

APPROACH – ANSWER: G. S. MAINS MOCK TEST - 2068 (2023)

Answer all the questions in NOT MORE THAN 200 WORDS each. Content of the answers is more important than its length. All questions carry equal marks. *12.5X20=250*

1. **Highlighting the achievements of the Montreal Protocol on Substances that Deplete the Ozone Layer, discuss the reasons behind its success.**

Approach:

- Give a brief introduction of the Montreal Protocol.
- Write about the achievements of the Montreal Protocol.
- Highlight the reasons behind its success.
- Conclude accordingly.

Answer:

The Montreal Protocol, is an international treaty, adopted in Montreal in 1987, that aimed to regulate the production and use of substances that contribute to ozone depletion.

Achievements of the Montreal Protocol

- **Truly global participation:** In 2009, the Montreal Protocol became the first UN treaty to achieve universal ratification, demonstrating the world's commitment to ozone protection, and global environmental protection.
- **Healing the ozone layer:** Global observations have verified that atmospheric levels of key Ozone Depleting Substances (ODS) are going down and it is believed that with implementation of the Protocol's provisions, the ozone layer should return to pre-1980 levels by the middle of this century.
- **Supporting developing countries:** With the assistance of the Multilateral Fund for the Implementation of the Montreal Protocol, developing countries had, by mid 2010, permanently phased out over 270,000 tonnes of Ozone Depleting Substances (ODS) that had been used to produce various products and have eliminated virtually all of their production of CFCs and halons.
- **High rates of compliance:** Taking into account all the Parties and all their phase-out commitments, the Parties to the Montreal Protocol have achieved a compliance rate of over **98%**. Further, in the process of phasing-out, many countries, both developed and developing, have met their phase-out targets well ahead of the schedule.
- **2010 phase-out milestone:** 1 January 2010 was the date by which all the Parties phased-out the consumption and production of chlorofluorocarbons, halons, carbon tetrachloride and other fully hydrogenated Ozone Depleting Substances (ODS).

Thus, the Montreal Protocol has indeed been successful in protecting the ozone layer. **The reasons behind the success of the Montreal Protocol can be attributed to following factors which are generally absent in other environmental treaties:**

- **Cooperative approach:** Much negotiation was held in small, informal groups leading to a genuine exchange of views amongst credible people.
- **Principles based:** The "precautionary principle" and the concept of **common, but differentiated, responsibility (CBDR) took root in the Montreal Protocol** when developing countries were given longer time to phase-out ODS.

- **Flexibility to accommodate newer information:** The protocol could be amended to include stricter controls i.e. more Ozone Depleting Substances (ODS) were added to the control list and ensure total phase out, rather than partial phase-out.
- **Trade Provisions and restrictions:** These limited the supplies of CFCs and other Ozone Depleting Substances (ODS) to non-signatories which forced them to ratify the Protocol.
- **Clear List of Targeted Sectors:** Clear articulation of chemicals and sectors allowed governments to prioritise the main sectors early.
- **Institutional Support:** An expert and independent Technology and Economic Assessment Panel (and its predecessors) helped signatories reach solid and timely decisions on often-complex matters.
- **Compliance Procedure:** It prioritised helping wayward countries back into compliance. If necessary, resources from the **Multilateral Fund** are available for some short-term projects.

Thus, the flexible and agile approach to the Montreal Protocol helped it become successful, which is also evident from the Kigali Agreement, which amended the Montreal Protocol to also include phasing out Hydrofluorocarbons (HFCs) as one of aims of the Protocol.

2. **What are Urban Heat Islands? Identifying the reasons behind their creation, discuss the measures which can help counter them.**

Approach:

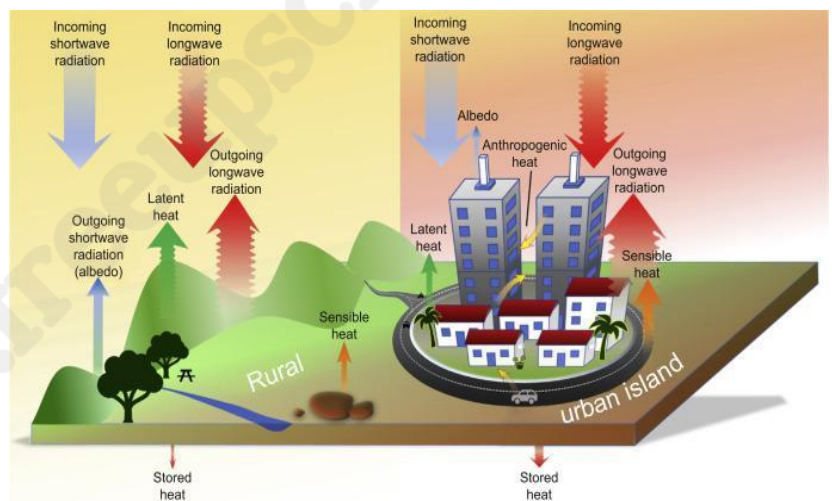
- Introduce the phenomenon of Urban Heat Islands (UHI).
- Write about the reasons behind their formation.
- Mention the measures to tackle UHI.
- Conclude accordingly.

Answer:

Urban Heat Islands (UHI) are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure **absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies.** Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas. It increases the demand for energy, leads to increased greenhouse gases emissions, discomforts human health and even affects the health of flora and fauna.

The major factors responsible for UHI

- **Anthropogenic heat discharges:** Sources of anthropogenic heat include cooling and heating buildings, manufacturing, transportation, and lighting. Heat from these sources warm the urban atmosphere by conduction, convection, and radiation.
- **Absorption of heat:** Paved over surfaces, such as roads and parking lots, absorb solar radiation as heat. Since these surfaces are impermeable, even water runoff is redirected to the stormwater system rather than being absorbed by plants or water bodies that help cool the area through evapotranspiration and evaporation.
- **Urban geometry:** The height and spacing of buildings affects the amount of radiation received and emitted by urban infrastructure. The tall buildings within many urban areas provide multiple surfaces for the reflection and absorption of sunlight, increasing the intensity with which urban areas are heated. High rise buildings also trap outgoing radiation.



- **Greenhouse effect:** Carbon dioxide (CO₂) and other greenhouse gases act like a blanket, absorbing IR radiation and preventing it from escaping into outer space.
- **Lack of vegetation:** Scant natural vegetation in urban regions reduces the natural cooling effect from the shade and evapotranspiration.

Measures that can be taken to countering UHIs:

- **Promoting natural vegetation:** Natural ventilation is one of the most effective passive cooling techniques. It can be done by arranging the openings in buildings to face the prevailing wind, ventilated roofs and building orientation with adequate gaps for good airflow.
- **Use of appropriate surface material:** An increase in the surface albedo has a direct impact on the energy balance of a building. Surface materials with a high albedo index to solar radiation reduce the amount of energy absorbed through building envelopes and urban structures, and keep the surface cooler.
- **Use of white pavement instead of Asphalt:** Asphalt temperature can reach 63°C and white pavements only reach 45°C. Lower surface temperatures contribute to decreasing the temperature of the ambient air because the heat convection intensity from a cooler surface is lower.
- **Providing appropriate landscape:** Providing an appropriate landscape in building can also contribute to energy consumption reduction. It can be done by making vertical and horizontal green spaces in different layers or floors of buildings with a multi-use function, which can significantly decrease the energy required to cool buildings.

Activities to reduce heat islands range from voluntary initiatives, such as cool pavement demonstration projects, to policy actions, such as requiring cool roofs via building codes. Most mitigation activities have multiple benefits, including cleaner air, improved human health and comfort, reduced energy costs, and lower greenhouse gas emissions. Heat island mitigation can also help cities reduce the impacts of climate change.

3. *Highlighting the causes of forest fires, bring out the measures to prevent their occurrence in India.*

Approach:

- Introduce by substantiating with reports/facts highlighting the vulnerability of forest fires in India.
- Mention reasons/causes leading to forest fires in India.
- Write about the measures to check instances of forest fires.
- Conclude accordingly.

Answer:

According to **India State of Forest Report (IFSPR) 2021**, India reported around 3.5 lakhs incidents of forest fires from November 2020 to June 2021. This is the highest ever recorded in the country for this period so far. Forest fires break out in India from November-May every year due to various natural and anthropogenic reasons including accumulation of inflammable materials such as dry leaves, twigs, pine needles, etc. Odisha reported the maximum fires among all states, followed by Madhya Pradesh and Chhattisgarh.

Causes of Forest Fires:

More than ninety five percent of forest fires are caused either by negligence or unknowingly by the human being. The rest of the fires are caused by natural reasons.

- **Natural causes:**
 - Climatic conditions such as rising atmospheric temperatures, duration of dry spells and low humidity in soil and atmosphere make favourable circumstances for a fire to start.
 - Lightning, volcanic eruptions can trigger forest fires.
 - Other causes include friction of bamboo due to high wind velocity and rolling stones that result in sparks setting off fires in highly inflammable leaf litter like chir pine trees.

- **Man-made causes:**
 - Shifting cultivation, fires induced for flush growth of tendu leaves, good growth of grass and fodder, to encroach upon the forest land, to conceal illicit felling.
 - Source of fire from cigarette buds, electric sparks etc.
 - Fires lit intentionally around forests to ward off wild animals, recreation etc.

The forest fires lead to loss of livelihoods, natural capital, and biodiversity. The government has taken certain steps like **Forest Fire Prevention & Management Scheme, National Action Plan on Forest Fire, 2018** and setting up of **Forest Fire Lines** to prevent forest fires in India.

Measures to prevent forest fires:

- **Fire risk zonation and mapping** for identifying areas of priority for management interventions and allocating resources to priority areas.
- **Stronger collaboration** between the State Forest Departments, the disaster management authorities and research entities would enable states to innovate new science-based management approaches for preventing fires and rehabilitating fire-affected areas.
- **Institutionalizing partnership with forest communities** and preparing a forest fire forecasting system. Further, assessing indigenous knowledge and techniques to detect and suppress forest fire, and upgrade it with scientific inputs and research.
- **A national forest fire knowledge network** must be established to cover all dimensions of forest fire in the country.
- **Forest Fire Management (FFM)** needs to be an **integral part of course curricula of forest department training institutes** with updated and enriched latest information about forest fire detection, suppression and rehabilitation.
- There is a need to **document good practices** in forest fire management so that good lessons can be learnt from them and utilize them in making forest fire management systems more effective and practical.
- **Monitoring** to provide early warning and vulnerability maps through satellites like NASA's MODIS (or Moderate Resolution Imaging Spectroradiometer).

Protecting forests from undesirable fires is crucial to sustaining India's progress on meeting its global pledge to create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ - equivalent through additional forest and tree cover by 2030 and achieving SDG -15 (Life on land- Sustainably managing forests).

4. What is carbon inequality? Discuss the need to address it and the measures that can be taken in this regard.

Approach:

- Introduce by giving a brief overview of the concept of carbon inequality.
- Discuss why it needs to be addressed.
- Suggest measures that can be taken to address it.
- Conclude accordingly.

Answer:

Carbon inequality refers to the **phenomena of the highly unequal distribution of carbon emissions throughout the world**. Carbon inequality today exists between countries as well as within countries, as reflected in the findings of the **World Inequality Report (WIR), 2022**.

- **Carbon inequality between nations:** A small number of developed countries are responsible for substantially higher share of the CO₂ emitted globally.
- **Carbon inequality within nations:** Within countries, carbon emissions of higher income groups are significantly higher compared to other citizens.

Need to address the carbon inequality:

- **To achieve the set targets:** Currently, carbon inequality undermines the ability of countries to meet the targets set out in the Paris Agreement, making it unviable.

- **Leads to socio-economic inequality:** The global carbon budget is being rapidly depleted, not for the purpose of lifting all of humanity to a decent standard of living, but to expand the consumption of a minority of the world's richest people.
- **Standard climate measures are unjust in unequal societies:** Climate policies have been disproportionately borne by low-income consumers over the past decades, in particular, via carbon and energy taxes.
- **Strengthen India's case on multilateral platforms:** India has been advocating for a fair and just transition for the developing countries with adequate time frame and financial assistance for climate adaptation and mitigation based on historical responsibilities.
- **Designing effective climate policies:** The scale of transformation required to cut carbon emissions drastically cannot be attained if environmental and social inequalities are not integrated into the design of climate policies.

Ways to address carbon inequality:

- **Systematic assessment:** Proper tracking of individual emissions within countries with a systematic assessment of the beneficiaries and losers of climate policies should be carried out by public authorities.
- **Policy instruments targeting investments in polluting and fossil activities:** Progressive wealth taxes on the ownership of polluting activities could accelerate divestments, reduce pollution levels of the wealthiest and generate the much-needed resources to scale up investments in low-carbon infrastructures.
- **Scaling up public investment:** Investment in low-carbon energy production infrastructures, transport and energy efficiency will help in ensuring a fair transition and enable lower income groups to take greener decisions.
- **Implementation of the Global Carbon Incentive (GCI):** Every country that emits more than the global average of around five tonnes per capita should pay annually into a Global Carbon Incentive Fund. It will help in balancing the national-level priorities with global needs.

Tackling extreme inequality and targeting the excessive emissions linked to the consumption and investments of the world's richest people, thereby addressing carbon inequality, is vital to achieving the **1.5°C Paris goal**.

5. *Stating the significance of Coastal Vulnerability Index, enumerate the initiatives taken to enhance resilience against coastal vulnerability in India.*

Approach:

- Give a brief introduction about Coastal Vulnerability Index (CVI).
- Bring out the significance of Coastal Vulnerability Index.
- Enumerate the initiatives taken to enhance resilience against coastal vulnerability in India.
- Conclude accordingly.

Answer:

Recently, the Indian National Centre for Ocean Information Services (INCOIS) prepared a **Coastal Vulnerability Index (CVI) for the entire Indian coast**. It determines the coastal risks due to future sea-level rise based on the physical and geological parameters for the Indian coasts. The CVI uses **parameters** like tidal range, wave height, coastal slope, coastal elevation, shoreline change rate, geomorphology, and historical rate of relative sea-level change.

Significance of Coastal Vulnerability Index: It helps in coastal disaster management and building resilient coastal communities by addressing the following factors:

- **Sustainable development:** Indian coasts are under threat due to multiple stresses like global climate change and human intervention. It will help in planning and sustaining the high productivity of the coastal ecosystem.
- **Climatic vulnerability:** Sea level along the India coast has been continuously rising leading to loss of land to coastal erosion and placing people's livelihood and homes in jeopardy.

- **Long-term displacement:** More than 26% of the Indian population live within 100 km from the shoreline. Sea level rise and flooding might lead to increased relocation in major coastal cities.
- **Informed policy making:** While most of the existing policies in India address displacement from rapid onset disasters such as monsoons and cyclones under disaster and rehabilitation policies, displacement due to slow onset disasters such as coastal erosions has yet to find a place at the policy level.

Initiatives taken to enhance the resilient against coastal vulnerability include:

- **Integrated Coastal Zone Management (ICZM) Project:** Its nodal agency is the Society of Integrated Coastal Management.
 - At the national level, it has the objective of establishing and supporting an appropriate national institutional structure for guiding and coordinating coastal zone management.
 - At the state level, its objective is to develop and empower the state-level authorities to adopt appropriate ICZM approaches consistent with the national strategies.
- **Enhancing Coastal and Ocean Resource Efficiency (ENCORE):**
 - In 2020, the World Bank approved a 400 million dollars multi-year-financing to help India to enhance its coastal resources, protect coastal populations from pollution, erosion and sea level rise and improve livelihood opportunities for coastal communities.
 - The first phase of this multi-phase approach (MPA) will provide 180 million dollars for ENCORE.
 - In phase 1, ENCORE will cover eight coastal states (Andhra Pradesh, Gujarat, Goa, Karnataka, Kerala, Odisha, Tamil Nadu, and West Bengal) and three coastal UTs (Daman and Diu, Lakshadweep and Puducherry).

India's coastal regions are on the front line of a shifting climate and are increasingly experiencing sea-level rise, erosion and natural disasters such as tropical storms and cyclones. In this context, the CVI will aid in improving the design and implementation of policies for making coastal regions resilient to any anthropogenic or natural vulnerability.

6. How is water scarcity different from water stress? Highlighting the issue of water stress in India, suggest measures to address it.

Approach:

- Give a brief introduction about water scarcity and water stress.
- Highlight the issue of water scarcity in India and associated implications.
- Suggest measures for water conservation.
- Conclude accordingly.

Answer:

Water scarcity refers to the lack of freshwater resources. Scarcity is human-driven, it is a function of the volume of human water consumption relative to the volume of water resources in a given area.

Water stress refers to the lack of fresh water resources to meet human and ecological demand. Compared to scarcity, water stress is a more inclusive and broader concept. It considers several physical aspects related to water resources, including water availability, water quality, and the accessibility of water, which is often a function of the sufficiency of infrastructure and the affordability of water, among other things.

The issue of water stress in India is reflected through the following:

- **Increasing demand:** India is home to nearly 17% of the world's population but has only **4% of the world's freshwater resources**. Further, estimates indicate that India's water demand will exceed supply by a factor of two by 2030.
- **Lack of access to clean water:** About 82% of rural households in India do not have individual piped water supply and 163 million live without access to clean water in their vicinity.

- **Per capita water availability:** In 1951, per capita water availability was 5,177 cubic meters. In the **2011 Census** figures, this came down to 1,545 cubic metres - a decline of about 70 per cent in 60 years.
- **Pollution:** 70% of India's surface water is contaminated, contributing to about 20% of the country's disease burden.
- **Dependency upon groundwater:** About 60% of the irrigation needs, 85% of rural drinking water needs and 50% of urban needs are met through groundwater, which is depleting at a rapid pace.
- **Paradoxical situation of flood and droughts:** In India, during 1996-2015, nearly 19 million and 17.5 million people annually were simultaneously affected by floods and droughts, respectively.

The impacts of water stress necessitate that relevant steps be taken. These include:

- **Water conservation** needs to be promoted. For instance, mandatory rain water harvesting structures in houses, development of small water harvesting structures such as low-cost farm ponds, nalla bunds, check-dams, etc.
- **Afforestation** including block plantations, agro-forestry and horticultural development, shelterbelt plantations, sand dune stabilization etc. must be given priority.
- **Sustainable agriculture** practices must be adopted. For instance, use of water efficient technologies, farmers' education, and advisory services etc. Also, the Minimum Support Prices (MSPs) and subsidies on water intensive crops must take into account the declining water table in the region.
- On the lines of American Planning Association (APA), **state and city governments** should consider water resource availability in the region while **creating city plans** and providing permits for new establishments, and restrict any development activities that are not sustainable in terms of water management.
- **Industrial water quotas, tradable permits, and water availability linked licenses** can help in optimizing water usage in scarce regions and minimize the water supply deficit.
- Shifting to alternatives such as **solar and wind energy** can reduce reliance on thermal power plants and create additional energy sources that are not heavily reliant on water for production.

All these measures, from the side of the government, residents, and civil society organisations will help reduce the water stress that India is currently facing.

7. ***Persons with Disabilities (PwDs) experience the impact of disasters disproportionately. Discuss. Also, mention the steps taken by the government to make disaster management more inclusive.***

Approach:

- Give a brief introduction on the statement.
- Highlight how the persons with disabilities (PWDs) experience the impact of disasters disproportionately.
- Mention the steps taken by the government to make disaster management more inclusive.
- Conclude accordingly.

Answer:

While disasters threaten the well-being of people from all walks of life, few are disproportionately affected, e.g., people with disabilities. They are especially vulnerable when disaster strikes not only due to aspects of their disabilities, but also because they are more likely to experience adverse socio-economic outcomes such as higher poverty rates. Disasters and poorly planned disaster response and recovery efforts can exacerbate these disparities, leaving persons with disabilities struggling to cope even more both during and after the emergency.

Disproportionate impact of disasters on Persons with Disabilities (PWDs):

- Persons with disabilities are too often **excluded from early-warning systems and evacuation processes**, which may prevent them from fleeing a disaster in a safe and timely manner.

- **Greater risk of being separated from their usual carers and assistive devices** while fleeing, which could exacerbate their vulnerabilities during displacement. This adds to their trauma and delays recovery. For instance, following the 2004 tsunami, many people with disabilities in India, including children with intellectual disabilities, were left destitute after being separated from family members.
- The stakeholders and service providers working in the field of disability, often confront **systemic gaps and challenges**. For instance, there is near absence of appropriate disability-sensitive and disability-responsive policies, inadequate planning, etc. Also, the evacuation centres **often lack necessary assistance and medical services** required by people with severe disabilities and high care needs.
- PWDs are more likely to face **discrimination and exploitation** during and after the disasters, especially when the resources are scarce.

The **UN Convention on the Rights of Persons with Disabilities (CRPD) 2006 and Sendai Framework for Disaster Risk Reduction, 2015-30** recognizes the disproportionate impact of disaster on PWDs and puts an obligation on the members to take concrete measures. India ratified the CRPD in 2007 and has taken following steps to make disaster management inclusive:

- **National Disaster Management Guidelines on Disability-Inclusive Disaster Risk Reduction (DiDRR), 2019:** From mitigation to relief and rehabilitation, the guidelines consider almost all the areas of disaster management to make the entire process equally participative for the differently abled population. It also marked the **responsibilities of ministries and departments** from national to local level for carrying out inclusivity in disaster management.
- **National Disaster Management Plan (NDMP):** It contains a dedicated chapter on 'social inclusion' for such '**more vulnerable**' sections of the population.
- **Accessible India campaign:** Its objective is to make it convenient for PWDs to access administrative buildings and transport, among other things. This will further strengthen the capacity of the differently abled to tackle disasters.

All these constructive steps initiated by the government are stepping stones in India's journey towards becoming a disability inclusive society. These measures also open up possibilities to take the movement forward, introducing more **need-based and disability sensitive strategies**.. The core principle to bring inclusivity in disaster management should be participation of the PWDs in planning process, non-discrimination and increased accessibility.

8. *Discuss the environmental and socio-economic impacts of invasive alien species.*

Approach:

- Briefly, write about invasive alien species and their characteristics.
- Highlight their environmental and socio-economic impacts. Give examples.
- Conclude accordingly.

Answer:

Invasive Alien Species are **plants, animals and microbes** introduced, accidentally or intentionally, **outside of their natural geographic range** which alter the ecosystem by **displacing native species**. These species have rapid reproduction and growth, high dispersal ability, phenotypic plasticity (ability to adapt physiologically to new conditions), and ability to survive on various food types and in a wide range of environmental conditions.

According to a 2017 study on global extinctions, invasive alien species are responsible for 25% of plant extinctions and 33% of animal extinctions. Their impact is growing globally, as discussed below:

Environmental impacts

- The global extent and rapid increase in invasive species is **homogenizing the world's flora and fauna** which is recognized as a **primary cause of global biodiversity loss**.

- Since there are no natural predators in new habitats, invasive alien species can reproduce rapidly and outcompete local species for food, water, and space, which **leads to extinction of native species**. For instance, **Lantana Camara**, a tropical American shrub, has invaded 40 percent of India's tiger range and resulted in the scarcity of native forage plants for wild herbivores.
- In addition, invasive alien species also change the ecosystem, biodiversity, and wildlife thereby **altering the habitats and affecting the food chain**.
- As a result of species composition changes, soil properties are altered, such as pH levels, nutrient cycles, and nutrient carrying capacities, which may result in **soil productivity losses**.
- These species can **introduce new diseases and parasites** that could negatively impact the native fauna and flora as well.

Socio-economic impacts

- Habitat degradation and fragmentation forces the wild animals to step out of forest into human habitations in search of nutritious food leading to **heightening of the man-animal conflict**.
- They **cause huge economic damage** by restricting the growth of cash crops or other plants, as well as by destroying the ecosystem services provided by forests. For example, the **serpentine leaf miner** introduced in India during 1990-91 feeds on several crops that are important to the economy such as cucumber, snake gourd, bottle gourd, pumpkin, watermelon, beans, causing crop losses and thereby putting food security at risk.
- The rapid growth of alien species besides native grasses makes it impossible to separate pure fodder from alien species, **increasing the risk that livestock consume adulterated fodder**.
- Introduction of harmful algal blooms, smothering plants like salvinia or the predatory species such as Nile perch has led to **closure of several fisheries and aquaculture facilities**.

Globalization increases the chance for the introduction of invasive alien species, and the most effective way to prevent their spread is to regulate trade and movement of species. Moreover, invasive alien species threatens the majority of species on the IUCN Red List, and climate change is only worsening their impacts, so it is essential to take immediate steps to combat the spread of these species by implementing specific initiatives, such as **Aichi Biodiversity Target 9** and **UN SDG 15**.

9. Elaborate on how soil pollution affects food security, human health and the environment.

Approach:

- Introduce by explaining the soil pollution.
- Discuss its effect on food security, human health and environment.
- Conclude by suggesting preventive measures.

Answer:

Soil pollution is defined as the addition of substances to the soil, which **adversely affects physical, chemical and biological properties** of soil. Common contaminants include pesticides, petroleum products, radon, asbestos, lead, chromated copper arsenate and creosote. According to the report released by the UN Food and Agriculture Organisation (FAO), soil pollution is a global threat that is particularly serious in regions like **Europe, Eurasia, Asia and North Africa**. Further, the report highlighted that the soil pollution presents a serious threat to agricultural productivity, food safety, and human health.

- **Impact on Food security:**
 - The toxic chemicals present in the soil can decrease soil fertility which **decreases agricultural productivity** and therefore food security. Around 3.7 million hectares of land in India is suffering from severe depletion of soil organic matter and nutrients.
 - Leaching of nutrients due to increased use of fertilizer, pesticide and microbial activity leads to **acidification of soil**, which is detrimental for agricultural productivity. Soil pollution thus also significantly impacts the food security, by reducing the crop yields.

- Further, the contact with **contaminated soils** has been identified as a potential source of food contamination due to **bioaccumulation** of heavy metal, radioactive nuclei, persistent organic pollutants etc. This makes it unhealthy for consumption.
- **Impact on Human Health:**
 - Soil pollutants enter our body through the food chain, causing illnesses to appear. It can cause **short term effects** such as, Headaches, nausea, vomiting, coughing, pain in the chest, and wheezing, irritation of the skin and the eyes, weakness etc.
 - **Long term exposures** may lead to permanent damage to the nervous system, depression of the Central Nervous System, damage to vital organs such as the kidney and the liver, higher risk of developing cancer etc. Further, the spread of antibiotics in the environment increases the pathogens' resistance to the drugs.
- **Impact on the Environment:**
 - The **ecological balance of any system gets affected** due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time.
 - Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional **problem of soil erosion**.
 - **Volatile contaminants** in the soil can be carried away into the atmosphere by winds or can seep into underground water reserves, soil pollution can be a direct contributor to **air and water pollution**.

Hence, it can be said that healthy soils are a key to food security and a sustainable future. Therefore, a number of ways have been suggested to check the soil pollution like regulating the disposal of hazardous waste from the industries, promoting organic methods of farming, sustainable soil management practices like quantify nutrient source, soil test to provide requisite amount of fertilizer, developing new methods for measuring, remediation monitoring and better understanding the soil cycle, promoting in-situ soil-remediation through bioremediation, phyto-remediation, etc.

10. What is Environmental Impact Assessment (EIA)? Highlight its objectives and describe the different stages involved in the EIA process.

Approach:

- Briefly explain Environment Impact Assessment (EIA).
- Highlight the objectives of EIA.
- Describe the different stages involved in the EIA process.
- Give a brief conclusion.

Answer:

Environment Impact Assessment or EIA is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human health impacts, both beneficial and adverse. It is statutorily backed by the Environment Protection Act, 1986 which contains various provisions on EIA methodology and process.

Objectives of EIA

- To formulate a transparent, decentralized and efficient **regulatory mechanism** to integrate environmental concerns into the developmental process with a view to facilitating sustainable development.
- To identify and describe elements of **community and environment likely to be affected** by the proposed projects.
- To ensure incorporation of **necessary environmental safeguards** at the planning stage in the project cycle, so as to ensure minimal impact on different components of the environment.
- To ensure **involvement of stakeholders** in the public consultation process through public hearing and to ascertain the views of the public on the proposed project or activity.

Different stages involved in the EIA process

- **Project Proposal:** Any proponent embarking on any major development project shall notify IAA (Impact Assessment Agency) in writing by the submission of a project proposal.
- **Screening:** To determine which projects or developments require a full or partial impact assessment study.
- **Preliminary Assessment:** If screening does not clear a project, the developer may be required to undertake a preliminary assessment. This involves sufficient research, review of available data and expert advice in order to identify the key impacts of the project on the local environment, predict the extent of the impacts and briefly evaluate their importance to decision makers.
- **Scoping:** Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts are commonly determined through the socioeconomic criteria.
- **Impact Prediction and Assessment of Alternatives:** Impact prediction is a way of mapping the environmental consequences of the significant aspects of the project and its alternatives.
- **EIA Report:** It should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives.
- **Public Hearing:** After the completion of EIA report the law requires that the public must be informed and consulted on a proposed development.
- **Decision-Making:** It involves consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary). The decision on environmental clearance has arrived.
- **Monitoring the Clearance Conditions:** Monitoring has to be done during both construction and operation phases of a project. It is done not just to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports are correct or not.

In this manner, EIA seeks to balance the environmental concerns in the developmental process in order to achieve long term sustainable development.

11. *What are the risks posed by droughts? Identify the risk reduction measures that can be used to combat droughts.*

Approach:

- Give a brief definition of droughts.
- Mention the the risks posed by droughts.
- Identify the risk reduction measures that can be used to combat droughts.
- Give a brief conclusion.

Answer:

A drought is a period of time when an area or region experiences **below-normal precipitation**. The lack of adequate precipitation, either rain or snow, can cause reduced soil moisture or groundwater, diminished stream flow, crop damage, and a general water shortage.

It is interplay between demand that people place on natural supply of water and natural events that provide the water in a given geographical region. The more the imbalance in supply the higher the drought.

Risks posed by droughts

- **Water supply and quality:** Reduced stream and river flows can increase the concentration of pollutants in water and cause stagnation. These levels can affect fish and other aquatic life and water quality. Moreover, communities may have limited access to water for household use, including drinking, cooking as well as hygiene and sanitation.
- **Agriculture and livestock:** Drought can limit the growing season and create conditions that encourage insect and disease infestation in certain crops. Low crop yields can result in rising

food prices and shortages, potentially leading to malnutrition. Drought can also affect the health of livestock raised for food.

- **Air quality and Health:** The dusty, dry conditions and wildfires that often accompany drought can harm health. Fire and dry soil and vegetation increase the number of particles that are suspended in the air, such as pollen, smoke, and fluorocarbons which can cause chronic respiratory infections.
- **Energy:** Droughts can raise concerns about the reliability of electricity production from plants that require cooling water to maintain safe operations.

Risk reduction measures to combat droughts

- **Public awareness and education:** If the community is aware of the do's and don'ts, then half of the problem is solved. Awareness regarding availability of safe drinking water, water conservation techniques, agricultural drought management strategies etc. can be generated through media.
- **Drought monitoring:** It includes continuous observation of the rainfall situation, availability of water in the reservoirs, lakes, rivers etc. and comparing with the existing water needs in various sectors of the society.
- **Water harvesting:** By either allowing the runoff water from all the fields to a common point or allowing it to infiltrate into the soil where it has fallen helps increase water availability for sustained agricultural production.
- **Expansion of irrigation facilities:** It reduces the drought vulnerability. Land use based on its capability helps in optimum use of land and water and can avoid the undue demand created due to their misuse.
- **Livelihood planning:** It includes identifying those livelihoods which are least affected by the drought such as off-farm employment opportunities, collection of non-timber forest produce from the community forests, raising goats, carpentry etc.
- **Drought planning:** It would help in effective coordination among state and national agencies, establishing a specialist team for drought situations, providing crop insurance schemes, creating drought emergency plans etc.
- **Deploying alternative systems:** It includes deploying green infrastructure for storm-water management, increasing energy efficiency in buildings and using renewable energy like solar that isn't reliant on water.

With a growing population globally, water will become scarce and drought management and taking preventive measures to mitigate the conditions which force droughts from present time will lead to sustainability.

12. What are Marine Heat Waves (MHWs)? Discuss the reasons behind their occurrence and their impact on the Indian subcontinent.

Approach:

- Introduce by explaining the meaning of Marine Heat Waves.
- Highlight the reasons behind their occurrence.
- Discuss their impact on the Indian subcontinent.
- Conclude accordingly.

Answer:

Marine Heat Waves (MHWs) are periods of extremely high temperatures over the seas and oceans. They occur when seawater temperatures exceed a seasonally varying threshold for at least 5 consecutive days. During a MHW, the average temperature of the ocean surface (up to a depth of 300 feet) goes 5-7 degrees Celsius above normal.

MHWs have been recorded in surface and deep waters, across all latitudes, and in all types of marine ecosystems. They can occur in summer or winter and can last for weeks or even years.

Their occurrence has increased by 50% over the past decade and the reasons behind their occurrence are:

- **Anthropogenic factors: Around 90 per cent of the warming** caused by greenhouse gas emissions is absorbed by the oceans. Climate change is causing ocean warming globally, and regionally, MHWs are driven by unusual weather patterns and disruptions in ocean currents and mixing.
- **El Nino:** The strong El Nino event with rapid warming in the Indian Ocean is one of the reasons for occurrence of Marine Heat Waves.
- **Ocean currents:** One of the most common drivers of Marine Heat Waves includes ocean currents, which can build up areas of warm water and air-sea heat flux or warming through the ocean surface from the atmosphere.
- **Increased sea surface temperatures (SST): As per IPCC 5th Assessment Report (AR5),** the SST has increased at a rate of nearly 0.6°C per century since 1880. This warming has increased the likelihood of occurrence of Marine Heat Waves.
- **Weak winds:** When there are light winds, the warm water does not mix with the cooler water below. It floats on the surface of the water and continues to heat up, resulting in Marine Heat Waves.

Impact of MHWs on the Indian subcontinent:

- **Impact on the Indian monsoon:** The MHWs in the Indian Ocean are majorly impacting the south-west monsoon in the Indian subcontinent. For example, the MHWs have contributed to reduced monsoon rainfall over central India, and increased rainfall over the southern peninsular area.
- **Habitat destruction:** They cause habitat destruction due to coral bleaching, seagrass destruction and loss of kelp forests, thereby affecting the fisheries sector adversely. For instance, an underwater survey showed that 85 percent of corals in the Gulf of Mannar near the Tamil Nadu coast got bleached after a Marine Heat Wave in May 2020.
- **Natural calamities:** Higher water temperature associated with MHWs can increase intensity of extreme weather events such as tropical storms and cyclones, floods, droughts and wildfires in the Indian subcontinent. For example, a government commissioned study found that the intensity of severe cyclonic storms in the North Indian Ocean region has shown an increasing trend in the past four decades.
- **Economic impacts:** MHWs severely impact Indian coastal communities as increased acidification and deoxygenation of Bay of Bengal and Arabian Sea can hamper aquaculture and cause increased mortality of economically important species like fisheries, crabs, prawns, etc. This also harms regional tourism in these areas.

Given the severe and long-lasting impacts of MHWs on marine life and human society, it is necessary to implement measures to slow ocean warming and counteract the impacts of MHWs by focusing on resilience. The government must invest in nature-based solutions alongside ambitiously reducing fossil fuel-based emissions to achieve the goals under the Paris Agreement. Further, the funding agencies and governments must build research capacity to monitor MHWs, understand their impacts, and predict future heat wave events.

13. What is the impact of rising plastic pollution on the environment? Discuss the recent measures taken globally to tackle the menace of plastic pollution.

Approach:

- Give a brief context of plastic pollution along with some facts.
- Discuss the implications of rising plastic pollution on the environment.
- Mention the initiatives taken to tackle this menace.
- Conclude accordingly.

Answer:

Plastic pollution is one of the most visible testimonies of the anthropogenic havoc caused to the planet. As per the recent **UNEP Report**, approximately **400 million tonnes of plastic waste** are produced every year of which **only 9 percent is recycled** and the vast majority of the rest

accumulates in landfills or the natural environment. Further, every year, an estimated **11 million tonnes of plastic enter the world's oceans.**

The rising plastic pollution has posed a debilitating impact on the environment in the following ways:

- **Soil and water pollution:** Chlorinated plastics can release harmful chemicals into the soil, which then seeps into groundwater or surrounding water bodies, and the ecosystem.
- **Contributes to greenhouse gas emissions:** About 8 percent of the world's oil production goes to manufacturing plastics. The level of greenhouse gas emissions associated with the production, use and disposal of conventional fossil fuel-based plastics is forecast to grow to 19 per cent of the global carbon budget by 2040.
- **Disruption of ecosystems:** Plastics can cause disruption of the ecosystems. For instance, the root systems of mangroves get adversely affected by plastic pollution in the sea. Plastics are also contributing to the destruction of coral reefs.
- **Impact on humans:** Microplastics tend to accumulate in organs like lungs, livers, spleens and kidneys. They have the potential to cause metabolic disturbances, neurotoxicity, and increased cancer risk in humans.
- **Marine pollution:** The level of microplastics in oceans is set to **grow 50-fold by the end of the century** raising the risk of widespread extinction of marine life in the most polluted areas, according to a report by the World Wide Fund (**WWF**). The Great Pacific Garbage Patch is a well-known example of marine plastic waste.
- **Threat to biodiversity:** Plastic pollution has been an additional stress factor pushing the marine population towards extinction, especially in hotspots. As per the WWF, already 88% of marine species studied have been negatively impacted by plastic pollution.
- **Vehicle for invasive species:** Floating plastic waste, which can survive for thousands of years in water, serves as mini transportation devices for invasive species and disrupts habitats.

The Basel Convention is the only global, **legally binding instrument that addresses plastic pollution**, and regulates the transboundary movement of plastic waste. **The recent measures that have been taken to tackle plastic pollution are as follows:**

- In the United Nations Environment Assembly (**UNEA-5.2**), in **Nairobi**, a resolution was passed to end plastic pollution and **forge an international legally binding agreement by 2024.**
- **The Global Plastic Action Partnership** was convened by the **World Economic Forum (WEF)** to create a unified platform to champion the transition to a circular economy model for plastic production.
- The **WEF's Uplink innovation crowd-sourcing platform** is running the **Global Plastic Innovation Network Challenge** for innovative alternatives to plastics.
- **Plastic-Free Rivers and Seas for South Asia (PLEASE)** is an ambitious \$50 million project to fight plastic pollution across all eight countries of South Asia, supported by the World Bank, Parley for the Oceans, and South Asia Cooperative Environment Programme (SACEP).
- India has pledged to **join the UN Environment's Clean Seas Campaign**, which seeks to turn the tide on marine litter.
- India has also pledged to **ban all single-use plastics by 2022.** For this, India has passed the **Plastic Waste Management Rules, 2016** and introduced the concept of **Extended Producer Responsibility.**

Managing plastic pollution requires multi-stakeholder involvement and sustained efforts at various levels including plastic production, regulation of its use, disposal etc.

14. What is radioactive waste? Discuss its various harmful effects and suggest ways to manage it.

Approach:

- Briefly explain about radioactive waste.
- Discuss its harmful effects on human health and environment.
- Discuss ways of radioactive waste management.
- Give a brief conclusion.

Answer:

Radioactive waste includes any material that is either intrinsically radioactive, or has been contaminated by radioactivity, and that is deemed to have no further use. A radioactive substance is a substance that contains naturally occurring (e.g. radium-226) or man-made radionuclides (e.g. caesium-137), the concentration of which necessitates radiation protection control.

The protection control of radioactive waste depends upon the **type of radionuclides** contained and the **radiation emitted** (alpha, beta, gamma), the **activity** (spontaneous disintegration per unit time); and the **radioactive half-life**.

Harmful effects of radioactive waste

- Radiation that is given off by nuclear waste is **extremely damaging** to organisms, because it causes **mutations** at a very high rate.
- A very high level of radiation exposure delivered over a short period of time can cause **symptoms such as nausea and vomiting** within hours and can sometimes result in death over the following days or weeks.
- It also causes **DNA damage** and raises the risk of cancer, particularly in young children and fetuses.
- If nuclear waste just **seeps into the ground**, it can eventually get into reservoirs and other drinking water sources thereby reaching the homes of people who unwittingly drink high radioactive material.

Management of radioactive waste:

Radioactive waste is extremely varied in terms of physical and chemical form, radioactivity and the half-life of the radioactive elements it contains, as well as volume. Therefore, specific processes have to be adopted for each category of waste, including operations like:

- **Sorting:** This consists of separating waste according to its different properties, in particular the half-lives of the radionuclides it contains. It also involves separating waste that can be compacted, incinerated or melted down to reduce the volume.
- **Treatment and conditioning:** Different types of waste undergo different types of treatment like incineration, calcination, melting, compacting, cementation, vitrification, etc. to reduce the quantity and toxicity of radioactive waste.
- **Packaging:** Most radioactive waste requires packaging in specially engineered containers for safe storage and disposal. This also allows for easier handling and transport.
- **Storage:** Storage facilities are designed to accommodate waste packages as per their categories. For example,
 - **Very short-lived waste** is stored long enough to decay before disposal through waste systems like hospital waste systems.
 - **Low- and intermediate-level short-lived waste** is cemented in metal or concrete containers before disposal into surface or underground facilities.
- **Disposal:** Disposal is the final stage of the waste management process and implies that the packages have reached their final destination or, at least, that there is no intention of retrieving them.
 - Radioactive waste, which cannot, for nuclear safety or radiation protection reasons, be disposed of at the surface or at a low depth, are disposed of in deep geological formations.
 - Other waste like Uranium mill tailings are disposed of in mining sites. Similarly, spent fuel is stored in spent fuel pools.

Radioactive waste needs to be managed with utmost care and finding suitable waste disposal solutions is imperative for all stakeholders including industry, regulatory authorities, public authorities and the local communities.

15. **Highlighting the impacts of land degradation and desertification, enumerate the initiatives taken at the national and international levels to combat them.**

Approach:

- Briefly provide the meaning of land degradation and desertification (LDD).
- Highlight its socio-economic impact.
- List initiatives at the national and international level to combat LDD.
- Conclude appropriately.

Answer:

Land degradation is defined as a negative trend in land condition, caused by direct or indirect human induced processes, including anthropogenic climate change, expressed as long-term reduction or loss of at least one of the following: biological productivity, ecological integrity, or value to humans. **Desertification**, on the other hand, refers to the land degradation within dryland regions (arid, semi-arid and dry sub-humid regions), which turns fertile land into a desert. As per the Desertification and Land Degradation Atlas of India, **around 29.7% of India's total geographical area** underwent land degradation during 2018-19.

Impacts of land degradation and desertification

- **Agricultural production decreases** with soil degradation which in turn affects agricultural income leading to associated deprivations in health, education, and living standards.
- It reduces the land's ability to store water resulting in **water scarcity**, which affects production potential of the industrial sector as well as household work.
- Loss of livelihood and other benefits associated with productive land **forces people to migrate** to other areas in search of economic opportunities. The influx of climate migrants in other areas lead to **societal tensions** owing to limited resources.
- **Negative health outcomes and diseases** are also observed in regions as it creates ground for zoonotic disease, water and foodborne diseases and respiratory diseases. Moreover, there are higher **threats of malnutrition** from reduced food and water supplies.
- It affects **tourism potential** of the region owing to loss of scenic beauty and ecosystem services.

National level initiatives

- India is a party to the United Nations Convention to Combat Desertification (UNCCD), which has pledged to reach **land degradation neutrality targets by 2030**.
- India promotes **sustainable land management practices** in agriculture sector through schemes such as Pradhan Mantri Fasal Bima Yojana, Soil Health Card Scheme, Soil Health Management Scheme, Pradhan Mantri Krishi Sinchayee Yojna, Per Drop More Crop, etc. which are helping to reduce land degradation.
- The Ministry of Environment consolidated the intervention on **participatory forest management** through the National Forest Policy, 1988, and then through enabling guidelines in 1990 on Joint Forest Management.
- The Ministry of Environment is also implementing three major schemes for **development of forest areas** i.e., National Afforestation Programme scheme, National Mission for a Green India and Forest Fire Prevention & Management Scheme.

International initiatives

- **United Nations Convention to Combat Desertification** established in 1994 is the legally binding international agreement linking environment and development to sustainable land management.
- **Reducing emissions from deforestation and forest degradation** mechanism aims to reduce emissions from deforestation and forest degradation.
- **Bonn Challenge** launched by Germany and IUCN in 2011, has a global goal to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020 and 350 million hectares by 2030.

- **Global Initiative on Reducing Land Degradation** aims to strengthen the implementation of existing frameworks to prevent, halt, and reverse land degradation within G20 member states and globally.

Land is the fundamental building block for supporting all lives and livelihoods. Restoration of land can start a virtuous cycle of good soil health, increased land productivity, food security and improved livelihoods. With its own efforts, India is already on the way to achieve land degradation neutrality (LDN) by 2030.

16. What are Renewable Energy Certificates (RECs)? Highlight their significance in India.

Approach:

- Briefly define Renewable Energy Certificates (RECs) and state its types.
- Enumerate their significance in India.
- Conclude accordingly.

Answer:

Renewable Energy Certificates (RECs), also called Renewable Energy Credits, are market-based instruments that certify that the bearer owns one megawatt-hour (MWh) of electricity generated from a renewable energy resource, like wind, solar, etc. Once the power provider has fed the energy into the grid, the REC received can be sold on the open market as an energy commodity. RECs are **traded in power exchange within the forbearance price and floor price** determined by the Central Electricity Regulatory Commission (CERC) from time to time.

There are two categories of RECs in India:

- **Solar RECs:** They are issued to eligible entities for the generation of electricity **based on solar power as a renewable energy source.**
- **Non-solar RECs:** They are issued to eligible entities for the generation of electricity based on **renewable energy sources other than solar power.**

Significance of RECs in India:

- **Promotion of stand-alone systems:** Since trade in RECs does not require transmission of electricity, the additional revenue from sale of RECs could help improve the viability of the stand-alone systems being used.
- **Competition in the electricity market:** Separating RECs from electrical energy allows near cost-effective renewable energy to participate in the power exchange in a competitive manner.
- **Alternative to meet Renewable Purchase Obligation (RPO):** The REC mechanism is aimed at addressing the mismatch between availability of renewable energy resources in a state and the requirement of the obligated entities to meet the RPO.
- **Enhance the reach:** In usual scenarios, it may not be economical to transmit electricity from remote locations. The RECs not only promote electricity generation in such regions but also provide scope to earn revenue.
- **Attract investment:** The REC market would provide appropriate opportunities for development of renewable energy based electricity generation and attract investment in this regard.
- **Corporate social responsibility:** Tradability of RECs allows wider participation by NGOs, development agencies as well as the corporate sector, as they may purchase RECs as a part of their corporate social responsibility.

The energy mix in India is rapidly changing from fossil fuel dominance to increasing non-fossil fuel share. With an impetus on promoting renewable energy, a pan-India market-based REC mechanism was introduced and has achieved success in a short span of time.

17. **What is zero budget natural farming (ZBNF)? Discuss its significance and challenges vis-a-vis traditional farming.**

Approach:

- Introduce by explaining the concept of zero budget natural farming (ZBNF).
- State the significance of ZBNF.
- Highlight the challenges associated with ZBNF.
- Conclude accordingly.

Answer:

Zero budget natural farming is a type of farming that promotes chemical-free agricultural practices. It was originally introduced by **agriculturist Subhash Palekar** in the mid-1990s as an alternative to the Green Revolution methods. In the recent years, ZBNF was introduced by the Andhra Pradesh government in 2016, as an alternative to chemical-based and capital-intensive agriculture through its implementing agency Rythu Sadhikara Samstha (RySS).

The term 'zero budget' means zero cost of production of all crops. It is based on **four pillars**, i.e.

- **Jeevamrit** (nectar of life): A fermented microbial culture derived primarily from cow dung and urine, jaggery, pulse flour and uncontaminated soil.
- **Beejamrit** (treatment of the seeds): Microbial coating of seed, seedlings by using cow dung, urine and lime.
- **Acchadana** (mulching): It is the process of covering the top soil with cover crops and crop residues.
- **Waaphasa**: It means soil aeration.

The **traditional conventional farming**, which is widely practiced in India, is dependent on extensive use of HYV seeds, fertiliser, pesticides, use of modern heavy equipment (like tractors, harvesters) etc. **Significance of Zero Budget Natural Farming (ZBNF) over traditional conventional farming includes:**

- **Use of chemical-free inputs:** While traditional farming practices are driven by using chemicals, zero budget natural farming promotes low-cost inputs such as the use of cow dung, aged cow urine, jaggery, pulse flour and other plant-based extracts.
- **Relief from debt cycle:** Traditional farming requires various inputs which are costly and farmers are forced to take loans. According to the FAO, ZBNF promises to end reliance on loans, which in turn, could help in ending the debt cycle for farmers.
- **Eco-friendly:** ZBNF processes require 50%–60% less water and less electricity (than non-ZBNF) for all the selected crops as compared to traditional farming.
- **Improving soil health:** The ZBNF method promotes soil aeration, minimal watering, inter-cropping, bunds and topsoil mulching. It also discourages intensive irrigation and deep ploughing, which is required in the conventional farming.

Challenges associated with ZBNF as compared to traditional farming:

- **Threat to food security:** Recently, the ICAR highlighted that ZBNF would result in tremendous reduction in production of agricultural crops as compared to traditional agriculture being practiced, thus compromising India's food security.
 - For instance, against claims that organic methods can produce comparable yields to conventional farming, domestic rice production fell 20 percent in Sri Lanka. The country which was self-sufficient in rice production was forced to import rice.
- **Not 'zero budget' in absolute terms:** ZBNF is hardly 'zero budget', as it includes wages of hired labour, imputed value of family labour, imputed rent over owned land, costs of maintaining cows and paid-out costs on electricity and pump sets, etc. Thus, when compared to traditional farming yields, the benefit in terms of cost is not appreciable.
- **Other issues in ZBNF:** In Andhra Pradesh, it has been found that in farmlands on which chemical farming has been practised intensively, the soil quality is poor and does not respond quickly to ZBNF.

- Also, in crops such as paddy, standing water in the field inhibits soil microbial population, which in turn impacts the yield after farmers switch to ZBNF.

It is necessary that before pushing the states to adopt ZBNF, the Centre should collect scientific data on how ZBNF technique affects yields after discounting the impact of drought years, soil quality and other external factors. The food security of the country, besides the livelihood of millions of farmers, needs to be borne in mind before plunging into natural farming.

18. Do you think there is a need to take account of Gross Environment Product (GEP) in the calculation of GDP? Also, bring out the issues in capturing GEP.

Approach:

- Briefly explain the concept of Gross Environment Product (GEP) in the introduction.
- Mention the need to include GEP in GDP calculation.
- Highlight the issues in capturing GEP.
- Conclude accordingly.

Answer:

Gross Environment Product (GEP) is the **total value of final ecosystem services** supplied to human well-being in a region annually and can be measured in terms of biophysical value and monetary value. It indicates the overall health of the environment, as the GEP measures prime indicators such as forest cover, soil erosion, air quality and dissolved oxygen in river water.

Need for GEP accounting in GDP calculation:

- **Economic growth alone cannot represent true economic development:** Economic growth may adversely impact human well-being if it is accompanied by growing inequity and environmental degradation. Resource depletion during industrial growth impacts rural growth disproportionately, as the rural economy largely depends on natural resources.
 - GEP thus forms a balanced development approach where ecology is given equal space. Accounting GEP into GDP will give a true measure of the nation's growth towards sustainable development.
- **Shortcomings of traditional systems:** The traditional System of National Accounts (SNA) like GDP/GNP does not account for the value of natural resources and ecosystem services, like the provisioning services (food, wood etc.) and regulating services (water purification, carbon sequestration etc.).
 - Also, the value of environmental/resource degradation taking place during the developmental process are not taken into account.
- **Framing adequate policies:** GEP helps in understanding the impact of anthropological pressure on our ecosystem and natural resources. This will enable us to make policies that will balance ecology and economy.

Despite its significance, there are several issues in capturing GEP, including:

- **Knowledge gap:** There is lack of data and an existent challenge to assign a monetary value to ecosystem services. Assigning monetary value to ecosystem services is possible only to a limited extent.
 - For example, the Pipal tree in India is revered as a holy tree and religious ceremonies are conducted under its shade. Here, economic valuation of the tree cannot encompass the complexity and the ecological, socio-cultural and institutional heterogeneity of a particular area.
- **Policy gap:** There is lack of recognition of ecosystem services in economic decision-making, development planning and resource allocation. Value of ecosystem services is either ignored or not understood adequately.
- **Institutional failure:** Insufficient 'Compensation for Ecosystem Services' (CES) is provided by the government to the stakeholders. CES involves recognising and compensating people who manage the land that contribute to the long-term security of ecosystem functions. A prominent CES mechanism is 'Payments for Ecosystem Services' (PES).

Therefore, there is an urgent need to incorporate environmental assets in GDP calculation by collecting data on various types of natural capitals like forests, groundwater etc. and converting them into monetary terms. Most recently, Uttarakhand has shown the way by becoming the first state in India to take into account the Gross Environment Product (GEP) while calculating its Gross Domestic Product (GDP).

19. Delineate the various Landslide Vulnerability Zones in India. Also, enumerate the measures that can be taken to mitigate the effects of landslides.

Approach:

- Briefly explain what landslides are in the introduction.
- Discuss the various Landslide Vulnerability Zones in India.
- Mention how landslides can be mitigated.
- Conclude accordingly.

Answer:

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity.

Landslide Vulnerability Zones in India:

- **Very High Vulnerability Zone:** Highly unstable, **relatively young mountainous areas** in the Himalayas and Andaman and Nicobar, **high rainfall regions with steep slopes** in the Western Ghats and Nilgiris, the North-Eastern regions, along with areas that experience frequent ground-shaking due to earthquakes, etc. and **areas of intense human activities**, particularly those related to construction of roads, dams, etc. are included in this zone.
- **High Vulnerability Zone:** Areas that have almost similar conditions to those included in the very high vulnerability zone are also included in this category. The only difference between these two is the combination, intensity and frequency of the controlling factors. All the Himalayan states and the states from the North-Eastern regions except the plains of Assam are included in the high vulnerability zones.
- **Moderate to Low Vulnerability Zone:** Areas that receive **less precipitation** such as the Trans-Himalayan areas of Ladakh and Spiti (Himachal Pradesh), undulated yet stable relief and low precipitation areas in the Aravalli, rain shadow areas in the Western and Eastern Ghats and Deccan plateau also experience occasional landslides. **Landslides due to mining and subsidence** are most common in states like Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Goa and Kerala.
- **Other Areas:** The remaining parts of India, particularly states like Rajasthan, Haryana, Uttar Pradesh, Bihar, West Bengal (except district Darjeeling), Assam (except district Karbi Anglong) and coastal regions of the southern states are safe as far as landslides are concerned.

Measures to mitigate the effect of landslides:

- **Need of area-specific measures:** Restriction on construction and other developmental activities such as building of roads and dams in the high vulnerability zones should be strictly enforced.
- **Horizontal drain to dewater the landslide areas:** A horizontal drain can be used to drain water to reduce pressure on the soil. Holes are drilled into a cut slope or embankment. They are then encased with a liner comprised of slotted-plastic or perforated-metal.
- **Afforestation drive:** Positive actions like promoting large-scale afforestation programmes and construction of bunds to reduce the flow of water can be taken to mitigate the impact of landslides.
- **Ground anchor walls:** Reaction blocks are anchored to slopes or existing retaining walls to stabilize them. The blocks are often placed in a row pattern across the slope or wall.
- **Reducing pressure on vulnerable areas:** Limiting agriculture to valleys and areas with moderate slopes, and control on the development of large settlements in the high vulnerability zones should be enforced.

- **Measures for North-Eastern states:** Terrace farming should be encouraged in the North-Eastern hill states where jhumming (slash and burn/shifting cultivation) is still prevalent.

Landslide hazard is one of the more difficult ones to address, as it involves extensive risk analysis and geotechnical investigations, in addition to risk maps. For critical infrastructure, the non-structural mitigation measures for reducing consequences such as warning system, evacuation plans, and restriction of construction should be given importance along with structural mitigation measures to reduce the impact on operational activity during such a hazard.

20. What are Marine Protected Areas (MPAs)? Highlighting their significance, discuss the challenges in extending the MPA network in the country.

Approach:

- Explain what you understand by Marine Protected Areas (MPAs).
- Write the significance of MPAs in India.
- Discuss the challenges in extending the MPA network in India.
- Suggest a way forward and conclude accordingly.

Answer:

A Marine Protected Area (MPA) has been defined by the World Conservation Union (IUCN) as “any area of intertidal or subtidal terrain, together with its overlying water, and associated flora, fauna, historical and cultural features, which has been reserved and protected by law or other effective means to protect part or all of the enclosed environment”. In the wake of global threats such as climate change, ocean acidification and intensified resource extraction, the world’s seas are at risk. As a result, many nations have adopted Marine Protected Areas (MPAs) as a tool for conserving biodiversity and ecosystem functions.

There are 24 MPAs in peninsular India and more than 100 MPAs in the country's islands. The Gulf of Kachchh Marine National Park, Gulf of Mannar National Park, Sundarbans National Park and Mahatma Gandhi Marine National Park are some of the important MPAs of India.

Significance of Marine Protected Areas (MPAs):

- **Protecting habitats:** A declaration of an area as a Marine Protected Area helps to protect habitats. For example, it can help to restore the nesting sites of the Olive Ridley turtles at Odisha’s Ganjam district, which is under threat due to sea erosion.
- **Helps to protect endemic species:** MPAs help the authorities deal with the invasive species to protect the local biodiversity. They are also the key to arresting and possibly reversing the global and local decline in fish populations and productivity by protecting critical breeding, nursery and feeding habits. Further, they are sites for scientific study.
- **Restrict human activities:** MPA network declaration addresses habitat conversion to other land use, over exploitation of resources, pollution from domestic and industrial effluents, which otherwise lead to ecosystem degradation and destruction of coastal areas.
- **Aid in income generation:** MPAs raise the profile of an area for marine tourism, as they provide sites for nature-based recreation and also broaden local economic options.

The marine protected area network in India has been used as a tool to manage natural marine resources for biodiversity conservation and for the well-being of people dependent on it.

Challenges in extending the MPA network in India:

- **Difference of opinion on factors:** There is no consensus regarding factors that should be considered in declaring an area as a Marine Protected Area like the size of area, its habitat heterogeneity etc.
- **Financial resources:** It is difficult for a developing country like India to maintain and manage such areas in the long-run due to lack of adequate financial resources.
- **Criticised as “paper parks”:** Lack of synchronisation between social conditions and conservation efforts have led to MPAs being deemed as mere “paper parks”.

- **Difficulty in extending the network:** Due to the socio-economic dependency on coastal areas, it is difficult to extend the MPA network as national parks or sanctuaries.
- **Lack of data:** Poor data on status and distribution of the marine species in India has resulted in a compromise of the assessment of the conservation status of coastal and marine species of India using the IUCN Regional Red Listing Guidelines.

Way forward:

- **Climate change adaptation plan:** There is an urgent need to frame a climate change adaptation plan for the coastal and marine protected areas in the country.
- **Inter-departmental coordination:** Coordination among all the organizations/institutions that work for conservation of threatened marine species and the welfare of coastal communities is required.
- **Maintaining data:** Documentation and updation of database of information obtained through research on threatened marine species is urgently required.
- **Human resource:** Development of human resources to manage the MPAs of India is critical.

Dedicated efforts are required to secure and strengthen community participation in managing the Marine Protected Area network in India. Such efforts will also help to achieve the Aichi Biodiversity Targets, especially Target Number 11 and Convention on Biological Diversity (CBD) Target of '30x30'.