



Approach – Answer: General Studies Mains Mock Test 1324 (2019)

1. Give an account of distribution of sugar industry in India. Also, highlight the problems plaguing the sugar sector.

Approach:

- Introduce with India as leading producer of sugar and sugarcane in the world.
- Draw the distinct sugarcane belts in India.
- Cite factors that determine location of sugar industry around these regions.
- Discuss the hurdles facing the sector and the related environmental challenges.

Answer:

India is the world's largest producer of sugarcane and cane sugar and contributes about 8% of the total sugar production in the world. At present, this is the second largest agro-based industry of India after cotton textile industry.

The sugar industry began in India in the early 20th century by the indigo planters in NE UP and Bihar when the demand for indigo declined due to introduction of the synthetic dye.

Distribution of Sugar Industry Sugar industry in India is based on sugarcane, which are a heavy, low value, weight losing and perishable raw material. Sugarcane cannot be stored for long as the loss of sucrose content is inevitable. Besides, it cannot be transported over long distances because any increase in transportation cost would raise the cost of production and the sugarcane may dry up on the way. Hence sugar mills are located in the cane producing areas. Also, it is a seasonal industry because of seasonality of raw materials.

Based on these factors, sugar industry has two major areas of concentration. One comprises Uttar Pradesh, Bihar, Haryana and Punjab in the north and the other that of Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh in the south.



Problems facing the sugar industry in India

- **Low yield per hectare** of sugarcane in India in comparison to other countries.
- **Short crushing season** – It makes the industry seasonal creating financial problems for the sector.
- **Fluctuating production trends** – leads to years of severe shortfall, followed by bumper harvest.
- **High cost of production** due to high cost of sugarcane, inefficient obsolete technology, uneconomic process of production and heavy excise duty result in high cost of manufacturing.
- **Small and uneconomic size of mills** with obsolete machinery.
- **Distortion in cropping pattern** – Sugarcane production is water-intensive and is located in water-scarce areas like Maharashtra.
- **Competition from khandsari and gur:** In India, 10 tonnes of sugar are obtained from 100 tonnes of cane but in case of khandsari only 7 tonnes of sugar are derived. The recovery content of gur is only 5 per cent. Thus there is a net loss to country by use of cane for khandsari and gur.
- **Policy issues-** state governments often announce higher Fair and Remunerative Prices (FRP) for the season, often ignoring market dynamics. The mills are required to pay FRP to farmers but are left to market for recovery. In times of bumper production, the market price of sugar almost always becomes uneconomic whereas FRP remains higher. This leads to delay in payments to farmers.

Given the significance of the industry, there is a need to have collaborative approach among, government, farmers and sugarcane mill owners to find solutions for these issues at earliest. The government has announced relief package that would help improve the liquidity of cash-starved sugar industry, including setting aside a sum of Rs 4,440 crore to boost ethanol production capacity and creating a buffer stock of 3 million tonnes of sugar. The CCEA has also decided to fix the minimum selling price of white/refined sugar at Rs 29 per kg and impose stock holding limits on sugar mills. These measures are expected to bring temporary relief to the industry and farmers.

2. **Bamboo has been referred to as green gold for its numerous commercial applications. Discuss the distribution of bamboo in India, and the recent steps taken by the government with regards to this industry.**

Approach:

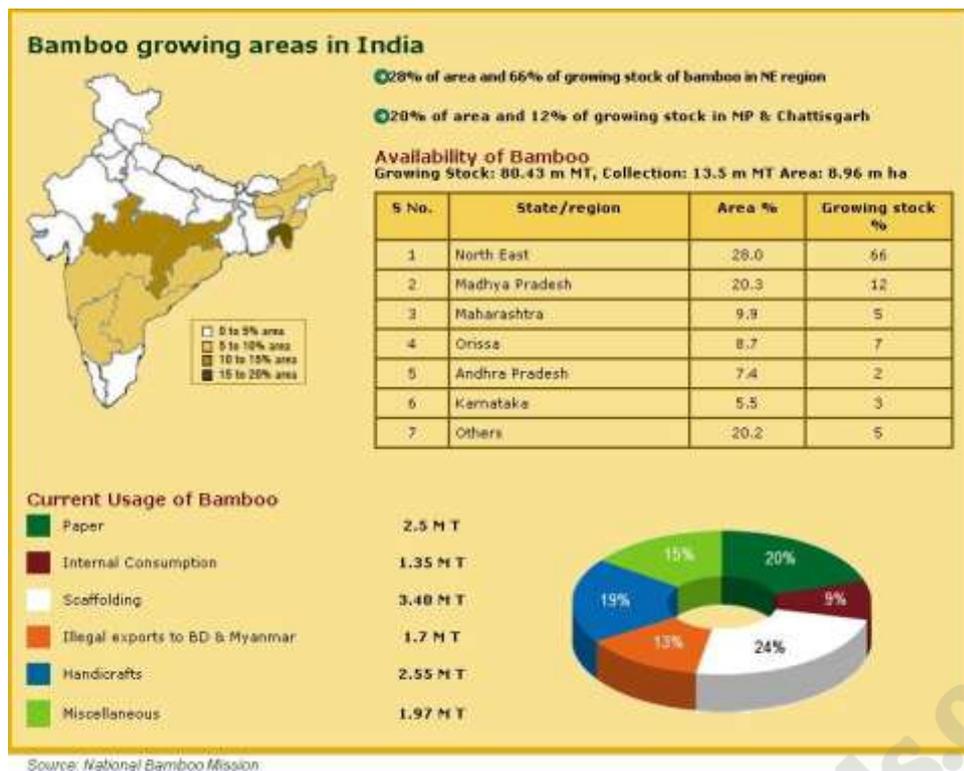
- Discuss in brief, the various applications of bamboo – timber, handicraft, food, paper and pulp, etc. and its relevance for livelihood security.
- Explain the favorable conditions for bamboo cultivation, and list the major bamboo-growing areas.
- Highlight recent initiatives in Budget 2018-19, Restructured National Bamboo Mission, and amendments in the Indian Forest Act, 1927.

Answer:

Bamboo, a member of the grass family, is the mainstay of rural life and culture in our country. It is called as 'green gold' because of versatility in its usage – construction, firewood, paper, handicraft, food and fodder, and it even has medicinal applications. It is used as a substitute for traditional timber, and aptly called 'poor man's timber.'

Bamboos are more common to the tropics, but they also occur naturally in subtropical and temperate zones. India along with China accounts for more than 50% of world's bamboo. They are a fast-growing species that can grow in wide variety of climatic and edaphic conditions.

As per State of Forest Report, 2017, total bamboo area in India is 15.69 million hectares, which is an increase over previous estimates. Madhya Pradesh followed by Arunachal Pradesh has the maximum area under bamboo cultivation. They are found almost throughout the country with Jammu and Kashmir as the only exception. The eastern, and northeastern India accounts for more than 50% of the bamboo areas.



Leveraging bamboo commercially has the potential to generate gainful employment and income generation in rural areas, especially north-eastern India. Some steps by the government to promote bamboo –

- Bamboo growing outside the forest area has been excluded from the definition of trees, as defined under Indian Forest Act, 1927. This means that felling and transportation of bamboo for inter-state trade would not require permits, as was the case earlier.
- In Budget 2018-19, a Re-structured National Bamboo Mission was launched, which aims to implement an area-based regionally differentiated strategy, in selected states with focus on increasing area under cultivation, integrating value chain with end-to-end solutions, handicraft development, skill development etc.
- Various state government are strengthening state bamboo boards and taking various measures for bamboo promotion. For example- Maharashtra has set up a Bamboo promoting company recently. Government support is crucial as this industry has huge employment potential. Thus, steps such as mandatory 10% procurement of bamboo furniture by all departments, curbing imports of incense sticks from Vietnam and China, generating awareness about its environment friendly nature, setting up a Bamboo development authority to coordinate its promotion etc. should be taken by the government.

3. Explain the concept of Diastrophism and elaborate on the processes that form part of it.

Approach:

- Briefly explain the concept of diastrophism including source of energy for this process.
- Elaborate various processes that form part of it.

Answer:

Diastrophism is an endogenic process and consists of all processes that move, elevate or build up portions of the earth's crust. It is the process that brings about changes in the configuration of the surface of the earth. They move, elevate or build up portions of the earth's crust owing to the energy emanating from within the earth. This energy is mostly generated by radioactivity, rotational and tidal friction and primordial heat from the origin of the earth.

Diastrophic movements are categorised into two types:

- Epeirogenetic
- Orogenetic

Epeirogenetic movement is the vertical movement of earth's crust, whereas orogenetic is the horizontal movement. Epeiro means land, and so these movements are responsible for continent formation. Orogenetic movements are responsible for mountain formation. When magma rises to the surface (vertical movement) and it spreads, continents are formed. Similarly, when a large portion of crust is pushed from below, plateaus are formed. This is known as upwarping. Similarly, on downwarping, basins are formed. In the same manner, block mountains are also formed. On the other hand, during horizontal movement, two plates collide, it leads to formation of fold mountains.

In particular, processes that form part of diastrophism are:

- **Plate Tectonics-** The outer shell of the earth i.e. the lithosphere is broken up into tectonic plates. Plates are classified as major, minor and micro. Plate tectonic is simply the process of horizontal movement of these plates. The current physical map of the world with distribution of continents and oceans is result of plate tectonic process.
- **Orogenic process-** This process takes place when tectonic plates collide, separate or slide along one another. This causes mountain building through severe folding and affects long and narrow belts of the earth's crust. Some examples of ongoing orogenies are the Mediterranean ridge, Andean orogeny, the Himalayan Orogeny etc.
- **Epeirogenic process-** It is strict vertical movement of a continent rather than horizontal movement. It involves uplifting or warping of large parts of the earth's crust. It lifts the whole region evenly and results in the formation of gentle arches and structural basins.
- **Earthquake-** This process is also a result of tectonic plate movement. This process generates seismic waves which are localized and bring relatively minor movements in Earth's crust.

4. **Despite continuous incidence of solar energy, earth's average temperature remains almost constant. Explain the reasons behind this. In this regard, discuss the heat budget of earth and enumerate the factors that control the distribution of temperature on earth's surface.**

Approach:

- With the help of concept of heat budget, discuss how earth is balancing out incoming and outgoing solar energy.
- Then discuss how earth's average temperature remain constant.
- Then briefly discuss factors that control the distribution of temperature on earth's surface.

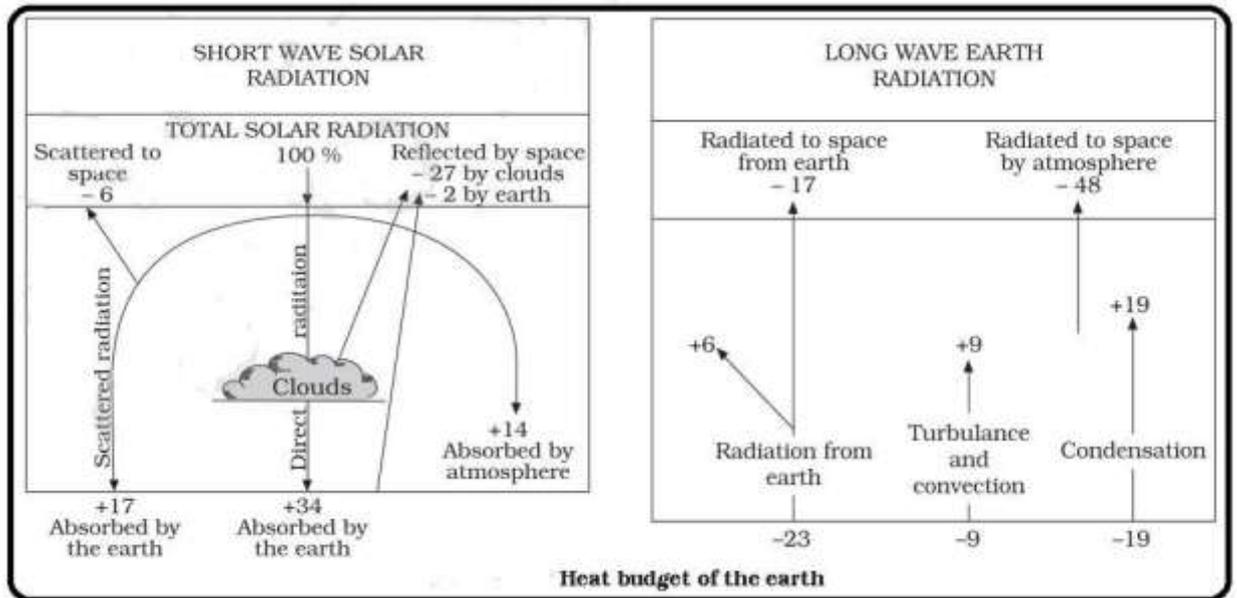
Answer:

Despite continuous incidence of solar energy, the earth as a whole does not accumulate or lose heat. Incoming heat being absorbed by the Earth in the form of short wave radiations and outgoing heat escaping the Earth in the form of long wave radiation are balanced. This balance is known as Earth's heat budget.

Earths Heat Budget:

Considering that the insolation received at the top of the atmosphere is 100 percent. While passing through the atmosphere some amount of energy is reflected, scattered and absorbed. Only the remaining part reaches the earth's surface.

- Roughly 35 units are reflected back to space even before reaching the earth's surface owing to albedo effect of clouds and snow and ice covered surfaces.
- The remaining 65 units are absorbed, 14 units within the atmosphere and 51 units in the form of terrestrial radiating i.e. long wave radiation.
- Of this 17 units are radiated to space directly and remaining 34 units are absorbed by the atmosphere.
- 48 units absorbed by the atmosphere (14 from insolation + 34 units from terrestrial radiation) are also radiated back into space balancing 65 units received.



Factors that control the distribution of temperature on earth's surface:

- **Earths Heat Engine-** There are variations in the amount of radiation received at earth's surface due to nearly spherical shape of the earth. Thus, there is surplus of net radiation balance between 40 degree North and South though the regions near the poles have deficit. However, atmospheric and oceanic systems (viz. global wind system and Ocean currents) work to even out solar heating imbalances, collectively called Earth's heat engine, by taking away heat from surplus region to the deficit one.
- **Latitude-** as latitude increases from equator towards poles, insolation decreases.
- **Altitude-** The atmosphere is indirectly heated by terrestrial radiation from below thus making the places near the sea level hotter than the places situated at higher elevations.
- **Distance from sea-** Compared to land, the sea gets heated slowly and loses heat slowly. The places situated near the sea come under the moderating influence of the sea and land breezes.

5. Explain the concept of Biogeochemical cycles and their significance in the functioning of ecosystems. What are the challenges that they face because of anthropogenic factors?

Approach:

- Introduce the answer by explaining the concept of biogeochemical cycles.
- Explain its significance in the functioning of the ecosystem.
- Conclude the answer by enlisting challenges faced by these cycles due to human interventions.

Answer:

A biogeochemical cycle is one of several natural cycles, in which conserved matter moves through the biotic and abiotic components of an ecosystem. The main chemical elements that are cycled are: carbon (C), hydrogen (H), nitrogen (N), oxygen (O), phosphorous (P) and sulfur (S).

Important biogeochemical cycles are :

- **Water Cycle:** All of the water that falls on the land does not immediately flow back into the sea. Some of it seeps into the soil and becomes part of the underground reservoir of fresh-water. Some of this underground water finds its way to the surface through springs. The groundwater is taken in by the roots of plants and is used for photosynthesis. The water is then released into the atmospheric through **evapotranspiration** or is consumed when the plants are eaten.

- **Nitrogen Cycle:** “Nitrogen fixers” are organisms that can turn nitrogen gas from the atmosphere into nitrogen compounds that other organisms can use to produce nucleic acids, amino acids etc. These nitrogen fixers are such a vital part of the ecosystem that agriculture cannot occur without them.
- **Oxygen Cycle:** The Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis.
- **Carbon Cycle:** Carbon is present in all living organisms and non-living things such as minerals, the atmosphere, the oceans and the interior of the earth. There are two fundamental processes in Carbon Cycles.
 - **Rapid Carbon Biogeochemical Cycle:** Here inorganic carbon, which is present in the atmosphere as CO₂, is captured by autotrophs. These are usually photosynthesizing organisms such as plants, bacteria and algae.
 - **Long Term Carbon Biogeochemical Cycle:** When an organism dies, the carbon stored within their body is broken down into CO₂ and other organic substances by decomposers. While some of this carbon is released into the atmosphere, a large portion of it remains sequestered within the soil. Through this process, soils become major reservoirs for carbon storage.

Anthropogenic activities have disturbed natural cycling of these elements. For example:

- Fossil fuels, which have stored carbon for years are burnt at the rate much faster than the ability of the atmosphere to sink it. It results in greenhouse effect and subsequent global warming.
- Deforestation is releasing carbon stored within plant matter and is reducing the number of plants available to capture it.
- Artificial nitrate fertilizer, when washed away in water sources lead to blooms of “red tides,” “brown tides,” and Pfiesteria bacteria – all of which produce toxins that can sicken or kill humans and other animals.

6. **Which are the major iron ore producing regions in the world? With examples, discuss the factors that influence the location of Iron and Steel industry.**

Approach:

- Briefly discuss about the major iron ore producing regions and countries in the world.
- Citing examples, discuss the factors influencing the locations of iron and steel industries. .

Answer:

Iron and steel industry is one of the most important capital goods industries which form the base of all other industries.

Major iron ore producing regions in the world:

Iron ores are rocks and minerals from which metallic iron can be economically extracted. China is among the world's largest producer and consumer of iron-ore, where Manchurian deposits are the most actively mined.

It is followed by Australia(Mt. Gold-worthy, Mt Whaleback) Brazil (Carajas iron ore reserves), India (Mayurbhanj, Baba Budangiri), Russia(Ural mountains, Tula region), Ukraine(Lipetsk, Kerch peninsula), South Africa(Transvaal), United States(Lake Superior, Pennsylvania), Canada, Iran, Sweden, Kazakhstan, Venezuela, Mexico, and Mauritania.



Factors influencing the locations of Iron and steel industries:

Raw material: Mostly large integrated steel plants are located close to source of raw materials, as they use large quantity of heavy and weight losing raw materials.

Iron ore based location includes Lorraine (France), Duluth (USA), Vishakhapatnam (India), Corby in UK. Coal-based plants are mostly located in Ruhr valley (Germany), New Castle (UK), Pittsburgh (USA), Bokaro (India).

In fact, iron ore regions and coal producing regions share a bi-directional relationship as after transporting coal to iron ore regions, the railway wagons would return with iron ore towards the coal producing regions, instead of empty wagons. For instance, Pittsburg-Lake Superior in USA, Bokaro-Rourkela in India etc.

Market: In order to minimize high transportation costs due to heavy and bulky materials, the plants are located near to the market, especially mini steel plants, as seen in Maharashtra. 'Tokyo-Yokohama' and 'Osaka – Kobe – Heemeji' iron steel regions are market based.

Capital: Iron and steel industry is a capital intensive industry. The requirement of capital is fulfilled either by big corporate or by government and other financial agencies.

Labour: Availability of cheap labour is also important. Example: Rourkhela plant, Orisa; Bhilai steel plant in Chattisgarh, mostly in Chota Nagpur region.

Electricity: Availability of electricity mostly hydro and water for cooling is a strong deciding factor. Example: Kar near river Bhadra, Bokaro steel plant on banks of river Damodar, Visheshwarya steel plant.

7. Identify the characteristics of commercial livestock rearing and mark the regions practicing it on a world map. Also, discuss its challenges and opportunities in context of India.

Approach:

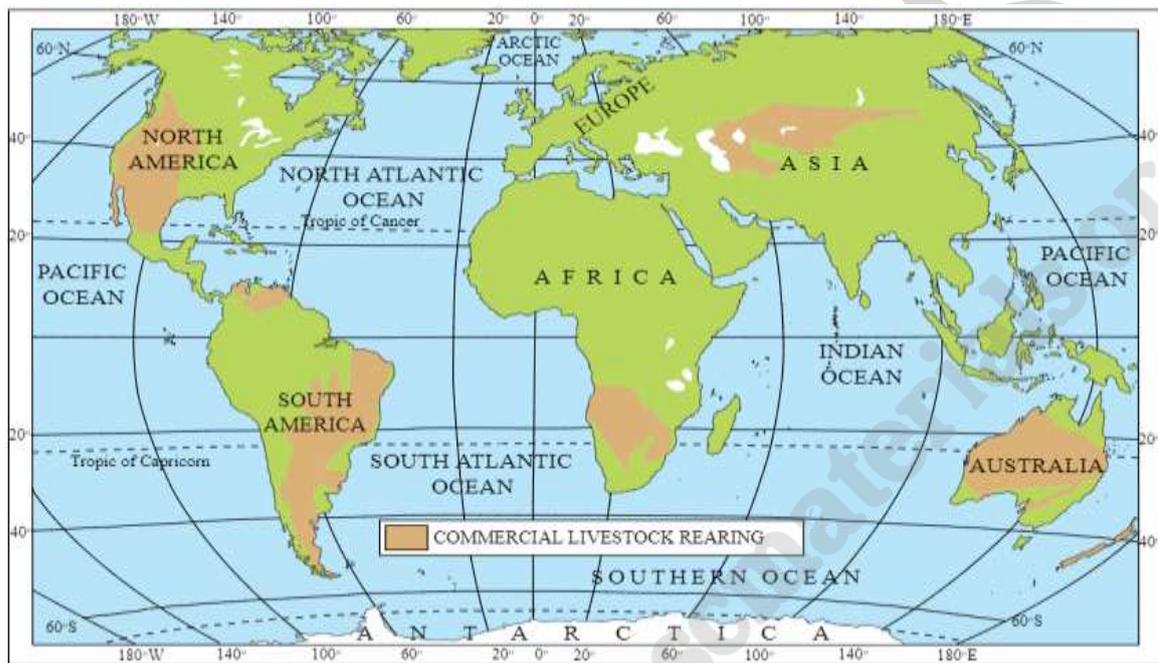
- Explain the meaning of commercial livestock farming briefly and highlight its basic characteristics.
- Show its geographical spread preferably on a world map.
- Discuss the challenges and opportunities of this sector for India.

Answer:

Commercial livestock rearing is a practice wherein animals are used to produce labour and commodities such as meat, leather and wool.

Main characteristics

- It is organized and capital intensive.
 - It is essentially associated with western cultures and is practiced on permanent ranches.
 - Number of animals in a pasture is kept according to the carrying capacity of the pasture.
 - It is a specialized activity in which only one type of animal is reared. Important animals include sheep, cattle, goats and horses.
 - Products such as meat, wool, hides and skin are processed and packed scientifically and exported to different world markets.
 - Rearing of animals in ranching is organized on a scientific basis.
 - Main emphasis is on breeding, genetic improvement, disease control and health care of the animals.
- New Zealand, Australia, Argentina, Uruguay and United States of America are important countries where commercial livestock rearing is practiced. The world map below highlights the important regions



Livestock in India: Around 20 million people are dependent on livestock sector for their livelihood.

Challenges

- Improving genetic resources in cattle and overcoming livestock diseases.
- Small size of herds in most parts of the country
- Livestock continues to be raised on crop residues and agricultural by-products. The area under cultivated fodder production is limited only to 4.60% of the total cultivable land.
- Disease diagnosis, health and hygiene maintenance of are affecting the production potential.
- Availability of quality nutrients through feed and fodder resources.
- Mitigating the issue of greenhouse gas emissions contributed by livestock.

Opportunities

- Growing demand for animal food products is an opportunity for the poor to escape poverty through diversifying livestock production.
- Greater integration of global markets under World Trade Organization (WTO) provides opportunities for exporting animal food products.
- With fragmentation of land, livestock presents an opportunity to the small landholders.
- Livestock rearing provides an escape route from the climate vagaries.

The extent to which the India expropriates benefits of emerging opportunities would depend on how policies, institutions and technologies address the constraints.

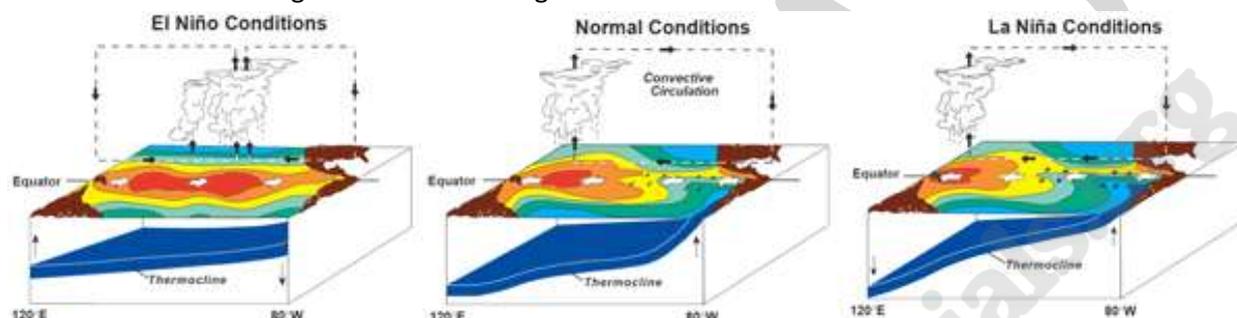
8. Explain the phenomenon of El Niño and La Niña. How do they affect the weather system in various parts of the world?

Approach:

- Briefly explain ENSO and Walker Circulation and their link to El Niño and La Niña
- Explain the phenomenon of El Niño and its impacts in the weather systems in various parts of the world
- Similarly, give a brief explanation of La Niña and state its impacts in the global weather system

Answer:

El Niño and La Niña are opposite phases of the El Niño-Southern Oscillation cycle (ENSO). The ENSO cycle describes fluctuations in temperature of the ocean surface and the fluctuations in the atmospheric pressure in the East-Central Equatorial Pacific. These phases relate to variation in Walker Circulation, which refers to an east-west circulation of the atmosphere above the tropical Pacific, with air rising above warmer ocean regions and descending over cooler ocean areas.



El Niño: A warm ocean current develops along Peruvian coast replacing cold Peruvian current, leading to increase in sea surface temperatures and weakening of trade wind, which weakens the Walker circulation and El Niño results. This normally occurs every 3-5 years, close to Christmas across central and East-Central Equatorial Pacific region.

Global weather impacts of El Niño:

- **Increased Rainfall:** Heavier rainfall occurs during El Niño years in China, Peru, Chile, Ecuador, Northern Argentina, Equatorial East Africa, Southern USA, etc.
- **Reduced rainfall:** Due to El Niño, there is reduced rainfall and drier conditions in the Indian subcontinent (Generally, Indian monsoons and El Niño are inversely related), Indonesia, Australia, Southern Africa, Saudi Arabia, etc.
- El Niño events produce more tropical storms and hurricanes in the Eastern Pacific.

La Niña: La Niña is associated with cooler-than-average sea surface temperatures in the central and eastern tropical Pacific Ocean due to strong, eastward-moving trade winds and ocean currents that bring the cold water to the surface through upwelling. During La Niña, the Walker Circulation is enhanced and becomes very pronounced with well-defined rising and sinking branches.

Global weather impacts of La Niña:

- **Increased rainfall:** La Niña leads to increased rainfall in the Indian subcontinent, particularly India and Bangladesh, Southern Africa region, Indonesia, Australia, Saudi Arabia, Pacific North-West and Western Canada, among others.
- **Decrease in rainfall:** Due to La Niña, there is reduced rainfall in Equatorial East Africa, China, Southern USA, Argentina, Peru, Chile, etc.
- La Niña cycles produce more Atlantic and Caribbean Sea hurricanes.

In this way, it atmospheric circulations show that changes at one place affects the weather in other parts of the world.

9. What are air masses? Highlight their role in affecting the local climate.

Approach:

- In the introduction define and explain the formation of air masses.
- Also mention the types of air masses.
- Then discuss how various air masses influence the local climate.

Answer:

Air Masses: When the air remains over a homogenous area for a sufficiently longer time, it acquires the characteristics of the area. The homogenous regions can be the vast ocean surface or vast plains. The air with distinctive characteristics in terms of temperature and humidity is called an air mass.

The homogenous surfaces, over which air masses form, are called the source regions. The air masses are classified according to the source regions. Tropical air masses are warm and polar air masses are cold. There are five major source regions. These are:

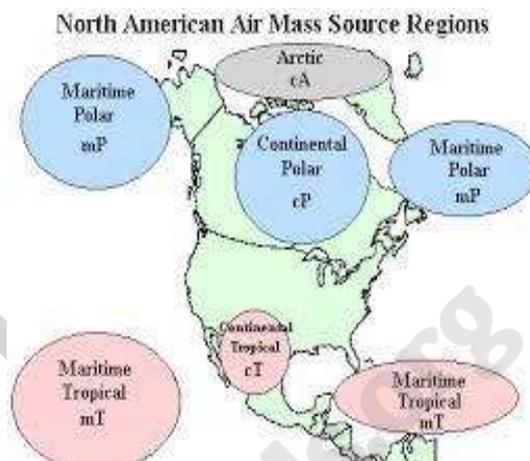
- Warm tropical and subtropical oceans
- The subtropical hot deserts
- The relatively cold high latitude oceans
- The very cold snow-covered continents in high latitudes
- Permanently ice-covered continents in the Arctic and Antarctica.

Accordingly, following types of air-masses are recognized:

- Maritime tropical (mT)
- Continental tropical (cT)
- Maritime polar (mP)
- Continental polar (cP)
- Continental arctic (cA)

Air mass being a large unit of the lower atmosphere exert significant meteorological and climatic influence such as:

- **Change in local weather:** An air mass on the move begins to transform as it passes over new landscapes, while at the same time retaining enough of its original conditions to alter local weather. For example, a cP air mass move south in winters and brings frigid temperatures to the central United States. While dry in its source region, such an air mass often picks up substantial moisture during an early-winter transit of the Great Lakes, allowing it to dump 'lake effect snow' on leeward coasts.
- **Cyclones and Anti-cyclones:** collision of two air masses leads to formation of fronts. For instance, when polar and tropical air masses merge in the mid-latitudes, prevailing westerly winds funnel along alternating low- and high-pressure centers causing cyclones and anticyclones, respectively.
- **Rainfall:** It also causes precipitation and temperature change in many regions. Maritime-tropical air sourced over warm waters of the Atlantic Ocean, Caribbean Sea and Gulf of Mexico is the main contributor of precipitation for much of North America east of the Rocky Mountains.
- **Cooling effect:** Maritime air masses also contribute to a moderating climatic influence on coastal temperatures, as oceans heat up and cool down more slowly and less dramatically than landmasses.



10. Giving an account of the spatial distribution of different types of forests in India, discuss the economic utility of each of them.

Approach:

- Give a brief about the forest cover.
- Discuss spatial distribution with economic usage and examples.

Answer:

The total forest cover in India is **21.54%** of the total area of the country. Forest is the second largest land use in India next to agriculture.

Forests add to the floral and faunal wealth of India, in addition to acting as important sources of livelihoods through agro-forestry, social forestry, farm forestry, forest produce, medicine, bio-diversity, carbon sinks and providers of fresh air.

Types of forests vis-a-vis their spatial distribution and their economic usage:

- **Tropical Evergreen and Semi Evergreen forests**
 - These forests are found in the western slope of the **Western Ghats**, hills of **the northeastern region and the Andaman and Nicobar Islands**.
 - Tropical evergreen forests are well stratified, with layers closer to the ground and are covered with shrubs and creepers, with short structured trees followed by tall variety of trees.
 - Example: rosewood, mahogany, aini, ebony, rubber, bamboos etc.
 - **Economic usage:** Fine grained, hard and durable timber used in Railways and construction work, rubber and associated industry etc.
- **Tropical Deciduous forests/ Monsoon Forests**
 - These are the most widespread forests in India. They are also called the monsoon forests. They spread over regions which receive rainfall between 70-200 cm. On the basis of the availability of water, these forests are further divided into moist and dry deciduous.
 - **Moist deciduous forests** are more pronounced in the regions which record rainfall between 100-200 cm. These forests are found in the **northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Odisha**. Examples: Teak, sal, shisham, hurra, mahua, amla, semul, kusum, and sandalwood etc.
 - **Dry deciduous forest** covers vast areas of the country, where rainfall ranges between 70 -100 cm. These forests are found in rainier areas of the **Peninsula and the plains of Uttar Pradesh and Bihar**. Examples: Tendu, palas, amaltas, bel, khair, axlewood, etc.
 - **Economic usage:** Source of timber, recreation and conserving wildlife, agro-forestry, medicine, bidi making, etc.
- **Tropical Thorn forests:**
 - Tropical thorn forests occur in areas which receive rainfall less than 50 cm **in semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh**.
 - **Economic usage:** Trees like babool, ber, and wild date palm, khair, neem, khejri, palas and Tussocky grass are mostly used in agro-forestry, medicine, fruits, handicrafts and other sources of livelihoods to the poor and tribals.
- **Montane forests:**
 - Mountain forests can be classified into two types, **the northern mountain forests and southern mountain forests**.
 - The Himalayan ranges show a succession of vegetation **from the tropical to the tundra, which change with the altitude**.

- Deciduous forests are found in the foothills of Himalayas. It is succeeded by wet temperate forests between an altitude of 1,000-2,000 m. In the higher **hill ranges of north-eastern India, hilly areas of West Bengal and Uttaranchal**, evergreen broad leaf trees such as oak and chestnut are predominant.
- The **southern mountain forests** include forests found in three distinct areas of Peninsular India viz; **Western Ghats, Vindhyas and Nilgiris**. As they are closer to tropics, and only 1,500 m above sea level, vegetation is temperate in higher regions, and subtropical on the lower regions of **Western Ghats, especially in Kerala, Tamil Nadu and Karnataka**. **Temperate forests / Sholas** are found in **Nilgiris, Anaimalai and Palani hills**. Such forests are also found in **Satpura and Maikal ranges**.
- **Economic usage:** Deodar is used in construction activity. Chinar and walnut, sustain Kashmir handicrafts. Grasslands in this region provide important source of livelihoods to tribes such as Gujjars, Bakarwals, Bhotiyas and Gaddis.
- **Littoral and Swamp forests:** Also called as wetland forests, they are found along:
 - reservoirs of Deccan Plateau with the lagoons and other wetlands of the southern west coast;
 - saline expanses of Rajasthan, Gujarat and Gulf of Kachchh
 - freshwater lakes and reservoirs from Gujarat eastwards through Rajasthan (Keoladeo National Park) and Madhya Pradesh
 - delta wetlands and lagoons of India's east coast (Chilika Lake)
 - freshwater marshes of Gangetic Plain
 - floodplains of Brahmaputra; marshes and swamps in hills of northeast India and Himalayan foothills
 - lakes and rivers of the montane region of Kashmir and Ladakh
 - mangrove forest and other wetlands of the island arcs of Andaman and Nicobar Islands
 - **Economic usages:** Mangroves and wetlands are important sources of bio-diversity, wildlife species and tourism.

11. Describing the process of their formation, explain the difference between meanders and braided channels.

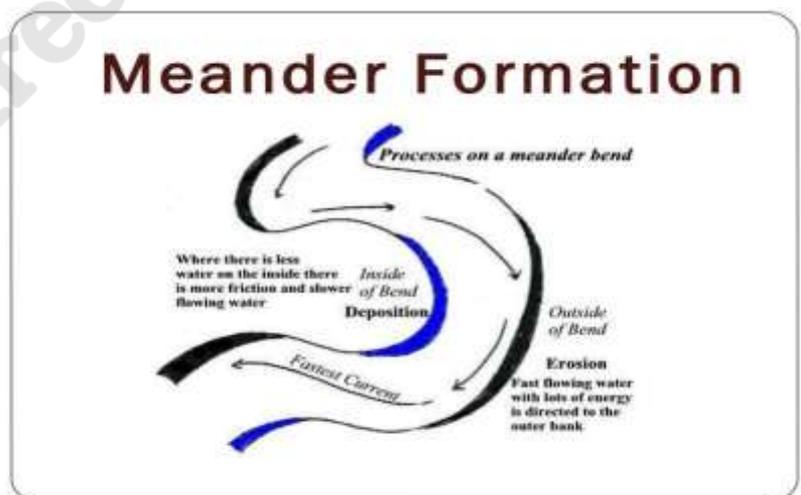
Approach:

- Describe meanders and braided channels and their formation.
- Differentiate between meanders and braided channels.

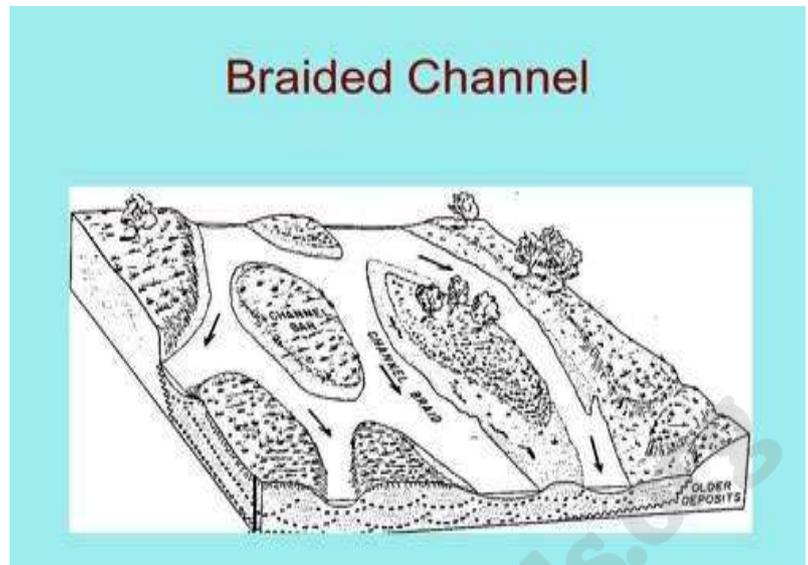
Answer:

A **meander** is a winding curve or bend in a river. Meanders are result of both erosional and depositional processes. They are typical of middle and lower course of a river. This is because vertical erosion is replaced by a sideways or lateral erosion, plus deposition within the floodplain. There are several stages involved in the creation of meanders:

- In low flow conditions straight river channels have bars of sediment on their beds. Flowing water weavers around these bars of sediment and creates deep and shallow areas causing the river flow to swing from side to side.



- Where the river swings towards the bank, lateral erosion causes undercutting. On the opposite side of the channel where the velocity is lower material is deposited.
- Continued erosion along the outer bank, as the result of hydraulic action and abrasion and deposition on the inner bank perpetuates meander formation. Eventually the neck of the meander is breached by the river creating an ox-bow lake.
- In streams having highly variable discharge and easily eroded banks, sediment gets deposited to form bars and islands that are exposed during periods of low discharge. In such a stream the water flows in a braided pattern around the islands and bars, dividing and reuniting as it flows downstream. Such a channel is termed a **braided channel**. The enormous Brahmaputra-Jamuna river is a classic example of a braided river.



Difference between meanders and braided channels

- A stream with cohesive banks that are resistant to erosion will meander whereas a stream with highly erodible banks will result in the formation of braided channels.
- Braided rivers, as distinct from meandering rivers, occur when a threshold level of sediment load or slope is reached whilst a steep gradient is also maintained.
- Braided channels are usually found close to high mountains while meandering streams usually exist across a wide flat floodplain.
- Braided rivers are wider and shallower than meanders of similar discharge; they transport more bed load and scour and fill their beds more dramatically; and above all they erode their banks more rapidly, extensively, and unpredictably.

12. The consequences of India's megacities producing tonnes of waste are troubling. Elaborate the statement and also discuss the significance of Solid Waste Management Rules 2016 in this regard.

Approach:

- State the extent and problem of urban waste in India.
- Discuss the consequences of urban waste.
- Enlist the significance of Solid Waste Management Rules 2016 in addressing this issue.

Answer:

India generates over 1,50,000 tonnes of municipal solid waste (MSW) per day, yet, only 83% of waste is collected and less than 30% is treated. According to the World Bank, India's daily waste generation will reach 3,77,000 tonnes by 2025. Unplanned urbanization, rapid industrialization, rising income, consumerism and unscientific disposal coupled with inefficient and insufficient waste infrastructure are the main reasons for the same.

Consequences

- **Strain on Urban Local Bodies (ULBs):** Most ULBs struggle to provide efficient waste management services due to excessive waste generation, financial issues, lack of infrastructure and technology and low participation of private sector and NGOs.
- **Environmental:** Open landfills emit hazardous gases like methane, toluene and methylene chloride. It also causes contamination of soil and water resources and leads to natural habitat degradation.
- **Economic:** Dumping sites take huge urban space, making business or housing projects difficult in its vicinity.
- **Public Health:** Open waste and dumping grounds pose serious risks to the public health and animals. The population living in and around the area becomes susceptible to respiratory, skin and gastrointestinal infections.
- **Social:** Often the population inhabiting the areas in proximity to landfills belongs to the more vulnerable lower strata of the society.

Solid Waste Management rules, 2016

Based on the principles of "sustainable development", "precaution" and "polluter pays", the rules are now applicable beyond Municipal areas and extend to urban agglomerations, census towns, notified industrial townships, State and Central government organizations, places of pilgrims, religious & historical importance etc. Various provisions which may help address the urban waste management menace include:

- **Segregation at Source:** Source segregation of waste has been mandated in order to channelize the waste to wealth by recovery, reuse and recycle.
- The developers of SEZs, industrial estate, industrial park to earmark area for recovery and recycling facility.
- **Collect Back Scheme:** The brand owners who sale or market their products in packaging material which are non-biodegradable, should put in place a system to collect back the packaging waste generated due to their production.
- **User fee:** Local bodies have been empowered to levy user fees for collection disposal and processing from bulk generators. The generator will have to pay "User Fee" to the waste collector and a "Spot Fine" for littering and non-segregation.
- **Integration:** The new rules also mention integration of rag pickers, waste pickers and kabadiwalas from the informal sector to the formal sector by the state government.
- **Waste Processing and Treatment:** It has been advised that the bio-degradable waste should be processed, treated and disposed off through composting or bio-methanation.
- The rules also emphasize promotion of waste to energy.

Though these rules are well intentioned, a massive awareness campaign in association with communities, NGOs, students and other stakeholders needs to be planned to push for better implementation of these rules.

13. List the different flood prone regions in India and identify the reasons behind their frequent flooding. What are the NDMA guidelines for management of floods?

Approach:

- Briefly, write about floods in India.
- List the different flood prone regions in India and the major causes of flooding in these regions.
- Highlight the NDMA guidelines for management of floods.

Answer:

Flood refers to a situation of high-water level along a river or on the coastal areas that leads to inundation of land. It occurs in almost all the river basins of the country. Around 12 per cent (40 million hectare) of land in India is prone to floods.

Flood affected areas and major reasons for flooding in these regions include:

- **The Brahmaputra River Region**
 - Heavy rainfall (around 250 cm) during the rainy season.
 - Silting of river channels reduces river's capacity to carry large amount of water.
 - Narrowness of the Brahmaputra valley.
 - Frequent earthquakes cause change in river course and the flow of water in the river is obstructed leading to inundation of large areas in this region.
 - Landslides results in formation of temporary dams across the river and submerges large areas under water. Later it gives way under the pressure of water and floods large area downstream.
 - Very high population pressure has forced people to live in the flood prone area, thereby, increasing vulnerability.
- **The Ganga River Region**
 - Tributaries in Northern UP and Bihar often change their course and cause flooding in low lying areas.
 - Large number of tributaries. For e.g. Chambal and Betwa adds to the flooding capacity of the Yamuna.
 - Drainage congestion in western UP.
 - In West Bengal, the southern and central parts are flooded due to inadequate capacity of river channels and tidal effect.
- **The North-Western River Region**
 - Inadequate surface drainage in Punjab-Haryana plain (due to saucer shaped topography of the region) causes inundation and water-logging over vast areas.
 - Satluj, Beas, Ravi and Chenab often flood large areas.
 - Flooding in Jhelum, raises level of water in Wular lake inundating nearby areas.
- **The Central and Deccan Indian Region**
 - Deltas of river Mahanadi, Godavari, Krishna and the Cauvery suffer from occasional floods owing to the large scale silting and the consequent change in the river courses.
 - Deforestation
 - High tide at the time of flood aggravates the flood situation.
- **The Coastal Region**
 - Godavari and the Krishna rivers have acute drainage problem and face floods particularly in the wake of cyclonic storms.
 - Floods in delta of rivers Mahanadi, Brahmani and the Baitarni is accentuated due to high tides.

NDMA Guidelines for flood management are:

Structural Measures

- Construction of reservoirs in the river courses to store extra water at the time of flood.
- Desiltation and building of flood protection embankments to control flood water from overflowing the banks.
- Diversion of flood water into a natural or artificially constructed channel, lying within floodplains.
- Afforestation and conservation of soil cover along with structural works like dams, detention basins etc.

Non-Structural Measures

- Flood Plain Zoning to regulate land use in the flood plains to minimize the damage due to floods.
- Flood Proofing to mitigate distress and provides immediate relief to the population in flood prone areas.
- Integrated management of water resources at the basin or watershed scale
- Real time discharge and rainfall data for the formulation of a flood forecast and warning system.
- Measures should be taken to strengthen Ganga Flood Control Board and Brahmaputra Board.

14. What are the priorities for action identified under the Sendai Framework for Disaster Risk Reduction? Elaborate how India's National Plan for Disaster Management has tried to integrate the Sendai Framework.

Approach:

- Give a brief overview of the Sendai Framework for Disaster Risk Reduction and state its priority action areas.
- State how India's National Plan for Disaster Management has tried to integrate the Sendai Framework.
- Mention the weaknesses of NDMP in this regard.

Answer:

The Sendai Framework for Disaster Risk Reduction (2015-2030) is a 15-year, voluntary, non-binding agreement, which recognizes that the State has a primary role in reducing disaster risk. However, the responsibility should be shared with other stakeholders including local government, private sector etc.

The four priority action areas identified under the framework include:

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

India's National Disaster Management Plan (NDMP) has been aligned broadly with the goals and priorities set out in the Sendai Framework for Disaster Risk Reduction. **Some aspects of the NDMP are:**

- For each hazard, the NDMP incorporates four priorities enunciated in the Sendai Framework under five thematic action areas including:
 - Understanding risk
 - Inter-agency coordination
 - Investing in disaster risk reduction (DRR) – structural measures
 - Investing in DRR – non-structural measures
 - Capacity development
- The response part of the plan identifies eighteen broad activities arranged into a matrix to be served as a ready reckoner and includes measures such as early warning, maps, satellite inputs, evacuation and search and rescue of people and animals, medical care etc.
- It covers all phases of disaster management: prevention, mitigation, response and recovery.
- It provides for horizontal and vertical integration of all agencies and departments of the government at various levels.
- It emphasizes on the need for dissemination of disaster-related information to communities.

However, the NDMP also has some shortcomings that need to be addressed. **These include:**

- It does not set any goals or targets, or spell out how the Sendai goals and targets shall be achieved.
- It fails to lay down a clear and practical roadmap as it is too generic in its identification of the activities to be undertaken by the government agencies.
- It refrains from providing a time frame for undertaking action beyond vaguely prescribing that these must be taken up in short, medium, mid- and long-term basis.
- It does not project the requirement of funds or provide sources for mobilization of funds.
- It does not provide any framework for monitoring and evaluation of the plan.
- It fails to address the needs of vulnerable groups, which could lead to millions of women, children, disabled and elderly people, lower caste and tribal communities being put at further risk.

15. Define the term invasive species and provide examples from flora and fauna in India. What are the threats associated with the expansion of invasive species? In this context also discuss measures to address these threats.

Approach:

- Briefly explain the concept of invasive species.
- Cite data and example of invasive species from fauna and flora in India.
- Discuss the threats associated with the expansion of these species.
- Finally discuss the measures to address these threats.

Answer:

According to Convention on Biological Diversity (CBD), invasive alien species are species that are established outside of its natural past or present distribution, whose introduction or spread threatens biological diversity. These are found in all taxonomic groups such as animals, plants, fungi etc and can affect all types of ecosystems. Many invasive species are successful because they have no natural predators in the environment. The rise in spread of invasive species is attributable to the increase in international trade and globalization.

Zoological survey of India has made a list of 157 invasive alien species out of which 58 are found on land and freshwater and 99 are found in marine ecosystem. Some of the common animal species found in India are African Apple Snail, Papaya Mealy Bug affecting papaya crops in Assam and West Bengal, Cotton Mealy Bug threatening cotton crops in Deccan, Amazon Sailfin Catfish destroying fish population in wetlands etc.

Also, 173 species of invasive exotic plants such as Cassia Uniflora, Prosopis Juliflora etc. are also found in India.

Threats associated with expansion of these species are:

- According to IUCN, around 5 to 20 percent alien species become invasive and is second most serious threats to the biodiversity after global warming. These species may threaten indigenous species by competing with them for the same resources. They can also change the food chain.
- Invasive species have been identified as an important factor of extinction.
- Many invasive alien species are major pests for the agriculture, forestry and fishing industries.
- Alien species can also pose a health hazard or function as disease carriers.
- At the economic front they may cause problems for recreational activities and tourism.

Measures taken to address the threats of alien invasive species are:

- Article 8(h) of CBD and Aichi target 9 aimed at controlling or eradicating alien species, by 2020.
- Global invasive species program to support Article 8(h) of CBD.
- IUCN's invasive species specialist group has been working to promote and facilitate the exchange of information and knowledge to ensure linkages between policy makings.
- Sustainable development goal (SDG) 15, which is aimed at controlling and eradicating it.
- Invasive alien species management through border control measures such as screening routes of transmission of these species.

16. What is Environment Impact Assessment? Identifying the different processes involved in the exercise, highlight the purpose of carrying out this assessment. Further, mention in brief the status of EIA in India.

Approach:

- Briefly explain the concept of Environment Impact Assessment (EIA).
- Bringing out different processes involved in the EIA, discuss the purpose of EIA.
- Explain the status of EIA in India.

Answer:

Notified under the Environment (Protection) Act, 1986, Environment Impact Assessment (EIA) is a formal process used to predict environmental consequences of any development project such as nuclear power, river valley projects, ports, petroleum refineries, chemical fertilizers, mining etc.

Purpose of EIA

- Identify the environmental, social and economic impacts of a project prior to taking a decision for its implementation.
- Mitigate the harmful impact and maximize the beneficial effects.

Different processes involved in carrying out EIA

- **Screening:** First stage of EIA, which helps determine whether the proposed project requires EIA or not.
- **Scoping:** Expert identification of key issues and impacts which needs to be further investigated, along with defining boundary and time limit.
- **Impact Analysis:** Identifying and predicting likely social and environment impacts such as air quality, noise levels, impact on wildlife and local communities etc.
- **Mitigation:** Recommendation of actions so as to reduce and avoid the adverse impacts.
- **Reporting** to decision making body, public hearing, review of EIA and decision making.
- **Post monitoring:** After project is commissioned, this step ensures that the impacts of the projects do not exceed the mandated legal standards.

Status of EIA in India

Till 1980s, almost all projects were implemented with little or no environmental concerns in India. However, in 1994, ministry released official “Environment Impact Assessment Notification” 1994, in which criteria were decided to take environment clearance for projects from Centre or State level.

The EIA in 2006 was issued to supersede the EIA of 1994. Since EIA, 2006, various developmental projects have been re-categorized in category A and B depending upon their threshold capacity and likely pollution potential, requiring environmental clearances.

Environmental clearances are also required in respect of all new projects listed in the schedule to the 2006 notification defining some special circumstances and relaxing norms for environmental clearances. It is used as a major tool for minimizing the adverse impact of rapid industrialization on environment and for reversing those trends which may lead to climate change in long run.

17. Identify and explain the importance of key elements of action in disaster management cycle during the post-disaster phase.

Approach:

- Give a brief introduction of the post-disaster phase.
- List the elements of actions during the post-disaster phase.
- State the importance of each action listed step by step.

Answer:

Post-disaster phase includes response to a disaster with a purpose to achieve early recovery and rehabilitation of affected communities, immediately after a disaster strikes. These are called as response and recovery activities.

The key elements of action in the post disaster phase of the disaster management cycle includes:



- **Response and Relief:** It is the earliest action and immediate intervention to be taken in the post-disaster phase. It includes search and rescue, ensuring security of people, providing food and water, shelter and sanitation, clothes-medical and trauma center care.

Importance:

- This response is the foremost attempt to control the situations after disaster hits, to ensure the situation does not worsen further.
- It ensures that the survivors are kept alive, healthy and safe.
- It prevents the epidemics from spreading post disasters.
- It prepares the ground for further rehabilitation of people, their animals and their property.
- **Rehabilitation:** This includes the restoration of basic services and functions after the response to the disaster.

Importance:

- After the security of people has been ensured, this process ensures that their lives return back to normal.
- It prepares the ground for further reconstruction and resorting back to the development that was either hampered or pushed back due to disaster.
- **Reconstruction:** It means full resumption of services, along with reinstatement of the preventive measures in order to stay prepared for the disasters in future.

Importance:

- The process brings back the affected area back on the path of development.
- It facilitates creation of sustainable livelihood.
- Provides people with enlarged livelihood options and improved land, water and resources.
- Normalization of economics and trade of the region.
- Prepares community for future disaster resistance.

Natural disasters can hit any region and any community but the amount of damage it causes is totally based on the amount of preparedness and resilience of that community. After the disaster hits, it is important for that community to stand back again to normalcy and develop resilience for future disasters. It is not possible to move on without post-disaster phase of management.

18. Identify the areas affected by and the causes of landslides in India. Mention different steps that need to be taken to mitigate the effects of landslides.

Approach:

- Define Landslide.
- List down the causes of the landslides.
- List down the areas prone to landslide in India.
- List down steps that can be taken to mitigate the landslides.

Answer:

The term 'landslide' can be defined as the downward and outward movement of slope forming materials composed of rocks, soils, artificial fills or combination of all these materials along surfaces of separation by falling, sliding and flowing, either slowly or quickly from one place to another.

Although the landslides are primarily associated with mountainous terrains, these can also occur in areas where an activity such as surface excavations for highways, buildings and open pit mines takes place. They often take place in conjunction with earthquakes, floods and volcanoes. At times, prolonged rainfalls may cause landslides.

The causes of landslides in India are not much different from the world, but there are some peculiarities. Important factors considered to be responsible for causing landslides are:

- Slope instability due to removal of lateral and underlying support.
- Indiscriminate chopping down of trees, slash and burn cultivation practices in hills and road construction and mining activities.
- With increasing population pressure, there is an increase in grazing activities, urbanization which reduces dense natural evergreen forest cover. Due to these activities the ecological balance is disrupted, thereby resulting in loosening of the soil.
- Under conditions of heavy rain, there is increased and substantial soil erosion and frequent landslides.

The major areas affected by landslides in India based on landslide hazard zonation are:

- The Western Himalayas (in states of Uttar Pradesh, Uttaranchal, Himachal Pradesh and Jammu & Kashmir)
- The Eastern & North-eastern Himalayas (in states of West Bengal, Sikkim and Arunachal Pradesh)
- The Naga-Arakan Mountain belt (in states of Nagaland, Manipur, Mizoram and Tripura)
- The Western Ghats region including Nilgiris (in states of Maharashtra, Goa, Karnataka, Kerala & Tamil Nadu)
- The Plateau margins of the Peninsular India and Meghalaya plateau in North-east India.

Mitigation Steps for landslides in India

- Excess water in catchments areas should be stored to reduce the effect of flash floods; this will also recharge the ground water level in areas prone to landslide in India.
- The runoff collection ponds in the catchment areas must be dug to store water.
- On community lands, fuel or fodder trees should be grown to increase forest cover to reduce landslide hazard in India.
- Grazing should be restricted and better grass must be grown on the surface previously grazed to increase the hold on soil by plant roots. These grasses can be of some commercial importance so that economic returns encourage farmers in areas prone to landslide in India.

Government has also taken various steps for mitigating the effects of landslide – National Disaster Management Guidelines on Management of Landslides and Snow Avalanches, National Landslide Susceptibility Mapping (NLSM), real-time landslide warning system recently set up in the Sikkim-Darjeeling belt etc.

19. Discuss the reasons and implications of land degradation and desertification as major environmental challenges facing India. Suggest the measures needed to address them.

Approach:

- Define land degradation and desertification (LDD), explaining how it is a major environmental challenge for India.
- Discuss the major reasons behind desertification.
- Mention few implications of land degradation and desertification.
- Suggest some measures to address it.

Answer:

Land degradation is any change in the condition of the land which reduces its productive potential. Desertification is a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife.

Major Reasons for Land degradation and Desertification:

- **Water Erosion:** Loss of soil cover due to rainfall and surface run-off.
- **Vegetation Degradation:** Deforestation, shifting cultivation and degradation in grazing grassland and scrub land.

- **Wind Erosion:** Removal of top-soil (spread of sand) due to wind especially in western part of the country.
- **Salinity:** Cultivated lands especially in irrigated areas with improper drainage.
- **Human made/Settlements:** Developmental activities such as mining and unplanned urbanization.
- **Others:** Water logging, frost shattering, mass movement etc.

Extension of crop cultivation to marginal and low potential lands or to lands vulnerable to natural hazards, improper crop rotations, overuse of agrochemicals etc. adds to the problem of land degradation and desertification.

Implications of Land Degradation and Desertification:

- Loss of habitats, which is pushing the planet towards a sixth mass species extinction.
- It is a major contributor to climate change, with deforestation alone contributing about 10% of all human-induced greenhouse gas (GHG) emissions.
- Loss of biodiversity and ecosystem services.
- Land degradation and desertification can affect human health through complex pathways. The potential impacts of desertification on health include:
 - higher threats of malnutrition from reduced food and water supplies;
 - respiratory diseases caused by atmospheric dust from wind erosion and other air pollutants.

Measures to combat Land Degradation and Desertification:

- **In rangeland** areas through grazing pressure management, pasture and forage crop improvement, Silvopastoral management, Weed and pest management, maintaining appropriate fire regimes, etc.
- **In mining areas** through on-site management of mining wastes, reclamation of mine site topography and early replacement of topsoil.
- **In wetland areas**, through controlling point and diffuse pollution sources, adopting integrated land and water management strategies and restoring wetland hydrology, biodiversity, etc.
- Shifting towards less land degrading diets and less animal protein from unsustainable sources and reductions in food loss and wastage.
- Recognizing the **key role of Land managers**, including indigenous peoples and local communities in the design and implementation of sustainable practices.
- **Eliminating perverse incentives** e.g. irrigation subsidies and devising positive incentives that reward the adoption of sustainable land management practices.
- **Others:** Urban planning, replanting with native species, green infrastructure development, remediation of contaminated and sealed soils (e.g. under asphalt), and river channel restoration.

Reduction and reversal of land degradation is important not only for socio-economic gains but also for the achievement of SDGs and Paris agreement goals.

20. **Explain the concepts of Bio-magnification and Bio-accumulation. Also, provide examples of the harmful impact of these two processes on the environment and human health.**

Approach:

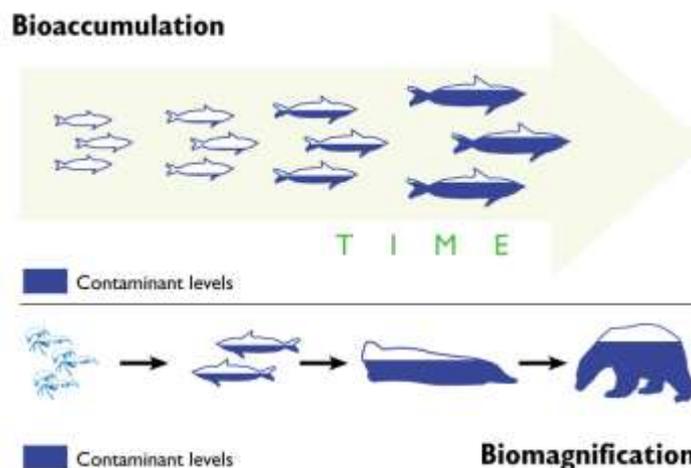
- Introduce with the process of pollutants entering the food chain.
- Explain the concept of Bio-magnification and Bio-accumulation.
- Highlight the harmful impact of these two processes on the environment and human health. Also, give examples.

Answer:

Non-degradable pollutants, which cannot be metabolized by the living organism, gets into the food chain and do not degrade. A pollutant moves through various trophic levels in an ecosystem. Mainly, it involves two processes:

Bio-accumulation

'Bio-accumulation' is often used as a general term to describe the process whereby a substance is taken up by living organisms from their environment and diet and stored in the body. Although it is an essential process, bio-accumulation is seen as an unwanted phenomenon in relation to persistent chemicals/pollutants since these could progressively 'build up' to levels that could be harmful. It occurs when an organism absorbs a toxic substance from all sources at a rate greater than that at which the substance is lost.



Bio-magnification

Bio-magnification refers to the process through which a substance becomes stored at higher concentrations in predator organisms than in their prey as we move up the trophic levels. Pollutants that exist in small amounts in the environment (such as certain heavy metals and organic agents found in pesticides) become concentrated in organisms near the top of the food chain. This occurs when a pollutant is resistant to degradation, mobile, soluble in fats (lipophilicity), shows hydrophobicity and is biologically active.

While, the Bio-magnification occurs across various trophic levels in a food chain, the Bio-accumulation occurs within a trophic level.

Example of Bio-accumulation & Bio-magnification:

In the process of collecting nutrients, phytoplanktons also collect certain human made chemicals, especially some persistent chemicals like DDT. The chemicals biologically accumulate (bio-accumulate) in the organism and become concentrated at levels that are much higher in the living cells than in the open water.

The small fish and zooplankton eat vast quantities of phytoplankton. In doing so, any toxic chemicals accumulated by the phytoplankton are further concentrated in the bodies of the animals that eat them. This is repeated at each step in the food chain and is called bio-magnification.

The top predators at the end of a long food chain, such as lake trout, large salmon and fish-eating gulls, may accumulate concentrations of a toxic chemical high enough to cause serious deformities or death even though the concentration of the chemical in the open water is extremely low.

Harmful impacts on Environment

- **Effects on reproduction and development of marine creatures** – Accumulation of toxic elements such as DDT, Mercury in the aquatic creatures affect their reproduction and development.
- **Destruction of the coral reefs** - Use of cyanide in gold leaching and fishing damage the coral reefs, which provide food and shelter for sea creatures.
- **Disruption of the food chain** - When chemicals and other toxins are carried into the soils, rivers, lakes or oceans and taken up by various organisms, it disrupts the relationships within the food chain.

Harmful impacts on Human Health

Consumption of seafood poisoned by mercury and polycyclic aromatic hydrocarbons (PAHs) can cause diseases like hepatitis and cancer and adversely affect survival, growth and ability to fight disease in other organisms.

Further, exposure to heavy metals like cadmium, chromium, and high doses of essential nutrients like iron and zinc can adversely affect the nervous system, liver and kidneys.