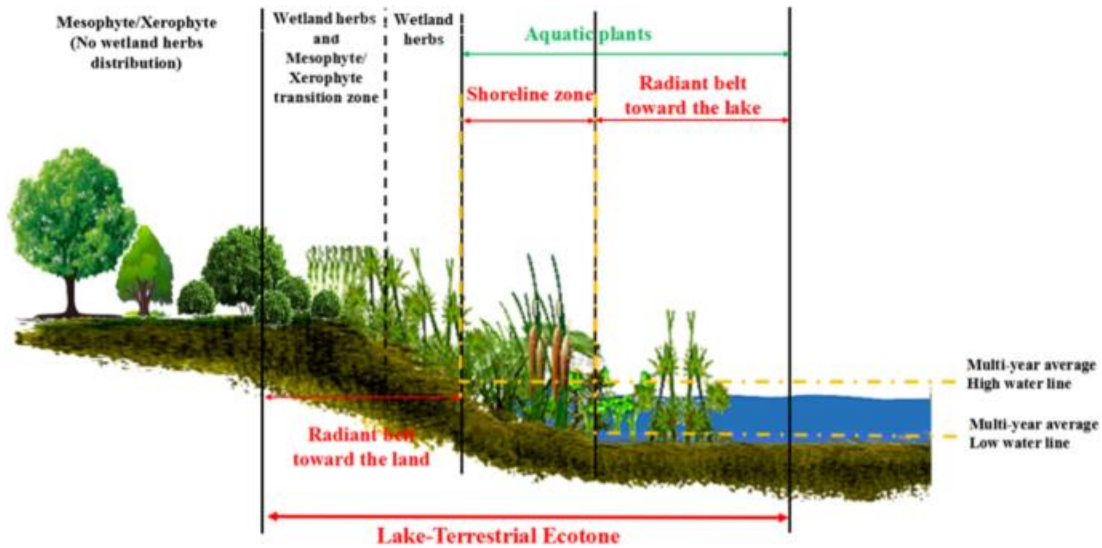
**Ans .6 (a)** Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season. Water saturation (hydrology) largely determines how the soil develops and the types of plant and animal communities living in and on the soil. Wetlands may support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils.




Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance. Indeed, wetlands are found from the tundra to the tropics and on every continent except Antarctica. Two general categories of wetlands are recognized: coastal or tidal wetlands and inland or non-tidal wetlands.

**Coastal/Tidal Wetlands**

Coastal/tidal wetlands are closely linked estuaries where sea water mixes with fresh water to form an environment of varying salinities. The salt water and the fluctuating water levels (due to tidal action) combine to create a rather difficult environment for most plants. Consequently, many shallow coastal areas are un vegetated mud flats or sand flats. Some plants, however, have successfully adapted to this environment. Certain grasses and grass like plants that adapt to the saline conditions form the tidal salt marshes .Mangrove swamps, with salt-loving shrubs or trees, are common in tropical climates. Some tidal freshwater wetlands form beyond the upper edges of tidal salt marshes where the influence of salt water ends.




**Inland/Non-tidal Wetlands**

Inland/non-tidal wetlands are most common on floodplains along rivers and streams (riparian wetlands), in isolated depressions surrounded by dry land (for example, playas, basins and "potholes"), along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (vernal pools and bogs). Inland wetlands include marshes and wet meadows dominated by herbaceous plants, swamps dominated by shrubs, and wooded swamps dominated by trees. Certain types of inland wetlands are common to particular regions of the country.

Many of these wetlands are seasonal (they are dry one or more seasons every year), and, particularly in the arid and semiarid West, may be wet only periodically. The quantity of water present and the timing of its presence in part determine the functions of a wetland and its role in the environment. Even wetlands that appear dry at times for significant parts of the year -- such as vernal pools-- often provide critical habitat for wildlife adapted to breeding exclusively in these areas.

**Importance of wetlands**

- Provide habitat for a wide variety and number of wildlife and plants.
- Filter, clean and store water. In other words, acting like kidneys for other ecosystems.
- Collect and hold flood waters.
- Absorb wind and tidal force.
- provide places of beauty and many recreational activities.


**IUCN Water Program and Wetlands**

IUCN is working with the Ramsar Convention and Contracting Parties, but also with grassroots communities and river basin agencies, to implement wetland conservation as part of its water management work. The benefits are clear: not only does it help to conserve biodiversity and livelihoods, but wetland conservation brings benefits to water quality, fisheries and protection against floods.

In 1985, IUCN together with WWF, started a major wetlands campaign called 'Life at the Water's Edge'. This campaign promoted the need for wetland conservation, produced a vast array of communication materials, and set out a clear wetland conservation program.

Since then, the multiple roles of wetland ecosystems and their value to humanity have been increasingly understood, as documented in the TEEB report on Water and Wetlands. The knowledge that millions of people around the world rely on wetlands for livelihoods is familiar now to many.

The Inner Niger Delta, for example, hosts about 20% of the population in Mali and generates on average 90,000 tonnes of fish catch per year. The lower Mekong delta supports the world's most productive inland fisheries, valued at around USD 3 billion per year. These inland fisheries provide 56 million people with up to 80% of their animal protein intake.

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention) was signed in Ramsar, Iran, on 2 February 1971, and came into force on 21 December 1975.

The Convention provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Originally emphasizing the conservation and wise use of wetlands primarily to provide a habitat for water birds, the Convention has subsequently broadened its scope to address all aspects of wetland conservation and wise use. This shift in focus reflects the increasing recognition of the importance of wetlands as ecosystems that contribute to both biodiversity conservation and human well being. Wetlands cover an estimated nine percent of the Earth's land surface, and contribute significantly to the global economy in terms of water supply, fisheries, agriculture, forestry and tourism.

The Ramsar Convention is the only environmental treaty dealing with a particular ecosystem. A total of 2000 wetland sites, covering 168 million hectares, were included in the Ramsar List of Wetlands of International Importance. Parties to the Convention commit themselves to: designate at least one site that meets the Ramsar Criteria for inclusion in the Ramsar List and ensure maintenance of the ecological character of each Ramsar site; include wetland conservation within national land-use planning in order to promote the wise use of all wetlands within their territory; establish nature reserves on wetlands and promote training in wetland research and management; and consult with other parties about Convention implementation, especially with regard to trans boundary wetlands, shared water systems, shared species and development projects affecting wetlands.

Contracting parties meet every three years to assess progress in implementing the Convention and wetland conservation, share knowledge and experience on technical issues, and plan for the next triennium. In addition to the Conference of the Parties (COP), the Convention's work is supported by a Standing Committee, a Scientific and Technical Review Panel, and the Ramsar Bureau, which carries out the functions of a Secretariat.

**Important areas of functioning**

Focused on the interrelations between human societies and wetland habitats

- Focusing on “Water, wetlands, life and culture,” delegates adopted more than 40 resolutions addressing policy, technical, programme and budgetary matters, including wetlands and agriculture, climate change, cultural issues, mangroves, water allocation and management, and the Report of the World Commission on Dams.
- “Wetlands and water: supporting life, sustaining livelihoods.” additional scientific and technical guidance for the implementation of the Ramsar wise use concept; engagement of the Convention in ongoing multilateral processes dealing with water; the Convention's role in disaster prevention, mitigation and adaptation; wetlands and poverty reduction; cultural values of wetlands; and the emergence of avian flu.
- “Healthy Wetlands, Healthy People,” wetlands and climate change; wetlands and biofuels; wetlands and extractive industries; wetlands and poverty eradication; wetlands and human health and well-

being; enhancing biodiversity in rice paddies as wetland systems; and promoting international cooperation on the conservation of water bird flyways.

**Que .6 (b) Elaborate on concept of Optimum Population. Also outlines its merits and demerits.**

**Ans .6 (b)** Optimum population is where the amount of resources available in a country is equal to the country's population needs, so there are enough resources to maintain its population. If it is below its optimum population then it has more resources than needed for the population, if it is above then it has too little resources to maintain its population.

To achieve optimum population, a country must change some of the following dimensions to lower or increase their fertility rate, before they can achieve optimum population. Immigration, age distribution and changes in lifespan must also be taken into account.

**Achieving Optimum Population**

**Social and Cultural:** Changing people's views and attitudes on religion to adjust it into a modern fashion, changing social attitudes, such as giving women more rights and thought in starting a large family than following tradition.

**Economic:** Increasing career opportunities will have peoples' minds set on education and career prospects, and maintaining their job, such that the immediate impulse to start a family might be delayed.

**Medical and Scientific**: Increasing the amount of contraception in LEDC (Less Economically Developed Country) educating adults and children about sexual education, on how to use contraception and the risks involved.

**Political:** Improving education to direct people into a career, this will have people concentrate on getting a stable job rather than plan ahead on starting a family.

The founders of the theory state it as "Given the natural resources, stock of capital and the state of technical knowledge, there will be a definite size of population with the per capita income. The population which has the highest per capita income is known as optimum population".

The economists like Carr Saunders considered 'optimum population' as that which produces maximum welfare. On the other hand, Prof. Cannan defined this theory in terms of 'return to labour'. He remarked, "Knowledge and circumstances remaining the same, there is what may be called maximum return when the amount of labour is such that both an increase and decrease in it would diminish proportionate return." Similarly, Bounding has rightly observed, "Optimum population is that at which standard of living is maximum.

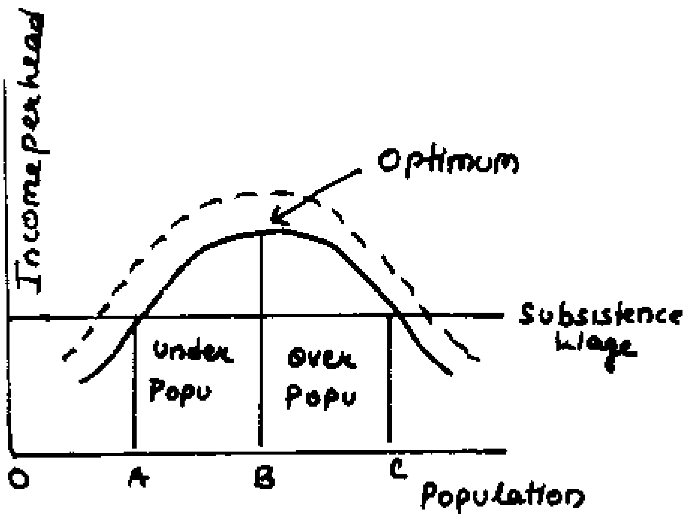
**Under Population**: If the actual population in a country is less than the optimum or ideal population, there will not be enough people to exploit all the resources of the country fully. Thus, the population and the per capita income will be lower. In other words, if the per capita income is low due to too few people, the population is then under population.

**Over Population:** If the actual population is above the level of optimum population, there will be too many people to work efficiently and produce the maximum goods and the highest per capita income. As a result, the per capita income becomes poorer than before. This is the stage of over population. In other words, if the per capita income is low due to too many people, the population under these circumstances would be over population.

**The optimum theory is based on two important assumptions:**

- The proportion of working population to total population remains constant as the population of the country increases.
- As the population of a country increases, the natural resources, the capital stock and state of technology remain unchanged.

**Diagrammatic Representation of the Theory:**




In the diagram I volume of population is shown along OX axis and income per head along OY-axis. OS is the income per head which gives only subsistence wage rate to the population. This level of wages puts the minimum limit to the income per head.

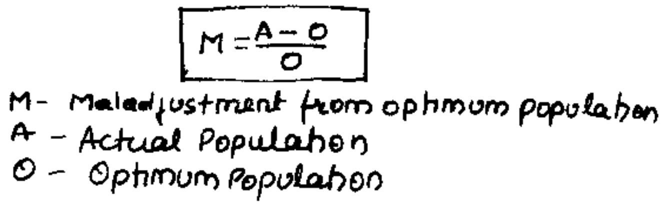
The subsistence income per head can prevail with two levels of population:

- When population is too small to exploit the country's resources with maximum efficiency. This is the level of OA population.
- When population is too large and the efficiency falls to give only a subsistence income to the labour force. This is the level of OC population.

OB shows optimum population which uses the available resources to give itself the maximum income per head. For a population less than OB, income per head increases with the increase in population. For a population higher than OB, income per head can increase with the decrease in population through preventive checks.

The dotted curve in the diagram shows the level of income per head with an improvement in technology or expansion of foreign trade. This will help to raise the income curve and generate population growth until wages are once again equal to subsistence level.

**Dalton's Formula:** Prof. Dalton expresses the theory in the form of a formula which is given below:




If M is zero, population is optimum, when M is positive, it is over population, when M is negative, it is under population.

Optimum population is not fixed and a rigid one. It is rather variable and relative to resources and technology. Optimum population is not just an economic concept but qualitative in nature. Prof. Cannan has correctly remarked, "It is being perpetually altered by the progress of knowledge and other changes affecting the economic system. It is, thus, a dynamic concept. It may be higher or lower as different methods of production are used."

**The theory is a landmark in the science of demography.**

Its merits are under noted:

**Comprehensive Approach:** It explains the problems of population in a comprehensive way from the production side. It also explains the relationship between productive efficiency and production.

**Qualitative Nature of the Theory:** Optimum population is difficult to find because size of population must lead to the fullest development of social and economic life

**Pragmatic Approach**: This theory is also pragmatic, i.e. it is concerned with practical results.

**More Detailed Analysis:** The optimum theory of population provides more detailed analysis as it considers over and under- population and brings out the evils of both.

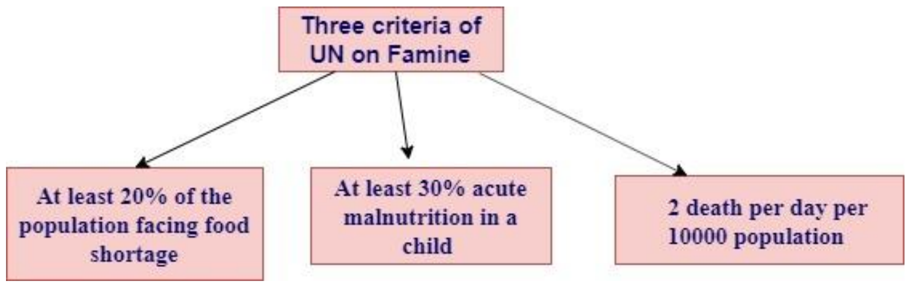
The optimum theory of population is not free from defects. The critics have criticized the theory on the basis of the following grounds:

**Difficult to Determine Optimum Population:** It is extremely difficult to know the optimum population of a country at any time. Many factors like technical knowledge, stock of capital, per capita income and natural resources etc. have to be taken into account for this purpose.

**A Static Theory:** The optimum theory is criticized as a static short period theory. It ignores changes in natural and human resources which affect per capita income. This theory is also silent about the important questions of the determinants of population growth.

**Que . 6 (c) 'Famines are complex humanitarian emergencies'. Explain.**

**Ans .6 (c)** Famines are sustained, extreme shortages of food among discrete populations sufficient to cause high rates of mortality. Signs and symptoms of prolonged food deprivation include loss of fat and subcutaneous tissue, depression, apathy, and weakness, which progress to immobility and death of the individual, often from superimposed respiratory or other infections. The social consequences of famines are disruption from mass migrations of people in search of food, breakdown of social behavior, abandonment of cooperative effort, loss of personal pride and sense of family ties, and finally a struggle for individual survival. Famines have been common ever since the development of agriculture made human settlements possible.

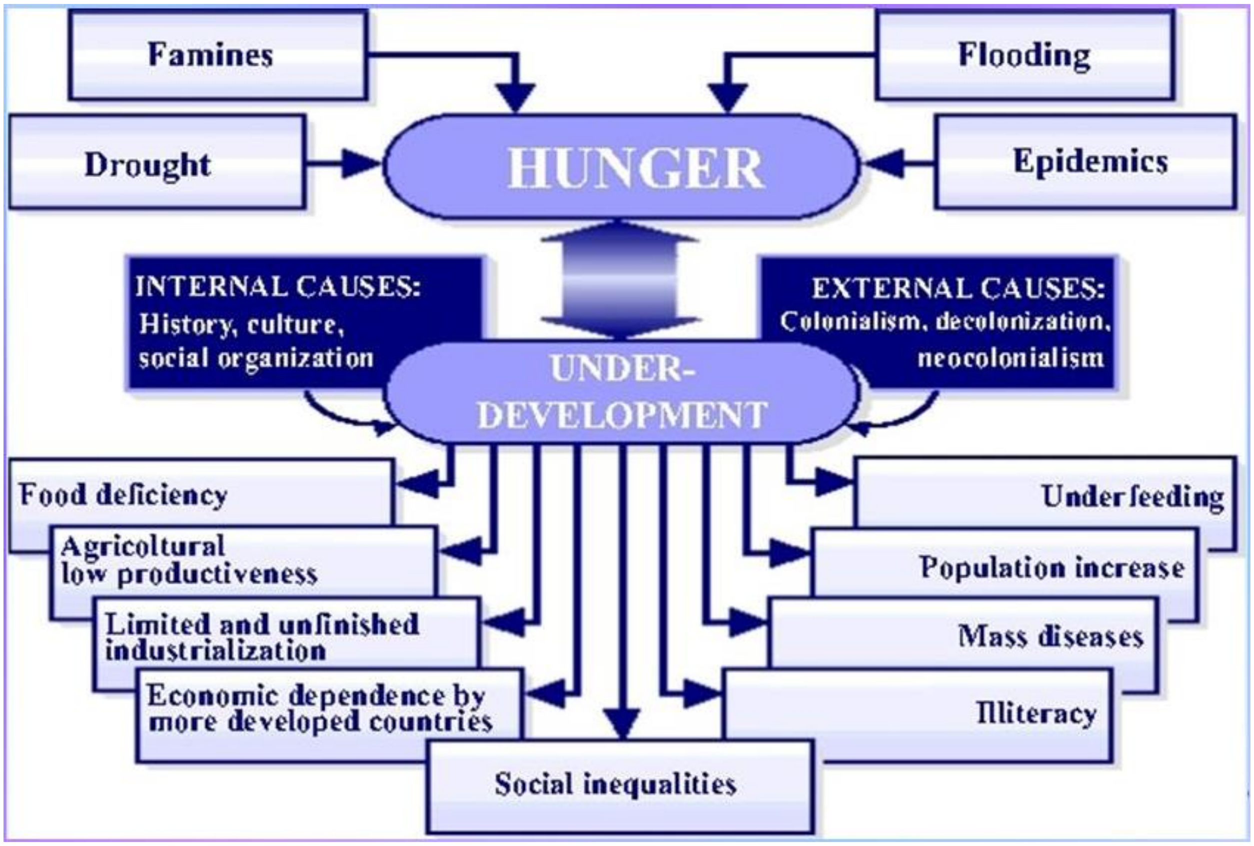



Food shortages due to crop failures caused by natural disasters including poor weather, insect plagues, and plant diseases; crop destruction due to warfare; and enforced starvation as a political tool are by no means the only causative factors. Many of the worst famines have been due to poor distribution of existing food supplies, either because of inequities that result in a lack of purchasing power on the part of the poor or because of political interference with normal distribution or relief movements of food. Europe and Asia, which in the past experienced frequent severe famines, sometimes with deaths in the hundreds of thousands or millions, have now largely eliminated famines through social and technological change. However, in Africa, political and social factors have destroyed the capacity of many populations to survive drought-induced variations in local food supplies and prices. Thus, famines are due to varying combinations of inadequacy of food supplies for whatever reason and the inability of populations to acquire food because of poverty, civil disturbances, or political interference. **Despite the role of natural causes, the conclusion is inescapable that modern famines, like most of those in history, are man-made.**

**Causes for Famine**

In many poor developing countries, income and wealth levels are quite low.

Thus, people are often not able to earn enough money to afford appropriate housing and basic things for daily life, including sufficient food. Therefore, especially in poor regions, people often suffer from famine simply due to a lack of money.




**Unequal wealth distribution**

Another reason for famine is that wealth is often quite unequally distributed. In some countries, the top 1% owns almost all wealth while the majority of the local population suffers from serious levels of poverty. Thus, while the top 1% can afford almost everything they want, the remaining 99% of the population will suffer from significant levels of famine since they will often not have the money to afford enough food and drinks. Making things worse, the global warming issue will further exacerbate the water shortage issue, since when the average air temperature increases, water will become an even scarcer resource and many farmers will lose their livelihood due to this.

**Gender discrimination**

Famine can also be caused by gender discrimination.In many countries worldwide, women are still not regarded as equally valuable as men.In those countries, women will often have a quite hard time since they will have it harder to find a good job and will also have disadvantages in several parts of their daily life.In turn, women in those countries will also have a higher chance of suffering from famine since they are at greater risk to become unemployed or not to find a job that pays sufficient money in order to buy food or drinks.Moreover, women may also be treated quite poorly by their husbands and may also suffer from famine due to that.

**Unemployment**

Another reason for famine may be unemployment. Especially in countries with insufficient social security schemes, people are at great risk for poverty since if they become unemployed, they will not get any financial support from the government. If these people do not have family or friends who could support them, chances are that they may suffer from significant levels of famine since without money, they are likely not able to afford food or other things for daily life.

**Global warming**

Climate change may also contribute to the famine issue in several ways. For example, if the global air temperature increases, regions that currently suffer from water shortages may suffer even more in the future.Moreover, global warming will also increase the probability of natural disasters, which may destroy large areas of land. In turn, the result will be vast destruction and also high levels of famine since most of the important infrastructure will be destroyed due to hurricanes, earthquakes or tsunamis.

**Inflation**

Inflation may also contribute to the famine issue. In countries with high levels of inflation, the local population often loses trust in the local currency. This may end up in a state where stores will no longer accept the local currency and may only accept foreign currency. In turn, people who only have local currency will suffer from significant levels of famine, since they will no longer be able to buy basic food due to the inflation issue.

**Population growth**

Since our world population is growing, so does the demand for material goods, including food.Many poor families often also have many children, since parents often regard their children as insurance for retirement when they will no longer be able to work themselves. However, the higher the number of children, the more food parents have to supply and the higher the risk that some of the children will suffer from famine

**Food shortages**

From time to time, especially in rural areas in poor developing countries, significant food shortages may occur.

This may be due to low crop yields caused by droughts or other natural events that have an adverse impact on the farmers' yields.In turn, since the local population often relies on those farmers, there will be a significant level of food shortage and famine since there will simply be not enough food to meet the demand of the local population.

**Corruptive actions**

In countries where corruptive activities are a big problem, famine may also be a significant issue since it often leads to a state where the minority of people own almost all of the wealth of a country while the majority of people remain poor and suffers from poverty and hunger.

**Conflicts**

Conflicts lead to all sorts of horrible events, including famine for a high number of people.If regions are hit by large conflicts, chances are that important parts of their infrastructure may be damaged or even destroyed.

Moreover, many people will have to give up their homes, which may also lead to a loss of livelihood for them.All this may significantly increase the likelihood of poverty and may also result in famine.

**Political goals**

Political goals may also play a big role in the development of famine. In some countries, there are still dictatorships

These dictators often fear losing their power if the general public gets too much freedom and wealth

Therefore, dictators often try to keep the local population poor, which may result in significant levels of famine for a high number of people.

**Excessive public debt**

High public debt may also contribute to the famine issue.Countries that suffer from high levels of public debt may often not be able to provide sufficient social security to locals since these countries simply do not have enough financial measures.Thus, people in those countries may suffer from significant famine since in case they become unemployed, they will not get support from the government and may not be able to buy food due to that.

**Migration**

Many people give up their homes due to wars or other issues and try to migrate to other countries in order to find a better future.

However, they often end up in quite bad conditions since they often have no language skills and also often only have low levels of education which makes it hard for them to find a job.

Consequently, those migrants will suffer from serious levels of famine if they are not able to integrate into different cultures.

**Lack of education**

Education is key to overcome poverty and therefore to decrease the risk for famine.

If people have a high level of education, they have better job opportunities and also have the chance to move to rich developing countries where they can have a higher quality of life.

In contrast, people who lack proper education may often be trapped in poverty since they will not have the opportunity to find a good job abroad, which may turn into significant levels of famine, especially in countries with low or no social security at all.

**Que. 7 (a) Analyze the theoretical perspectives of process of migration.**

**Ans. 7 (a)** Migration theorists attribute international economic migrations to a series of often overlapping mechanisms. Differentials in wages and job opportunities between home and destination countries are perhaps the major driving force in such individual migration decisions. Those differentials are in part rooted in a built-in demand for workers at the bottom of the labour hierarchy in more prosperous developed countries whose own workers disdain low-income, menial jobs. Migrants are available to fill those jobs, some argue, because advanced economies make industrial investment in developing or colonial economies to take advantage of lower labour costs there.

'Laws of migration' by E.G. Ravenstein (1834-1913). Among those that remain relevant are the following:

- Most migrants go only a short distance.
- Longer-distance migration favours big city destinations.
- Most migration proceeds step-by-step.
- Most migration is rural to urban.
- Most migration flow produces a counter flow.
- Most migrants are adults; families are less likely to make international moves.
- Most international migrants are young males.

There is no universally accepted definition of migration. It applies to a relatively settled population. It is a form of spatial mobility that shows the change from one geographical area or residential unit to another. The phenomenon of migration is so complex that the theoretical and empirical understandings are unable to comprehend it. Since the phenomenon is time and culture specific there is no universally valid theoretical formulation. Migration includes both additive as well as separative aspects. It involves change

due to separation from the place of origin and addition to the place of destination. These aspects make the concept of migration less precise when compared with other demographic processes.
There are different theoretical views or perspectives that enrich our understanding of the issues related with the process of migration.

***There are two broad perspectives***

**Economic Perspectives**
The three economic approaches to migration give primacy to the economic aspects of migration. They discuss how these aspects associated with the place of origin and destination regulates the movement of population, what pattern the movement follows. One of the economic approaches is the theory about the **empirically and mathematically verified generalized patterns of migration.** It originates from the contributions made by E.G Ravenstein .His laws of migration appeared during the year 1885-89.He published two famous and classic studies in 1885 and 1889 on the laws of migration in which he made empirical generalizations regarding patterns of migration. The following are the basic generations that he made.
The migration process is predominantly short distance The volume of migration decreases with distance. As the distance from the center of absorption increases, the volume of migration decreases. This implies that the role of migration is inversely proportional to the distance between the place of origin and the destination.
In most cases long distance migration proceeds to the greatest centers of commerce and industry. This implies that the rate of migration is directly proportional to the available opportunities at the places of origin and at the place of destination. The migrants who travel long distances will tend to move to nearby towns and then gravitate towards rapidly growing cities depending on available opportunities. This generalization gives rise to the gravity model of migration. According to this model the movement of population gravitates around the centers of socio-economic opportunities that are referred to as the factors of attractiveness. The availability of opportunities or propensities determines migration. The rural and urban differences in opportunities or differences within a region motivate people to move out for better opportunities to improve their conditions for living. The natives of towns are less mobile than the natives of villages.
There are a number of factors of migration but the economic motive always predominates in the matrix of factors as seen by Ravenstein.

**The second approach under the economic perspective** is the situation specific push and pulls factors analysis. It is an alternative model of migration. This approach is not concerned with empirically rested generalizations. It is situation-oriented approach dealing with socio-economic differentials existing at the place of origin and at the place of destination. Those differentials determine the migratory movement. The pull-push hypothesis is the central thrust of this approach. According to this view point migration is the result of the interplay between the expulsive forces at the place of origin and the attractive forces at the place of destination. The approach takes into account all possible factors that determine the movement of population.

The most prominent name associated with this approach is Everett S Lee .He acknowledges the relevance of Ravenstein's theory of migration. He identifies the factors of migration and examines the volume of migration and the characteristic of migrants. Migration is a source of permanent or semi permanent change of residence. It may of short or long duration. The act of migration involves the place of origin, the place of destination and the set of intervening opportunities that affect migration.
The push and pull factors and their effects vary by region and by factors of age, education, occupation, class, caste, tribe, ethnicity, region and religion etc. The roles of these factors or individuals traits differ from the place of origin and to the place of destination but according to Lee there are certain common factors of similar reaction. People may like to move from one place to another for better education, higher wages, more job opportunities and better living conditions.

The third economic approach under the economic perspective is the **cost and benefit model of migration.** This approach also gives primacy to the economic factors. The most prominent name associated with this is Todaro.He defines the cost of migration as the moving cost or money available to move, travel and afford the costs of living at the destination. It also refers to the costs of searching and getting training for new jobs. The cost of migration also includes the psychic costs and temporary cost of staying without any job at the place of destination.
Migration is the interplay between the costs of migration and benefits of migration. If the migrant finds that the opportunities at a given place will maximize his expected gains in terms of actual income she/he decides to migrate. The central premise of Todaro's model is that the decision to migrate is taken by people on the basis of their assessment of the opportunities available to them in rural and urban areas. There is an element of subjectivity as an individual makes a subjective assessment of the objective opportunities at a given place to maximize expected benefits from migration taking into account the costs of migration and earning at the source of migration. There is always a basis of permanent income calculation in the mind of migrant.

**Sociological Perspectives**
Among the sociological approaches the most important is the **structural –functional approach**.
It focuses on migration as one of the integrated social processes and as an integral part of the larger social system. It is the society that provides a social context to migration and makes the process of migration socially conditioned. The socio-structural and cultural conditions affect the process of migration and in turn are affected by the process. Thus the movement of population becomes an institutionally and normatively or culturally determined phenomenon. Its occurrence depends on institutional suitability. For example the rapid process of spatial mobility of population, particularly the long distance migration is institutionally or structurally and culturally suitable for and consistent with the urban industrial society while the immobility or the slow process of spatial mobility is structurally consistent with the traditional rural agrarian society.

The theories of **social stratification** also provide another viewpoint on migration. They focus on the social class character of the society and highlight various tendencies of the social class. A class tends to maintain itself and the same time it tends to optimize gratification through spatial and vertical patterns of mobility. These social class tendencies have a bearing on the process of
migration because they focus on the social class character of the process of mobility. The class component functions as a push factor at the source to move out for gratification of motives through improvement in the social status. The class factor also functions as a pull factor to hold the people together and does not allow them to move out from the place of residence. The class factor promotes spatial mobility from the source and develops adjustment and adaptation at the destination.

Various theories of social change and modernization in sociology also provide different viewpoints on migration. The culturological approaches have special significance in this regard because of their emphasis on a cultural basis of change and transformation. They assume that culture is the cause and effect of social change. In this frame of reference migration is considered
a cultural change. It is both the cause and consequence of the cultural basis of spatial migration.
The caste, class and related cultural bases of spatial disparities in income, resources, opportunities and associated styles of life, difference in value orientations of the people towards rural and urban styles of work and work subcultures. The act of migration affects these cultural factors. They are the push as well as pull factors of migration. There are cultural causes of migration at the source and cultural consequences of migration at the destination.

Among the sociological approaches the theory of social evolution provides another viewpoint on migration and social change. The theory assumes that the society is inherently unstable in the homogenous form and pushes it to move in a linear evolutionary direction of social change. This model consists of a series of universal laws of progress focusing on the evolution of the society from homogeneity to heterogeneity and multiformity. In this process of unilear direction of social transformation every component of the system tends to change adjust each other in an integrated form and evolves into a higher social form.
In this process the society also evolves demographically through a spatial movement of the population and changes in other demographic components. In Durkheim’s social evolution migration is a necessary social condition to push the process of social evolution from one type of social order or another. The active movement of population pushes the society to evolve from simple, segmental and mechanical society to a complex structurally differentiated interdependent and organically well-knit society with an elaborate division of labor.
The **economic and sociological viewpoints** are the two broad perspectives on migration. They show that migration is a complex and multivariate phenomenon. A single variate explanation of
migration as viewed by economists is a limited viewpoint. Sociologists view migration in a holistic perspective that is inclusive of the economic viewpoints. The socio-economic and cultural milieu of the village itself and its wider social environment explain the out migration from a village.

**Que .7 (b) Critically examine the concept of limit to growth.**

**Ans. 7 (b)** In 1970, the Club of Rome began a large-scale study of the growth question. ***The Club of Rome*** is a loosely-knit group of multi-national and highly respected scientists, scholars, and other assorted professionals. The Club's stated purpose is to develop ways of dealing with an ever more complicated world.

Because of the worldwide scope and complexity of the growth issue, the Club hired an international team of scientists to head the study. The team was led by computer experts from the Massachusetts Institute of Technology (MIT).

The study group identified five basic factors that determine and, in their interactions, ultimately limit growth on our plant. They are –

- Population
- Agricultural production
- Consumption of non-renewable resources
- Industrial output
- Pollution

They identified three features that these five factors have in common:

1. The factors are all **interrelated** and cannot be studied separately.
2. At the time of their study, the factors were all growing exponentially.
3. Since the Earth is finite, the factors all appear to have upper limits.

Using data about the five factors and their growth rates, the scientists built a computer model to **simulate** the major ecological forces at work in the world. The model related all the important variables. For example, a rise in population is ordinarily accompanies by a rise in agricultural production, because more food is needed.

***The Limits to Growth***, a non-technical report of the findings, came out in 1972. The results of the simulation were startling. The basic finding was: *If there are no major changes in the physical, economic, or social relationships that have historically governed the development of the world system, the system will continue to grow exponentially until the rapidly diminishing resource base forces a collapse (≃ 2020 A.D.)* This conclusion, shown in Figure 14.3, illustrates the change in the five basic factors over time. The message was loud and clear. If we do not change our ways of doing things, we have had it.

**Responding to the Prediction of Doom**

Needless to say, the appropriate next question was, What should we do? The computer was asked a series of 'what if' questions, and this is what it said:

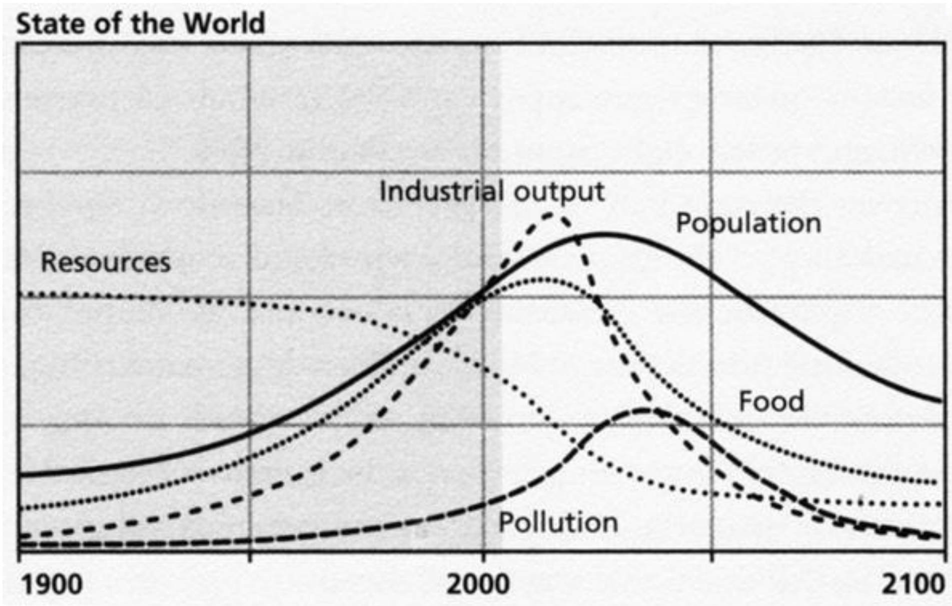
***1.*** **What if** – non-renewable resources are discovered and developed in great abundance?

**Then** – growth will continue and industrialization will expand. The rate of pollution generation will finally exceed the ecosystem's ability to cleanse itself. At this point, the ecosystem collapses. The death rate increases and food production declines.

2. **What if** – non-renewable resources are found in great abundance and the effectiveness of pollution control is increased by a factor of four?
   **Then** – population and industry will grow until the limit of arable land is reached; collapse then occurs.
3. **What if** – non-renewable resources are abundant, pollution control is effective, and agricultural productivity is increased?
   **Then** – population and industry grow to high levels. Although each unit of industrial production generates much less pollution, total production is so great that a pollution crisis finally brings an end to growth.
4. **What if** – non-renewable resources are abundant, pollution control is effective, and effective birth control is available, but voluntary?
   **Then** – since the birth control is voluntary and does not involve any value changes, population continues to grow (but more slowly than before). Nevertheless, the food crisis is postpones for only a decade or two.
5. **What if** – world population is held constant after 1975?
   Then – the growth of industrial and agricultural output deplete the non-renewable resource base the system collapses.
6. **What if** – population and average living standards (in terms of material wealth) are held constant after 1975.
   **Then** – there is some hope, although lack of non-renewable resource recycling would cause a decline in the non-renewable resource base.
7. **What if** – population and average living standards (material wealth) are held constant after 1975 and recycling is effective?
   **Then** – the world can sustain itself far into the future.
8. **What if** – we wait until the year 2000 before we take effective action to deal with growth?
   **Then** – we waited too long.

The overall conclusion in 1972 was that without constraints, exponential growth would continue. Two factors dominated the situation: exponentially increasing population and non-renewable resource consumption. In any program designed to produce a future world that is stable, the exponential growth of both of these factors would have to cease. Any combination of the variables influencing growth that did not stabilize both population and non-renewable resource consumption would eventually lead to collapse.

***The Limits to Growth*** study hit the world's thinkers like a bomb. It attacked some fundamental beliefs of modern-day society. It predicted a doomsday that was soon to be. There was hardly time to debate the study or make plans for a change. Either we were to accept the conclusions and change our values, or the world would collapse around use. It was repent or perish.




**Criticism of the Limits to Growth Report**

Many criticized the study, and some flaws were found. The most serious charges were:

***The study sponsors (The Club of Rome) had hidden agendas*** – Should an elitist group of technocrats be telling humankind what direction it ought to be taking? The Club members had already reaped the benefits of the growth they now abhorred. Maybe the way to ensure that one will make it alive through a revolution is to lead it.

***The assumptions determined the conclusion*** – An assumption was made that the Earth and its resources were finite. It also assumed that non-renewable resource consumption and population would grow exponentially. As in any simulation, the results depend on the initial assumptions. In this case, nothing could happen but collapse.

***Skimpy and insufficient evidence was extrapolated years into the future*** – The human inventive genius was ignored. We were assumed to be utterly incapable of adjusting to problems of scarcity. Would humans really sit by idly as technology stagnated, pollution built, and millions choked to death? Could not we learn from experience to invent and adapt?

***Some important variables were not included*** – As you know, pricing and behaviour are linked. Pricing, however, was not a variable in the Club of Rome model. In the real world, rising prices would act as an economic signal to conserve scarce resources, provide incentives to use cheaper materials and/or substitutes, stimulate research efforts to develop ways to substitute or save on resources, and make exploration attempts more profitable. (Rationing could be used to accomplish some of these goals with less impact on the poor. Also, at present some minerals have no substitutes. Their prices could reflect their true value.)

***The Limits to Growth*** model did not assume that crowding was a variable that might limit population. Crowding might cause people to reduce their numbers before pollution, food shortages, and resource depletion overtook us. By ignoring crowding as a factor, the Limits study implied that crowding actually increases birth rates.

***The book told us what the world of the future should be like, but did not tell us how to get there*** The recipe for recovery was too generalized to be useful for policy-making. It is easy to say that population should be stabilized by equating birth rates to death rates. It is a totally different level of reality to begin dealing with how this is to be done. The mechanisms for reducing population growth, redefining the good life, changing value systems and reordering priorities are what the problem is all about.

***The Limits to Growth*** study only lightly touched on these issues. The above shortcomings in the study deserve serious study and thought.

**Accomplishments of the Limits to Growth Report**

However, even with these faults exposed, The Limits to Growth study can still be praised for accomplishing the following:

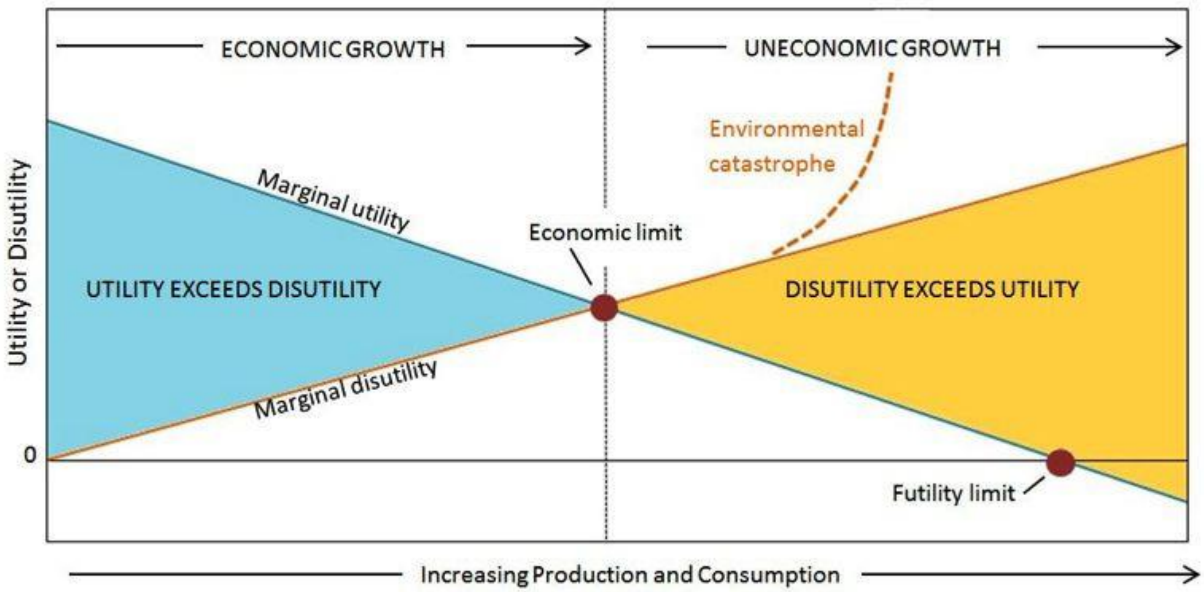
- It forced us to look at the direction in which we seem headed. It nailed down the fact that exponential growth is abnormal in a finite system. It put that fact in a time reference that hits us all – now. Every living thing reaches a limit beyond which it cannot grow. Trees reach a certain height. Animals and humans do the same. When growth continues beyond maturity, we call it obesity or cancer. Abnormal growth is dangerous.
- It pointed to recent historical evidence that there are limits to the five basic factors. The study organized and documented many of these signs.
- It provided a glimpse of what the future might be like – if we chose their proposed road to survival.

Although the sketch of what a no-growth world would be like was vague, and the route to get there was not clearly defined, the idea of a **sustainable** future is of value in itself. Certainly, changes in our behaviour are required if life as we know it is to survive on this planet. Though not the last word on predicting the future, ***The Limits to Growth*** was of value because it served to make us more aware of important issues.

**Limits to Growth Revised**

Twenty years after the release of ***The Limits to Growth***, three of the original authors updated and improved their system dynamics computer model (called World3). They then assembled a team of researchers and writers to revise the original report. They rewrote the report and called it ***Beyond the Limits*** (1992).

Beyond the Limits does not foresee as dire a future as Limits projected. Instead, it advocates a cautious journey forward where waste is punished and moderation is rewarded.




- Human use of many essential resources and generation of several pollutants have passed sustainable rates.
- Unless there are meaningful reductions in resources and energy flows, the world faces a sharp decline in food output, energy use, and industrial production.
- To avoid this decline, growth in resource consumption and population must be eased down at the same time as there is a rapid increase in the efficiency of resource and energy use. A sustainable society is technically and economically possible.

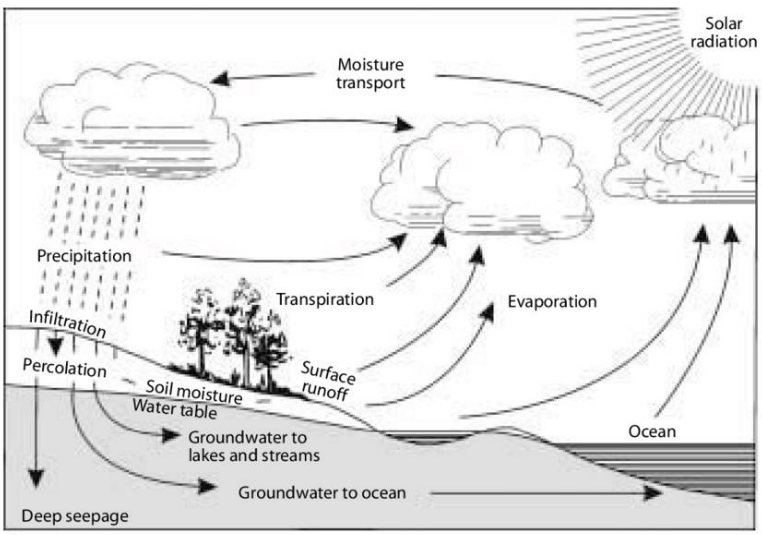
The transition to a sustainable society must be made carefully. Issues of ***equity*** and quality of life must be boldly faced. We will have to learn to distinguish between growth and development. Growth means to get larger. Development means to make changes. There are limits to growth. There need not be limits to development.

**Que . 7(c) Elaborate on types of hydrological cycles. Outline human induced effects on each.**

**Ans . 7(c)** Water is essential to life on Earth. In its three phases (solid, liquid, and gas), water ties together the major parts of the Earth's climate system — air, clouds, the ocean, lakes, vegetation, snowpack, and glaciers off site link.

The vast majority of Earth's water is salt water in the oceans. Only 2.5 percent of the water on Earth is fresh water, and an even smaller portion of that (0.034 percent) is fresh water readily available to humans. Where water is located and its accessibility is important drivers of human habitation, distribution, and success, and they are particularly critical to agricultural production.

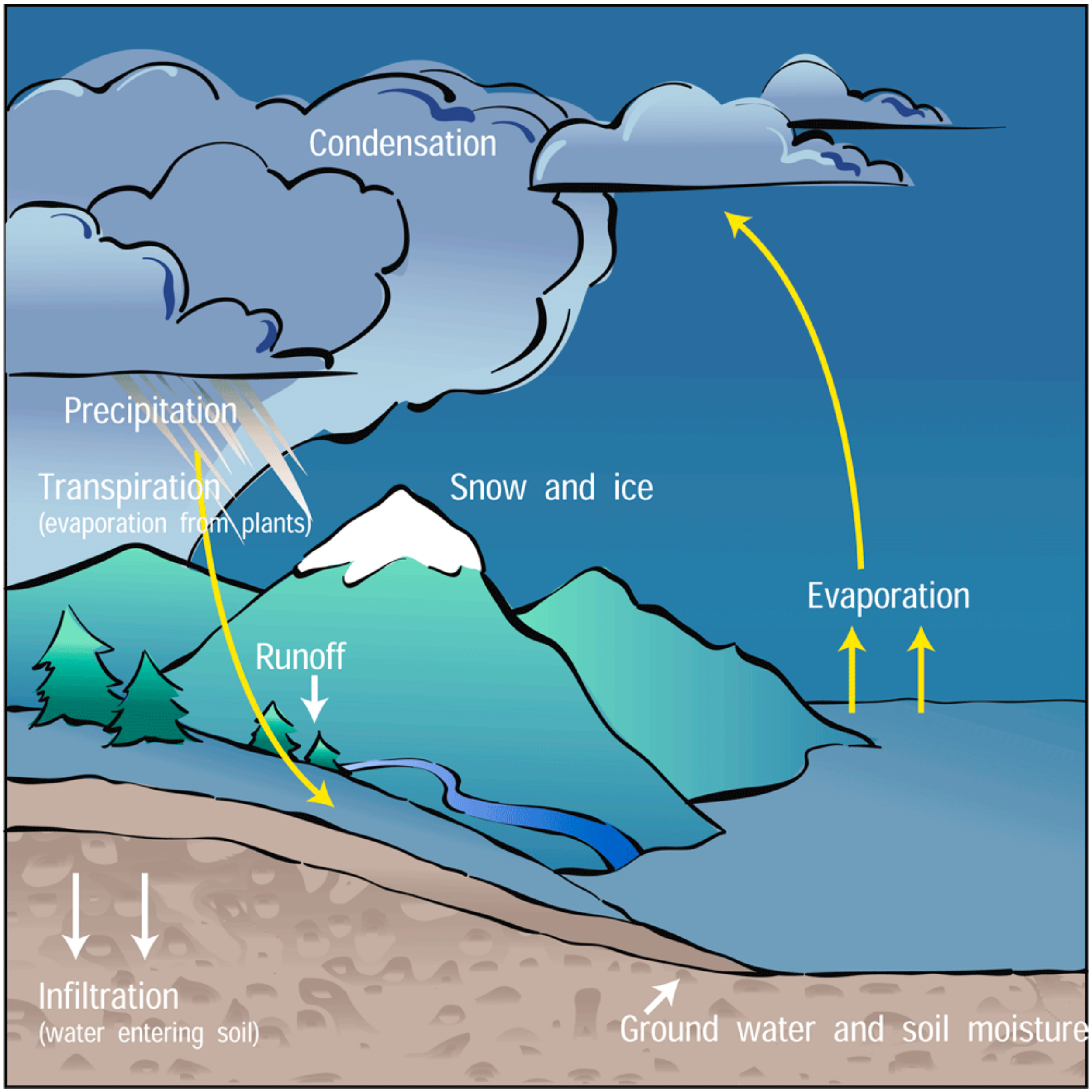
The water cycle shows the continuous movement of water within the Earth and atmosphere. It is a complex system that includes many different processes. Liquid water evaporates into water vapor, condenses to form clouds, and precipitates back to earth in the form of rain and snow. Water in different phases moves through the atmosphere (transportation). Liquid water flows across land (runoff), into the ground (infiltration and percolation), and through the ground (groundwater). Groundwater moves into plants (plant uptake) and evaporates from plants into the atmosphere (transpiration). Solid ice and snow can turn directly into gas (sublimation). The opposite can also take place when water vapor becomes solid (deposition).




**The hydrologic cycle is composed of two phases,** the first of which is the atmospheric phase, which describes water movement as gas (water vapor) and liquid/solid (rain and snow) in the atmosphere. The second phase is the terrestrial phase, which describes water movement in, over, and through the Earth. The terrestrial phase is often broken down into the surface water phase (runoff, stream flow) and the groundwater phase (infiltration, percolation, aquifer recharge).

**Delayed Hydrological Cycle**

Once precipitation has reached the soil surface, some of it can infiltrate the soil. Infiltration is the downward entry of water into the soil. The amount of water that infiltrates and how quickly it infiltrates varies widely from place to place and depends on soil properties such as soil moisture content, texture, bulk density, organic matter content, permeability, porosity, and the presence of any restrictive layers in the soil. Permeability is a measure of how fast water flows through the soil. Infiltration and permeability are greater in porous materials, such as sands or gravels, than in clay soils. Porosity is a measure of the total amount of open space or voids in a soil that are capable of retaining water. Water retained in the soil pores is part of the soil storage, a portion of which is available to plants during transpiration. Water that percolates downward through the soil, below the plant root zone toward the underlying geologic formation, is responsible for recharging aquifers.




**Atmospheric Hydrological Cycle**

Virga is a meteorological phenomenon where precipitation, typically bands of rain, can be observed forming at the base of a rain cloud but disappear before reaching the ground as a result of evaporation or sublimation.

The types of clouds associated with this occurrence are, in general, the type that produces precipitation. They include cumulus, nimbostratus, cumulonimbus, stratocumulus, and altocumulus clouds. Rain forming at the cloud base level and then suddenly "disappear" in mid-air is quite common, as mentioned in the introduction. The reason you don't see it more often is that it does not always appear in view or at an angle, which makes it more visible. The rain does not actually disappear. It merely changes from a liquid (rain) into a gas (water vapor) through a process of evaporation or sublimation, making it invisible to the naked eye.

Unstable weather conditions also occur higher in the atmosphere, where virga is the result of adiabatic compression. This heats the air, which causes pockets of warm & cold air at the same altitude, the perfect recipe for turbulent conditions.

**Human induced effects** One of the most fundamental properties of water is that it is neither created nor destroyed. That is there is the same amount of water on Earth today as there was millions of years ago; water just changes phases — from liquid to solid to gas. However, while the mass of water is conserved, water quality is not, and degradation of water quality effectively reduces availability of accessible waters for domestic, industrial, or agricultural uses.
**Climate change is likely causing parts of the water cycle** to speed up as warming global temperatures increase the rate of evaporation worldwide. More evaporation is causing more precipitation, on average. We are already seeing impacts of higher evaporation and precipitation rates, and the impacts are expected to increase over this century as climate warms.

Higher evaporation and precipitation rates are not evenly distributed around the world. Some areas may experience heavier than normal precipitation, and other areas may become prone to droughts, as the traditional locations of rain belts and deserts shift in response to a changing climate. Some climate models predict that coastal regions will become wetter and the middle of continents will become drier. Also, some models forecast more evaporation and rainfall over oceans, but not necessarily over land. Warmer temperatures associated with climate change and increased carbon dioxide levels may speed plant growth in regions with ample moisture and nutrients. This could lead to increased transpiration, the release of water vapor into the air by plants as a result of photosynthesis.

**More rain and flooding:** With more evaporation, there is more water in the air so storms can produce more intense rainfall events in some areas. This can cause flooding – a risk to the environment and human health.

**More extreme drought:** Warmer temperatures cause more evaporation, turning water into vapor in the air, and causing drought in some areas of the world. Places prone to drought are expected to become even drier over the next century. This is bad news for farmers who can expect fewer crops in these conditions.

**Stronger hurricanes:** Warmer ocean surface waters can intensify hurricanes and tropical storms, leading to more hazardous conditions as these storms make landfall. Scientists continue to research how climate change affects the number of these storms, but we know that the storms will be powerful and destructive in the future.

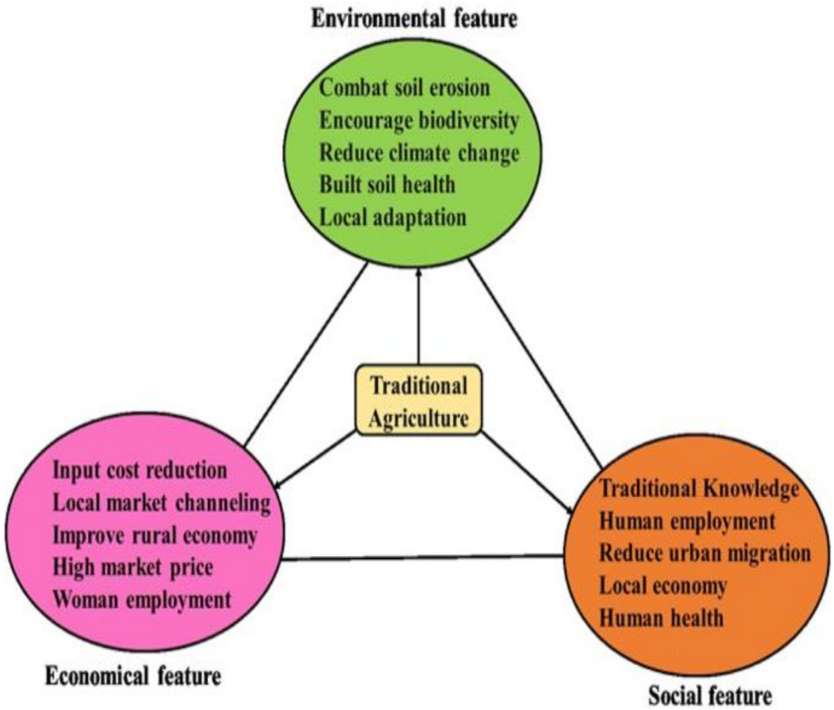
**Ocean water is warming and growing acidic.** Warmer waters in the shallow oceans have contributed to the death of about a quarter of the world's coral reefs in the last few decades. Many of the coral animals died after weakened by coral bleaching, a process tied directly to warmer waters. Also, corals and other marine life find it more difficult to grow their shells and bones as seawater takes in carbon dioxide from the atmosphere and becomes more acidic.

**Sea ice is shrinking, causing more warming** warmer temperatures have caused more ice to melt in the summer and less ice to grow in winter. The summer thickness of sea ice is about half of what it was in 1950. Melting sea ice could cause changes in ocean circulation as the temperature and density of water changes. It is also speeding up warming in the Arctic – with less ice, less sunlight is reflected out to space and more is absorbed by the water and land. Typically, almost all of the sunlight that hits sea ice is reflected back out to space, but as the ice melts, the ocean underneath is exposed, which absorbs more sunlight, causing more climate warming.

**Que .8 (a) What are the new agricultural inputs? How they influence productivity?**

**Ans .8 (a)** Agricultural production more than tripled since 1960, owing in part to productivity-enhancing Green Revolution technologies and a significant expansion in the use of land, water and other natural resources for agricultural purposes. The same period witnessed a remarkable process of industrialization and globalization of food and agriculture. Food supply chains have lengthened dramatically as the physical distance from farm to plate has increased; the consumption of processed, packaged and prepared foods has increased in all but the most isolated rural communities.

Expanding food production and economic growth have often come at a heavy cost to the natural environment. Almost one half of the forests that once covered the Earth are now gone. Groundwater sources are being depleted rapidly. Biodiversity has been deeply eroded. Every year, the burning of fossil fuels emits into the atmosphere billion of tonnes of greenhouse gases, which are responsible for global warming and climate change.




All of these negative trends are accelerating in pace and intensity, and agriculture is an important part of the problem. Deforestation, mainly for farming, produces a significant share of global greenhouse gas emissions and causes the destruction of habitats, the loss of species and the erosion of biodiversity. The incidence of natural disasters has increased fivefold since the 1970s. Deforestation, the degradation of natural buffers protecting coastlines and the poor state of infrastructure have increased the likelihood that extreme weather events will escalate into full-fledged disasters for affected communities and the economy. The lengthening of food chains and changes in dietary patterns have further increased the resource-, energy-, and emission-intensity of the global food system. These trends threaten the sustainability of food systems and undermine the world's capacity to meet its food needs. Although the full implications of climate change on agriculture, forestry and fisheries are difficult to predict, it is expected that the impacts will be of different levels and of a different nature in each region, ecological zone and production system. Even small changes in the climate, for example slight shifts in annual rainfall or seasonal precipitation patterns, can severely affect productivity.

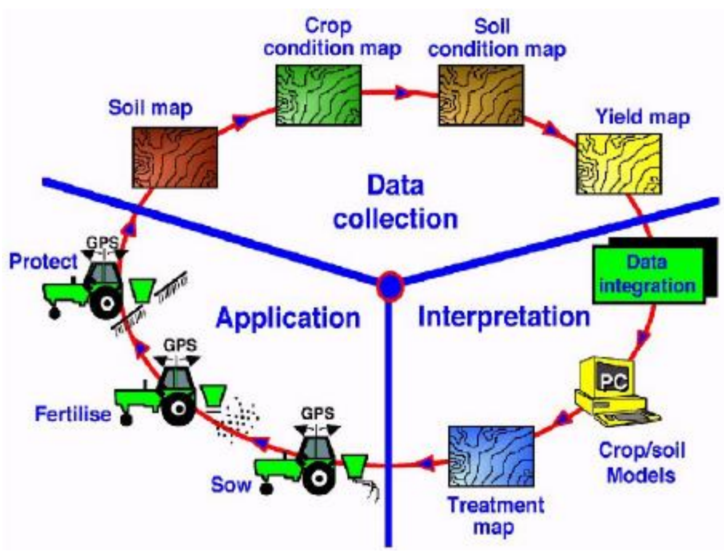
**The Future of Agriculture inputs**

"Smart farming" is an emerging concept that refers to managing farms using technologies like IoT, robotics, drones and AI to increase the quantity and quality of products while optimizing the human labor required by production.

Smart farming refers to managing farms using modern Information and communication technologies to increase the quantity and quality of products while optimizing the human labor required. Among the technologies available for present-day farmers are:

- Sensors: soil, water, light, humidity, temperature management
- Software: specialized software solutions that target specific farm types or applications agnostic IoT platforms
- Connectivity: cellular
- Location: GPS, Satellite
- Robotics: Autonomous tractors, processing facilities
- Data analytics: standalone analytics solutions, data pipelines for downstream solutions

Armed with such tools, farmers can monitor field conditions and make strategic decisions for the whole farm or a single plant without even needing to step foot in the field. The driving force of smart farming is IoT connecting machines and sensors integrated on farms to make farming processes data-driven and automated.




**The IoT-Based Smart Farming Cycle**

- The core of IoT is the data you can draw from things and transmit over the internet. To optimize the farming process, IoT devices installed on a farm should collect and process data in a repetitive cycle that enables farmers to react quickly to emerging issues and changes in ambient conditions. Smart farming follows a cycle like this one:
- Observation Sensors record observational data from the crops, livestock, soil, or atmosphere.
- Diagnostics. The sensor values are fed to a cloud-hosted IoT platform with predefined decision rules and models also called "business logic"—that ascertain the condition of the examined object and identify any deficiencies or needs.
- Decisions After issues are revealed, the user, and/or machine learning-driven components of the IoT platform determine whether location-specific treatment is necessary and if so, which.
- Action After end-user evaluation and action, the cycle repeats from the beginning.Precision Farming

**Precision farming,** or precision agriculture, is an umbrella concept for IoT-based approaches that make farming more controlled and accurate. In simple words, plants and cattle get precisely the treatment they need, determined by machines with superhuman accuracy. The biggest difference from the classical approach is that precision farming allows decisions to be made per square meter or even per plant/animal rather than for a field.

**Precision Livestock Farming** As is the case of precision agriculture, smart farming techniques enable farmers better to monitor the needs of individual animals and to adjust their nutrition accordingly, thereby preventing disease and enhancing herd health.

**Automation in Smart Greenhouses** Traditional greenhouses control the environmental parameters through manual intervention or a proportional control mechanism, which often results in production loss, energy loss, and increased labor cost. IoT-driven smart greenhouses can intelligently monitor as well as control the climate, eliminating the need for manual intervention. Various sensors are deployed to measure the environmental parameters according to the specific requirements of the crop. That data is stored in a cloud-based platform for further processing and control with minimal manual intervention.

**Agricultural Drones** Agriculture is one of the major verticals to incorporate both ground-based and aerial drones for crop health assessment, irrigation, crop monitoring, crop spraying, planting, soil and field analysis, and other spheres.

Since drones collect multispectral, thermal, and visual imagery while flying, the data they gather provide farmers with insights into a whole array of metrics: plant health indices, plant counting and yield prediction, plant height measurement, canopy cover mapping, field water pond mapping, scouting reports, stockpile measuring, chlorophyll measurement, nitrogen content in wheat, drainage mapping, weed pressure mapping, and so on.

Importantly, IoT-based smart farming doesn't only target large-scale farming operations; it can add value to emerging trends in agriculture like organic farming, family farming, including breeding particular cattle and/or growing specific cultures, preservation of particular or high-quality varieties, and enhance highly transparent farming to consumers, society and market consciousness.

Smart farming and IoT-driven agriculture are paving the way for what can be called a Third Green Revolution.

Therefore, smart farming has a real potential to deliver a more productive and sustainable form of agricultural production, based on a more precise and resource-efficient approach. New farms will finally realize the eternal dream of mankind. It'll feed our population, which may explode to 9.6 billion by 2050.

**Que .8 (b) Write down main features of intensive subsistence with and without paddy cultures, also the environmental challenges related to it.**

**Ans .8 (b)** Subsistence agriculture is the type of farming in which crops grown are consumed by the grower and his family. Subsistence agriculture may be of different types. It may be shifting or settled agriculture, it may be primitive or non-primitive in character, it may be both inten-sive and extensive in nature.

As long as its major purpose is fulfilling needs of its producers it remains subsistence farming. The main distinction between primitive and non-primitive  depends on the tools and equipment's used.

The tools of the primitive agriculturists are more or less the same as those used in shifting cultivation, while in non-primitive subsistence agriculture wooden plough, harrows, hedges and permanent bandings are used.

The intensity of agriculture and multiple cropping are directly governed by the pressure of population in a given region at a given point of time. In shifting cultivation tracts where the density of popu-lation per square kilometer is generally less than ten persons, the in-tensity of agriculture is very low.

The land is such areas are sown only once in a year and that too abandoned after one or two years. But in those parts where density of population is relatively high, at least two crops in a year is .the usual practice and the same piece of land is sown season after season and generation after generation. Intensive subsistence agriculture is best developed and practi-cally confined to the monsoon lands of Asia.

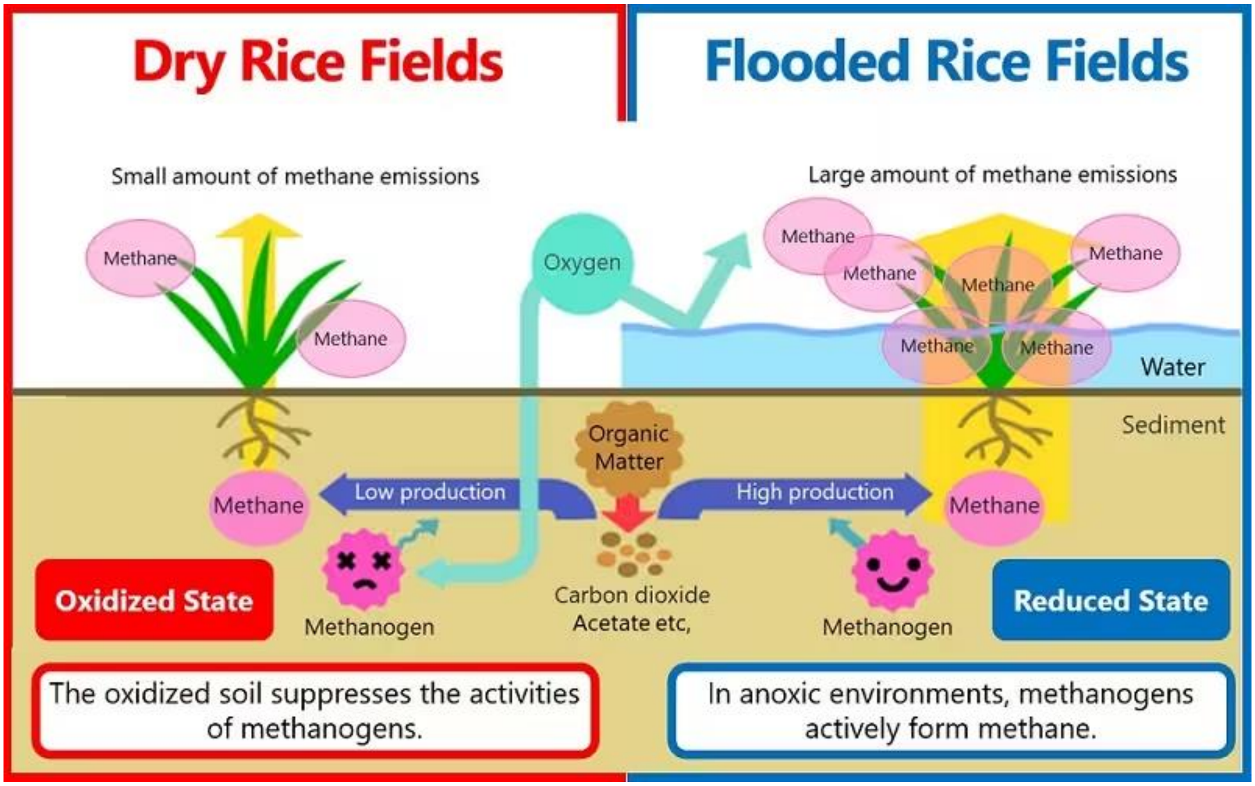
It is carried on mainly in China, Japan, India, Bangladesh, Myanmar (Burma), Thailand, Sri Lanka, Malaysia, Philippines, Indonesia, Laos, Cambodia and the is-lands of Pacific Ocean, Indian Ocean and Southeast Asia. These are the most densely populated parts sustaining about two-third popula-tion of the world. In these countries, the density of population is higher than that of the industrial countries of Europe and America.

The fast growing population, almost unchecked for centuries, neces-sitates an even greater intensity in the tillage of land. Farming in both the wet lowlands and the terraced uplands is, therefore, very inten-sive to support the dense population of teeming million. There are two types of the intensive subsistence agriculture. One is dominated by wet paddy and the other is dominated by crops other than paddy, e.g., wheat, pulses, maize, millets, sorghum, kaoling, soya-beans and vegetables.

**Intensive Subsistence Agriculture Dominated by Wet Paddy:**

Intensive subsistence agriculture dominated by wet paddy is practiced mostly in the Monsoon Asia. In this agricultural typology, the size of holding is generally very small. Farm sizes are also very small and they, through many generations, have been subdivided so that they have become extremely small and often uneconomic to run.

An average farm in Japan is 0.6 hectare, and in some parts of Kerala and West Bengal it is even smaller. Individual peasants grow crops mainly to support their families, though there may be some surplus for sale which fetches some amount for the farmers secondary and tertiary needs. In the Monsoon Asia the farmers are so 'land hungry' that almost every bit of tillable land is utilized for agriculture.




The fields are separated only by narrow handmade ridges and footpaths by which the farmers move around their fields. The boundary bunds, locally called as maindh or daul, are kept very narrow to save space. Only the steepest hills and the infertile and alkaline (reh and kaller) patches of land are left uncultivated. The farming is so intensive that two and even three crops of rice can be raised in one year. In tracts where only one crop of rice can be raised the fields are normally used in the dry season to raise other food or cash crops such as oats, pulses, tobacco, oilseeds and vegetables.

In wet paddy agriculture, traditionally much manual and hand la-bour is required. Ploughing is done with the help of buffaloes, oxen, mules and horses. Paddy crop is planted in narrow rows by females, while hoeing and harvesting operations are done by both males and females. Harvesting and thrashing are done manually.

The farm im-plements are often very simple. Machines have been developed re-cently which can work on the flooded plains for ploughing and hoe-ing. Small machines are used in the farms of China, South Korea and Japan which are gradually being diffused in other countries of Mon-soon Asia.

In this type of agriculture the cultivator concentrates on the culti-vation of food crops, especially rice and vegetables, comparatively, few sheep, goats or horses are kept in wet paddy areas. He-buffaloes are kept as draught animals in many parts of the monsoon world.

Poultry on a small scale is common and pigs are kept as scavenger animals on the Chinese and Japanese farms. Many farmers practice fish culture in paddy fields. Fish culture in paddy fields is carried on in Assam, Arunachal Pradesh, West Bengal (India) and Bangladesh with the set objective to satisfy the protein demand of the farmer's family.

In paddy intensive subsistence farming the farmers make use of every available type of manure, including farm waste, rotten vege-tables, fish waste, cow dung and human excreta to ensure higher agri-cultural returns and also to maintain the high fertility of the land. The green manuring and chemical fertilizers are also used to enhance the productivity of land. In India, the farmers of West Bengal, Kerala, the coastal Andhra Pradesh and Tamil Nadu provide a good example of intensive subsistence wet paddy agriculture.

**Intensive Subsistence Agriculture without paddy:**

Owing to variations in terrain, soil, vegetation, temperature, length of growing season, moisture conditions, sunlight, wind and many socio-economic constraints, it is neither practicable nor profitable to grow paddy in many parts of the monsoon world. In the intensive subsis-tence farming, dominated by other crops, the methods and operations of cultivation are equally intensive and farming is on subsistence ba-sis.

In north China, Manchuria, North Korea, and Punjab, Haryana and western Uttar Pradesh in India, wheat, maize, millets, pulses, soya-bean and oilseeds are intensively grown. In Myanmar, Thailand and peninsular India, millets, maize and pulses are the dominating cereal crops as soil moisture in these areas is not conducive for the cultivation of paddy.

Farming in these regions has very similar fea-tures to those of wet paddy cultivation. There is intensive use of land, multiple cropping, heavy use of manual labour, little use of farm ma-chinery and use of a variety of manures and fertilizers.

In India, operational holdings and sizes of fields are generally small and uneconomic. About 25 per cent of the total rural popula-tion has land less than 0.4 hectare and another 25 per cent is landless. As a result, the farmers are poor and the majority of them cannot af-ford to purchase modern agriculture implements, fertilizers, quality seeds, insecticides and pesticides. Though tractors are popular in the relatively large farms of Punjab, Haryana and western Uttar Pradesh, yet the oxen and buffaloes are the principal draught animals. Most of the agricultural operations are, however, labour intensive.

Climate impacts manifest in various forms and intensities in agriculture, to which farmers have varying capacities to adapt. Some impacts are sudden and extreme, termed shocks by climate researchers, often causing large-scale crop failures and leaving thousands of casualties and displaced people. Adapting to shocks is challenging; continental and global action is needed to limit greenhouse gas emissions to potentially mitigate warming, and thus, the prevalence of such extremes in the first place. But other climate impacts develop gradually and are not as intense. For instance, across most parts of Africa, temperatures have risen slowly by about 0.5°C in the last 50–100 years. This slow warming nonetheless put natural resources and crops under stress, the term for the gradually arising and often predictable climate impacts. Examples include groundwaters becoming depleted and rivers, lakes, and dams drying off, subsequently accelerating soil salinization and making croplands inarable, especially in semi-arid and intensively farmed areas. Additionally to such stress on land and water resources, rainfall and temperature changes are moving beyond the levels that crops and livestock can tolerate, thus directly impacting agricultural production. As a result, staple food production is predicted to fall by a third by the end of this century and aggravate food insecurity in Africa.

**Que.8 (c) What have been the nature, objectives and outcome of pronatalism?**

**Ans. 8 (c)** During the second half of the twentieth century debates about population policy, and consequent programmatic action, were centered on the issue of rapid population growth in the less developed world. Toward the end of this period, however, a quite different demographic phenomenon has begun to attract increasing attention: aggregate fertility levels that are inadequate for the long-run maintenance of the population. Analytically, the potential population policy issue raised by low fertility is identical to the problem inherent in rapid population growth: it is caused by the disjunction between the sum total of individual reproductive decisions and the collective interest in a long-run demographic equilibrium. But this time individual aspirations generate a deficit rather than an excess in population growth. The syndrome, as was noted above, is not entirely novel: it was detectable in fertility trends in the West, especially in Europe, in the 1920s and 1930s, and in some instances, notably in France, even earlier. But in the decades immediately following World War II, the baby boom seemed to make the issue of low fertility moot. Indeed, by any historical standard, population growth was rapid during the second half of the twentieth century even in the developed world. Europe's population, for example, grew during that period from 550 million to about 730 million. The baby boom was, however, a temporary interruption of the secular downward trend in fertility. By the 1970s, the net reproduction rate was at or below unity in most countries in Europe and also in the United States. In the US fertility stabilized at or very close to that rate, but in Europe fertility continued to decline. By the beginning of the twenty-first century, the average total fertility rate in Europe was 1.4. Such a level, if maintained indefinitely, would result in a population loss of one-third from generation to generation, that is, roughly, over each period of some 30 years.

In some countries, notably in Southern, Central, and Eastern Europe, period fertility rates were at low levels without historical precedent for large populations. If continued, in the absence of large compensatory immigration this would not only lead to rapid population decline but also result in very high proportions of the population at old ages. It might be expected that in the affected countries such prospects would generate not only concern, but also vigorous remedial policy action. By and large, however, this response has not been evident. Most governments as well as the general public tend to view below-replacement fertility with equanimity quite unlike the alarmed reaction that the same phenomenon elicited when it first emerged between the two World Wars. And explicit pronatalist policies, common in the 1930s, are conspicuous by their absence. There are a variety of reasons explaining this indifference.

**First,** the preeminent population issue confronting policymakers in the post–World War II period was rapid global population growth. Programs aimed at moderating fertility in the developing world received assistance or at least encouragement from the rich, low-fertility countries. Although the rationale was modified over time, such assistance and encouragement have continued, as indeed substantial further population increase in the less developed countries is still anticipated in the early decades of the twenty-first century. Even though population issues tend to be sui generis, reflecting differences in demographic behavior country-by-country, there was, and remains, a perceived dissonance between fertility-lowering assistance to other countries and engaging in action at home serving the opposite aims. Faulty logic notwithstanding, the international terrain has not been favorable for domestic pronatalism.

**Second,** the natural rate of increase—the difference between the number of births and the number of deaths—is still positive in many of the countries with fertility well below replacement. This is the result of age distributions—reflecting past fertility and mortality and notably the effects of the postwar baby boom—that still favor population growth. While this momentum effect is temporary, the longer-term implications for population decline and population aging are only dimly perceived by the general public and provide an excuse for inaction on the part of policymakers.

**Third,** when those longer-term demographic effects are understood, a calmer attitude still prevails. There is an inclination, reinforced by increasing concern with the quality of the natural environment, to regard a degree of demographic "decompression" as a not necessarily unwelcome prospect, especially in countries with an already dense population. And it is assumed that the economic and social disadvantages that might be imposed by a declining population can be effectively dealt with through institutional adjustments and social policy measures other than measures aiming for a higher birthrate. A demographic policy often regarded as potentially helpful in this regard is encouragement of immigration. That willing immigrants are available to compensate for low birth rates is taken for granted—a realistic assumption in high-income countries.

**Fourth,** there is a vague expectation that the population decline, impending or already begun, will in due course trigger corrective homeostatic mechanisms, leading to a spontaneous rebound in the level of fertility. Another baby boom may not be in the offing, but fertility may rise sufficiently to once again reach or at least approximate replacement level. Governments, it is assumed, would be ill-advised to interfere with this natural process by trying to increase birth rates and then seeking to fine-tune them at the desirable steady-state level. According to this view, a laisser-faire fertility policy is justified since, apart from broad upper and lower limits, governments are not competent to determine what constitutes an optimal fertility rate, or growth rate, or population size in any given year, decade, or even longer time interval.

**Finally,** even if the will were there, there is a paucity of effective pronatalist policy instruments. Exhortation from governments is not promising, and in any case unlikely to be tried in a democratic polity. Restrictions imposed on access to modern contraceptive technology are not politically acceptable; they would be also certain to prove a failure. This leaves the traditional levers of social policy: dispensing material incentives and disincentives so as to increase the willingness of couples to have children. Such incentives can be engineered by the government through fiscal measures, such as differential taxation, and/or through provision of services in kind. Although the redistributive policies of the contemporary welfare state are biased in favor of the elderly and the poor, government-organized transfers to parents of children, or to children directly (such as through publicly financed day-care services and free or subsidized education often beyond the secondary school level, which lessen the cost of children to parents), are substantial in all low-fertility countries. Indeed, it is typically assumed that existing family and welfare policies sustain fertility above a level that would ensue in their absence. Accordingly, making these policies more generous—socializing an even larger share of child costs—is often seen as a means toward increasing fertility, whether as an outright policy objective or, more in the prevailing spirit of the time, as an unintended but welcome byproduct. Such extension, however, is difficult, given the fiscal constraints of already overcommitted welfare states. And more to the point, the net effect of family-friendly redistribution of incomes and provision of services is uncertain.