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ANSWER WRITING WORKBOOK

Geography

GS PAPER 1

Complete Revision of Geography through **200+ Question & Answers**

- ✓ Preparation Approach
- ✓ Micro Detailing of UPSC Syllabus
- ✓ 20 Practice Sets and Model Hints
- ✓ Previous Year Questions & Solutions

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PREFACE

While current affairs changes every year there are some parts in syllabus which do not change and a candidate requires conceptual understanding and a good grip over these topics. The purpose of this workbook is to serve as one stop destination for students. It will help in building a base of knowledge and conceptual clarity

GS answer writing workbook aims to function as a standalone product that will promote self-learning habits in students and help in maximum syllabus coverage of the static portion.

• Features of Workbook

The workbook has following features that aim to resolve various issues faced by students in an efficient and holistic manner.

Feature	Issue resolved
Static Topics from syllabus	Conceptual clarity
Topic wise sets	Syllabus coverage
Question & Answer format	Answer writing practice & Time management
Approach before each answer	Structuring of answers
Previous Year questions	Analysis
Blank Page at the end of each set	Self-note making

• How to optimally make use of workbook

In order to gain maximum out of it, a student must first attempt each of the set by himself and then compare his answers with model hint given. This exercise will help them to gain confidence in answer writing, in enrichment of their answers and in better management of time.

The approach given at the beginning of each answer is also aimed to give him an idea about how to approach an answer. Before going into the answer, he must first build his own answer around the approach and then compare with the given answer.

Any extra point to be remembered, revised or any other extra additions can be made at the Blank Page given at the end of each set.

• About GS score Geography workbook

It consists of total 22 sets that are broadly divided as per UPSC syllabus. It is intended to guide you and serve as a reliable source of information, ideas, concepts and facts. This will help you to approach the subject with much more clarity and confidence. It is essential that you must aim to utilize the workbook optimally as per steps given above, to gain maximum out of it

APPROACH TO PREPARE GEOGRAPHY FOR UPSC

Geography is often considered a tough subject under UPSC civil services examination. Its vastness sometimes poses a challenge for students but number of questions asked every year both in prelims and mains makes it inevitable.

It is essential that a student must make a comprehensive strategy that focuses on concept clarity as well as on answer writing practice. Geography involves understanding of multiple phenomena and their applications. Along with this a candidate must keep in mind the kind of questions been asked in UPSC every year.

Preparation of Geography is based on following 3 pillars

- Study of past year papers
- Books and resources
- Strategizing

• Study of past year papers

Past year papers are the guiding light for preparation. They help in giving a direction to the course of your study and also enable you to gain maximum output. Every year 6-7 questions are asked in UPSC mains GS paper 1. Thus in order to get a good score a candidate must analyze the trends in questions and topics that are being asked.

Areas from where questions have been asked include-

- Desertification
- Interlinking of rivers
- Importance of mangroves
- Location of steel industries
- Industrial corridors
- Mantle plume etc.

Thus as we can see above that what is required is point to point coverage of syllabus. Areas that have been asked require a broad overview, thus a candidate must keep in mind the syllabus also at all times.

• Books and Resources

Before going to any advanced books, it is advisable to go through NCERTs that will help in concept clarity and you will be able to gain confidence on almost all areas of UPSC syllabus. It will help you write lucid answers. The following NCERT books must be referred to strengthen the basics:

- NCERT Class 7 – Our Environment
- NCERT Class 8 – Resources & Development.
- NCERT Class 9 – Contemporary India 1
- NCERT Class 10 - Contemporary India II
- NCERT Class 11 - Fundamentals of Physical Geography
- NCERT Class 11 - India – Physical Environment
- NCERT Class 12- Fundamentals of Human Geography
- NCERT Class 12th – India – People & Economy

Advance Books and Resources

- Selected study of Certificate Physical and Human Geography by GC Leong
- Oxford School atlas
- Orient Black swan school atlas
- GS score Geography material

Strategizing

The best strategy is the one that works for you. It is best to devise a plan and stick to it. Thus discipline is the most important part in your strategy. After going through basics, cover the areas that you feel require more clarity from other sources. As soon as you come across any new place look into the map and study it in detail, mountain, seas, plateaus, ocean surrounding it etc. Frequent revisions are the key, if you require best outcomes. Instead of reading multiple sources stick to few. Answer writing practice is the most important part of the strategy. Make sure to give enough mocks and solve previous year papers to gain confidence in answer writing and practice time management.

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SYLLABUS

MICRO DETAILING

SUB TOPIC LISTING
(Geography)

UPSC Syllabus

- Disaster and Disaster Management.
- Salient features of world's physical geography
- Geophysical phenomena such as earthquakes, Tsunami, Volcanic activity, cyclone etc.
- Geographical features and their location-changes in critical geographical features (including water-bodies and ice-caps) and in flora and fauna and the effects of such changes.

Physical geography: India and the World

1. Geomorphology

- Earth's Interior
- Sources of Information about the Interior (Direct Sources, Indirect Sources - Earth Quake Wave, Volcanoes)
- Structure of the Earth's Interior
- Mechanical and Chemical categorization of internal structure
- Geology and Rock System
  - Minerals
  - Major Elements of the Earth's Crust
    - Physical Characteristics
    - Classification -
  - Rocks (Aggregate of Minerals)
    - Classification
    - Igneous
    - Sedimentary
    - Metamorphic
  - Rocks & landforms
    - Rocks & Soils
- Geomorphic Processes
  - Endogenic Forces
    - Diastrophism
    - Orogenic
    - Epierogenic
    - Earthquakes
    - Plate movements
    - Volcanism
  - Exogenic Forces
    - Denudation Processes
    - Weathering & its Significance
    - Mass movements& their impact
    - Erosion Transportation & Deposition
- Distribution of Continents & Oceans
  - Theories
    - Continental Drift Theory
    - Convectional Current Theory
    - Mapping of the Ocean Floor
    - Sea Floor Spreading
    - Plate Tectonics
  - Isostasy
- Landforms and their evolution
  - Causesof landform development
    - Geomorphic Processes
    - Geomorphic Agents
  - Geomorphic Agents and Landforms
    - Running Water
    - Development of a river System
    - Erosional Landforms

        - Depositional Landforms
    - Ground Water (Karst Topography)
        - Erosional Landforms
        - Depositional landforms
    - Glaciers
        - Erosional Landforms
        - Depositional Landforms
    - Waves and Currents
    - Winds
        - Erosional Landforms
        - Depositional Landforms
- Landforms across the world
    - Rivers and lakes
    - Mountain and Peaks
    - Plateaus

2. Oceanography

- Hydrosphere
    - Water on the Surface of the Earth
    - Hydrological Cycle
- Submarine Relief Features
    - Relief of the Ocean floor
    - Divisions of the ocean floor
    - Minor relief features
- Temperature and Salinity
    - Temperature of the Ocean Water
        - Factors affecting Temperature distribution
        - Horizontal and Vertical Distribution
    - Salinity of the Ocean Water
        - Factors affecting salinity
        - Horizontals distribution of salinity
        - Vertical Distribution of salinity
    - Density of Ocean Waters
- Movements of Ocean Water
    - Factors influencing Movement
    - Waves
        - Motion of waves
        - Characteristics of wave
    - Tides
        - Types of Tides
        - Importance of Tides
        - Ocean Currents
    - Characteristics of Ocean Currents
    - Types of ocean currents:
    - Major Ocean currents of the World
    - Effects of Ocean Currents
- Marine Resources
    - Surface water resources
    - Ground water resources
    - Inland water resources
    - Oceanic Water Resources (Marine Resource)
    - Utilization of oceans by man
    - Water consumption patterns
    - Water Conservation and Management (Techniques)
- Ocean Deposits and Corals
    - Terrigenous Deposits
    - Volcanic Deposits
    - Biotic deposits
    - Abiotic Deposits
    - Coral Reefs
        - Probable origin of Coral Reef
        - Types and significance of Coral Reef
        - Issue of Coral Bleaching

3. Climatology

- Atmosphere
    - Composition of the Atmosphere
    - Structure of the Atmosphere
- Solar Radiation, Heat Balance and Temperature
    - Solar Radiation and Isolation
    - Heating and cooling of atmosphere
    - Terrestrial Radiation
    - Heat Budget of the Planet Earth

- Temperature
- Factors Controlling Temperature Distribution
- Distribution of Temperature

- Atmospheric Circulation and Weather Systems
  - Atmospheric Pressure
  - Vertical variation of pressure
  - Horizontal distribution of pressure
  - World Distribution of Sea Level Pressure
  - Factors affecting the velocity and direction of the Wind
  - General Circulation of the Atmosphere – Pattern of Planetary Winds
  - Latitudinal Variation of Atmospheric Heating
  - Emergence of Pressure Belts
  - Hadley Cell , Ferrel Cell, Polar Cell
  - Seasonal Wind
  - Local Wind
  - Land and Sea Breezes
  - Mountain and Valley Winds
  - Air Mass, Fronts, Cyclones and Jet Stream
    - Air mass & fronts
    - Cyclones
    - Thunderstorms
    - Tornadoes
- Water in the Atmosphere
  - Water Vapour
  - Humidity – Absolute and Relative
  - Saturation – Dew Point
  - Evaporation and Condensation
    - Dew
    - Frost
    - Fog & Mist
    - Clouds
  - Precipitation
    - Rainfall
    - Snowfall
    - Sleet Hail
    - Hailstones
    - Types of Rainfall
    - World Distribution of Rainfall
- Climatic Zones of the World
  - World Climate
    - The Hot, Wet Equatorial Climate
    - The Tropical Monsoon and Tropical Marine Climates
    - The Savanna or Sudan Climate
    - The Hot Desert and Mid-Latitude Desert Climates
    - The Warm Temperate Western
    - Margin (Mediterranean) Climate
    - The Temperate Continental (Steppe) Climate
    - The Warm Temperate Eastern Margin (China Type) Climate
    - The Cool Temperate Western Margin (British Type) Climate
    - The Cool Temperate Continental (Siberian) Climate
    - The Cool Temperate Eastern Margin (Lauren-tian) Climate
    - The Arctic or Polar Climate
  - Koeppen's Scheme of Classification of Climate
  - Climatic Zones of World

4. Bio-Geography

- Soil& Its Characteristics
  - Soil Characteristics
  - Factors Responsible for Soil Formation
  - Process of Soil Formation
  - Soil Profiles and Horizons
  - Classification of Soil
  - Soil Degradation, Erosion and Conservation

- Vegetation resources
  - Types of natural vegetation
  - Forests
    - Significance of forests
    - Factors of forest development
    - Classification of forests
    - forest cover
  - Grasslands
  - Desert vegetation
  - Tundra Vegetation
  - Deforestation
  - Conservation of forests
  - Reforestation
  - Afforestation
  - Forestry
    - Social forestry
    - Agro-forestry
    - Farm Forestry
    - Community Forestry

5. Important Geophysical Phenomenon

- Occurrence of Earthquakes
- Earthquake Waves
- Shadow Zone
- Types of Earthquake
- Measuring Earthquake
- Effects of Earthquake
- What Causes Tsunami
- Effect of Tsunami
- Mitigating the Impact of Tsunami
- Volcanoes
- Types of Volcanoes
- What Causes Volcanoes?
- Volcanic Landforms
- Cyclone
- Tropical Cyclones
- Anti-Cyclone
- Extra Tropical Cyclones

6. Critical geographical features & effect of Climate change

- Factors Causing Changes in Critical Geographical Features
- Changing Geographical Features
- Impact of Changing Geographical Features

7. Physical Geography of India

- Physiography of India
  - Location
  - Geopolitical Significance of India
  - Geological Divisions
    - The Peninsular Block
    - The Himalayas and other Peninsular Mountains
    - Indo-Ganga-Brahmaputra Plain
  - Physiographic Divisions
- Drainage System
  - Drainage Patterns
  - Drainage System of India
  - Himalayan Drainage System
    - River Systems of Himalayan Drainage
    - Indus river system
    - Ganga River System
    - Brahmaputra river system
  - Peninsular Drainage System
    - River Systems of Peninsular Drainage
    - Small Rivers Flowing Towards East and West
- Climate
  - Factors influencing the climate of India
  - Monsoon
  - Mechanism of the Monsoon
    - Classical Theory
    - Modern theory
    - Air mass theory
    - Jet stream theory

- ELNINO and LANINA & their impact
- The rhythm of Seasons
  - The cold weather season
  - The hot weather season
  - The southwest monsoon season
  - The retreating monsoon season
- Climatic Regions of India

- Soils in India
  - Classification of Soils
  - Soil textures
  - Issue of Soil degradation & Soil Erosion
  - Soil Conservation
- Natural Vegetation
  - Types of Forests in India
  - Forest Cover in India
  - Forest Conservation
  - Forest Problems in India
  - Factors of forest development
  - Causes and factors of deforestation:
  - Immediate causes of deforestation
    - Indirect deforestation
    - Conservation of forests
    - Forest conservation strategies
  - Reforestation
  - Monoculture plantation

Economic Geography

1. Natural resources

- Land Utilisation
- Land Use Pattern
- Land Degradation & Conservation
- Forest Resources
- Mangroves
- Grasslands, Forests
- Himalayan resources
- Causes of Depletion
- Conservation of Forests
- Land-use Pattern and changes
- **Problems of Land Resources:**
  - Land Degradation: Causes and Impact
  - Concept of Land Degradation Neutrality
  - Land Use Planning and Policy

2. Water Resources

- Extent of Water Resources
- Water Resource Potential of India
- Utilization and related problems (Pollution)
- Inter- state water disputes in India
- Water management, conservation and Development
- National Water Policy
- Marine & Freshwater
- Water Scarcity
- Water Conservation
- Integrated Water Resources Management
- Interlinking of Rivers
- River pollution
- Drainage basins

3. Agriculture

- Agriculture Basic Terminologies
  - Cropping pattern
  - Agriculture Productivity
  - Agriculture Intensity
  - Land capability
- Location of agriculture
- World Agriculture Typologies
- Salient features of Indian Agriculture
- Problems of Indian Agriculture
- Factor Affecting Agriculture
  - Geographical factors

- Institutional factors
- Technological factors

- Major Crops and conditions for growth
- Regionalization of Agriculture
- Various Revolutions in Agriculture Sector
- Green Revolution
  - Impact of Green Revolution
  - Evergreen Revolution
- White Revolution
- Operation Flood
- Blue Revolution
- **Food Security**
  - Nature of Food Insecurity: Duration, Severity and types
  - Trend and Pattern in Food Insecurity
  - Causes and Geography of famine
  - Key Dimension of food security
  - Efforts and Remedies to ensure food security

4. Mineral & Energy Resources

- Types of Mineral Resources
- Distribution Pattern of Minerals in World
- Major Mineral Belts of India
- Problems related to mining
- Conservation of Mineral Resources
- National Mineral Policy, 2019
- Classification of Energy Resources
- Distribution and production trend of major energy Resources
  - Coal
  - Petroleum
  - Natural gas
- Strategic Oil Reserves
- Exploration of Coal Bed Methane
- Non-Conventional Energy Resources
  - Solar Energy
  - Wind Energy
  - Geothermal
- Nuclear Energy Resources: Challenges and prospects in India
- Recent Debates on Resources
  - Geopolitics of Natural Resources
  - Globalisation and unsustainable exploitation of natural resources
  - Depletion of natural resources versus Economic Growth
  - Changing Pattern of Land Use and Causes
  - Water Crisis: Causes, Conflicts and Resolution
  - Energy Crisis
  - Challenges and constraints faced by coal sector
  - Challenges in Hydropower sector
  - Renewable Energy: way toward sustainability
  - Energy Security: Energy Policy and strategy in India

5. Location of Industries & Transport

- Classification of Industries
- Factors affecting location of Industries
  - Weber's Model of Industrial Location
  - Losch theory of Profit Maximization
- Various Industries: Location, Prospects and Challenges
  - Iron and Steel Industry
  - Textile Industry
  - Jute Industry
  - Auto Mobile Industry
  - Fertilizer Industry
  - Agro-based Industries
  - Other Industries
- Industrial Regions and its Characteristics
- Major Industrial Regions of the World

- Industrial Regions of India
- Industrial Policies and Development
  - A Scheme for Promotion of Innovation, Rural Industry and Entrepreneurship (ASPIRE)
  - Scheme of Fund for Regeneration of Traditional Industries (SFURTI)
  - Stand Up India
  - Fourth Industrial Revolution
  - Role of Industrial development in minimizing regional inequalities
  - Problems of Industrial regions
  - Factors behind the growth and present location pattern of automobile industry in India
  - Pharmaceutical industry: Locational pattern and reasons
  - Sugar industry: Problems and challenges of current pattern
  - Food Processing Industry: Untapped Potential
  - Agro based Industries: Problems and Prospects
  - Impact of agro-based industries on cropping pattern
  - Tourism: Prospects and Impact on Environment
- Definition, Development and scope of Economic Geography
- Type of Economic Activities
  - Primary Activities
  - Secondary Activities
  - Tertiary, Quaternary and Quinary Activities
- Land Transport
  - Roads
    - Classification of roads
    - National Highway Grid
    - Problems and Prospects
    - BharatmalaPariyojana
  - Railways
    - Significance and Problems of Indian Railways
    - Dedicated Freight Corridors
    - Privatisation of Railways
  - Pipelines
    - Significance, Distribution and Challenges
- WaterTransport
  - Inland: National Waterways
    - Factors affecting Inland waterways
    - Significance and Challenges
    - Jal Marg Vikas Project
  - Seaways and Oceanic Route
    - Shipping
    - Major Ports of World and India
    - Challenges in Port Development
    - Sagarmala Project
- Air Transport
  - National Airways
    - National Civil Aviation Policy
    - Regional Connectivity Scheme (UDAN)
    - International Airways
  - Communications
    - Communication Infrastructure
    - National telecom Policy
  - Major Issues in Transport and Communication
    - Role of Transport in Regional Development
    - Need for holistic transport planning to improve the city's mobility
    - Carbon footprint of the transport sector
    - Road Transport: Investment Challenges
    - Inland Waterways: Development challenges and propects
    - Ports: Inclusive centres of economic development
    - Problem of Pot Development
    - Analysis of Sagarmala Project

- Environmental issues of maritime shipping
- Role of Transport in Regional Development
- Eco Tourism: Way toward Responsible Tourism

Human Geography

1. Population & Migration

- Concept of human resources
- Factors affecting the distribution of Population
- Population growth
  - Theories of Population Growth
    - Malthusian Theory
    - Marxian Theory
    - Demographic transition theory
    - Optimum Population Theory
  - Size, growth rate and distribution of population
  - Components of Population growth
- Demographic Dividend
  - Demographic Window of Opportunity
- Components of Population change
  - Birth Rate
  - Death Rate(Mortality Rate)
  - Migration
    - Factors responsible for migration
    - Type of Migration
    - Issues related to migration
    - Migration pattern in world and India
    - World Migration Report, 2018
- Population Composition
  - Age Sex Pyramids & their significance
  - Trends and Pattern in Sex Ratio
  - Initiatives to improve Sex ratio
  - Trends and Patterns in Literacy
  - Government's Efforts
- Fertility Rate
- Impact of Population Change
- Population Policies
  - Need for revision of National Population Policy
- Population problems
  - Global Nutrition Report, 2018
  - Global Hunger Index
- Rural Settlements
  - Classification of Rural Settlements
  - Function of Rural Settlements
  - Patterns of Rural Settlements
  - Changing Pattern of Rural Settlements
- Urban Settlements
  - Origin of Urban Settlements- Functional Classification of Towns
  - Urbanization
    - Indian Mega Cities
    - Central Place Theory
    - Primate City
    - Morphology of Indian Cities
    - Conurbations
    - Urban Slums
    - Rural Urban Fringe
    - Rural Urban Continuum
  - Issues related to Urbanization in India
    - Habitat – III Conference
- Concept of Region
- Types of Regions
- Issues of Regional Imbalances
- Strategies for Regional Development
- Growth v/s Development
- Approaches to Human Development
- Human Development Index

PRACTICE QUESTIONS

SET: 1 - 22

PHYSICAL GEOGRAPHY OF INDIA AND WORLD

SET-1: QUESTIONS

GEOMORPHOLOGY

Q1. **Describe the sources which provide the information about the Earth's interior. Why seismology is the only method which gives complete authenticated information about the earth's interior.**

Q2. **Evaluate the theory of Continental Drift as given by Wagner. How does the Plate Tectonic Theory seek to remove the shortcomings of the Continental Drift Theory?**

Q3. **Though oceanic floors are considered to be the most fundamental rocks in origin, no one of them are beyond the age of Mesozoic times. Explain it in the light of sea floor spreading theory. How is it different from continental drift theory?**

Q4. **Discuss briefly the theory of Isostasy? What is its role in the geo-morphological context?**

Q5. **The interior of the earth can be understood only by indirect evidences as neither anyone has nor anyone can reach the interior of the earth. Elaborate.**

Q6. **Discuss the economic and strategic significance of Indian islands.**

Q7. **Discuss the various reasons behind the formation of "Fire Girdle of Pacific" and major landforms along it.**

Q8. **Discuss the Orogenesis of Himalayan Mountain ranges on the basis of plate tectonics. Elaborate with geographical evidences supporting collision of different types and nature of tectonic plates during process of orogeny.**

Q9. **Different physiographic divisions of India are complementary to each other and lead to socio-economic development of the nation. Explain.**

Q10. **Discuss the formation of intermontane plateaus and tectonic plateaus citing examples.**

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SET-1: ANSWERS

1. Describe the sources which provide the information about the Earth's interior. Why seismology is the only method which gives complete authenticated information about the earth's interior.

(250 words)

Approach

1. **Briefly describe the sources which provide the information about the Earth's interior** ***(100 words)***
2. **Define the theories of the interior of the Earth.** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Understanding of the earth's interior is essential to understand the nature of changes that take place over and below the earth's surface.

The sources which provide knowledge about the interior of the earth may be classified into 3 groups,

- Artificial Sources
- Theories of the interior of the Earth
- Natural Sources
- Artificial Sources:

Density:

- The average density of the crust is around 2.9 to 3.3 g/cm3
- While the average density of the Earth is 5.5
- Thus, the core of the earth will be, without doubt, more than 5.5.
- Later, the density of the earth core was found out to be 11

Pressure:

- Now the question is what is the reason for very high density of the core?

- Previously it was believed that, as pressure increases, density also increases due to super incumbent force.
- But there is critical limit beyond which pressure increase does not increase density.
- Thus, core must be composed of intrinsically heavy metallic materials of high density (i.e. iron and nickel)

Temperature:

- Temperature of the upper part of the magma slab representing upper portion of oceanic crust has been estimated to be 0°C, while temperature at around 70km was found out to be 1200°C.
- With this rate of increase of temperature, core should be approx. 25000°C. But it would have melted the whole earth.
- Thus, it is evident that most part of the radioactive materials which releases heat in large amount and thus causes rock melting, are concentrated in the crust.
- While rate of increase of temperature downwards decreases with increasing depth.

Theories of the interior of the Earth:

- **Edward Suess theory:** According to him the earth is made up of three zones of different matter below the outer thin sedimentary cover viz. SIAL, SIMA and NIFE.

Natural Sources:

- **Volcanism:** The lava coming from inside the earth shows that the same material has to be there inside the earth.
- However, all these methods were just speculations or partially proved concepts. The real concrete proof about the interior of the earth was provided by the Seismic studies.
- The behaviour of seismic waves in different layers of the earth provides the most authentic evidence about the composition & structure of the earth. The different types of waves generated during the occurrence of earthquake, are generally divided into 3 broad categories; (a) Primary waves, (b) Secondary waves, (c) surface waves.
- **Seismic Waves**- both P-waves & S-waves travel faster through rigid material than through soft or plastic material. The velocities of these waves travelling through specific part of earth give an indication of type of rocks there. Abrupt changes in seismic wave velocities indicate significant changes in earth's interior.
- Seismic waves passing through the earth are refracted in ways that show distinct discontinuities within earth's interior & provide basis for the belief that earth has
- A solid inner core, (2) a liquid outer core, (3) a soft asthenosphere, (4) a rigid lithosphere.

2. Evaluate the theory of Continental Drift as given by Wagner. How does the Plate Tectonic Theory seek to remove the shortcomings of the Continental Drift Theory?

(200 words)

Approach

1. **Give a detailed description of Continental Drift Theory** ***(50 words)***
2. **What provided base for the development of Plate tectonic theory** ***(60 words)***
3. **Differentiate the Plate Tectonic Theory with the Continental Drift Theory** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

- Continental drift is the movement of the Earth's continents relative to each other, thus appearing to "drift" across the ocean bed. The speculation that continents might have 'drifted' was first put forward by Abraham Ortelius in 1596. The concept was independently and more fully developed by Alfred Wegener in 1912, but his theory was rejected by some for lack of a mechanism (though this was supplied later by Arthur Holmes) and others because of prior theoretical commitments. The idea of continental drift has been subsumed by the theory of plate tectonics, which explains how the continents move.
- Alfred Wegener a German meteorologist who put forth a comprehensive argument in the form of "the continental drift" in 1912.
- According to Wegener, all the continents formed a single continental mass and Mega Ocean surrounded the same. The super continent was named Pangaea, which meant all earth and Mega Ocean surrounded it named Panthalassa, meaning all water. He argued that, around 200 million years ago, the super continent, Pangaea first broke into two large continental masses as Laurasia and Gondwanaland forming the northern and southern component respectively. Subsequently, Laurasia and Gondwanaland continued to break into various smaller continents that exist today.
- When Wegener proposed continental drift, many geologists were contractionists. They thought Earth's incredible mountains were created because our planet was cooling and shrinking since its formation. But Wegener's continental drift theory was great step ahead of contractionist theory. It provided base for development of Plate tectonic theory.

However, the theory has many flaws:-

- He failed to explain the forces that lead to the drift of huge continental masses. As per the theory force of buoyancy, differential gravitational force along with tidal force of sun and moon are the real cause, which are not sufficient enough to drift huge land masses.
- nitially the theory considers that there is no resistance offered by the denser SIMA layer but later Wegener adopts the force full resistance offered by SIMA to explain the origin of mountains.
- The theory did not talk about the direction of the drift and chronological sequence of this displacement.
- At that time people hardly have any understanding about ocean bed topography.
- Also Wegener provided those evidences which supports theory and neglected those which did not support.
- Wegener did not explain about how Pangaea got formed .He don't talk about pre Pangaea condition of earth.

Plate tectonics is the widely accepted theory that Earth's crust is fractured into rigid, moving plates. In the 1950s and 1960s, scientists discovered the plate edges through magnetic surveys of the ocean floor and through the seismic listening networks built to monitor nuclear testing. Alternating patterns of magnetic anomalies on the ocean floor indicated seafloor spreading, where new plate material is born. Magnetic minerals aligned in ancient rocks on continents also showed that the continents have shifted relative to one another.

Though Wegner was a pioneer in bringing the concept of continental drift to limelight but the limitations in his theory ignited minds to improve the concept and explain the process**. This gives rise to Plate Tectonic Theory.**

- Plate tectonics revolve around the concept of continental drift and sea floor spreading. The theory describes constructive plate margins or divergent plates leading to upwelling of lava from mantle that are responsible for forming new oceanic ridges.
- It explains the destructive plate margins when two plates collide along a margin, leading to one plate overriding the other. The overridden plate is sub ducted into the mantle thereby losing a part of the crust.
- Strahler & Stahler who are behind this new theory considered the constant thermal convection currents from the inner part of earth as the forces responsible for this movement along with geo magnetic field of the earth.
- To overcome the limitations of continental drift and to explain the cause of the drift incorporating seafloor spreading moulded into plate tectonic theory in 1968. According to which, it was assumed that the Earth was divided into lithosphere and asthenosphere at about 7000km. As asthenosphere is said to be made of viscous flowing material which can bear non hydrostatic force only for 1000-10000years or longer and convection currents can occur here. While lithosphere comprising of Earth's crust and upper mantle having variable thickness of 200km, can bear non hydrostatic force for a 100 million years or so. The lithosphere is further divided into a number of large and small plates, which are in constant relative motion due to convection currents in the asthenosphere. It is this movement of tectonic plates which leads to the continental drift. This caused Pangaea to break up which is still continuing, that proves the Wegener's hypothesis. Due to this tectonic framework, the continents have been coming together and then fragmenting and drifting apart for billions of years.
- The plate tectonic was based on the evidence of seafloor spreading and palaeomagnetism. Both concepts were backed by strong scientific evidence. The theory assumed that continents are part of "plates", mass of lithosphere, which floats over asthenosphere, evidence for the same has been found. The theory suggests plate movement based thermal convective current movement in mantle.
- Plate tectonic based on strong scientific evidence conclusively explained the breaking up Pangaea and drifting of continent as on present day. It also explains the expansion of oceans floor and orogeny. Thus the theory explains all events along with strong scientific evidence. And hence PT is a large improvement over CDT.

3. Though oceanic floors are considered to be the most fundamental rocks in origin, no one of them are beyond the age of Mesozoic times. Explain it in the light of sea floor spreading theory. How is it different from continental drift theory?

(250 words)

Approach

1. **Discuss the theory of sea floor spreading.** ***(50 words)***
2. **"Though oceanic floors are considered to be the most fundamental rocks in origin, no one of them are beyond the age of Mesozoic times" Give reasons behind this anomaly** ***(100 words)***
3. **Discuss the difference between sea floor spreading and continental drift theory are as follows** ***(100 words)***

Hints

Seafloor spreading is a geologic process in which tectonic plates—large slabs of Earth's lithosphere—split apart from each other.

The theory of sea floor spreading was propounded by Harry Hess. During Glomar expedition of the Atlantic Ocean he observed that oceanic rocks are the first to form over the earth surface but still no one of them are beyond Mesozoic times. There were several reasons behind this anomaly as follows

- There is a continuous release of magma along the mid oceanic ridge due to divergence and thus the oceanic floor is continuously getting formed.
- Also, there if there would have been only divergent boundaries then earth size by now would have increased enormously which is not true.
- Thus, he said that there must be some convergent boundary which exists between continental margins which sub ducts the oceanic slab and recycle them.
- It may be concluded that due to subduction of the plates along the plate boundaries, the old plates are continuously consumed.

The difference between sea floor spreading and continental drift theory are as follows:

- CDT explains movement of continental plates only while SFS theory explains movement of oceanic plates only.
- Forces responsible for the movement of the continents according to CDT are buoyancy force, gravity, tidal currents while according to SFS the oceanic plates move due to convection currents.
- CDT theory is too general with vague conclusions while SFS theory is partial in its explanation.

4. Discuss briefly the theory of Isostasy? What is its role in the geo-morphological context?

(200 words)

Approach

1. **Discuss briefly the theory of Isostacy** ***(100 words)***
2. **Discuss is its role in the geo-morphological context** ***(100 words)***

Hints

Isostasy is the state of gravitational equilibrium between Earth's crust and mantle such that the crust "floats" at an elevation that depends on its thickness and density. The term 'isostasy' was coined in the year 1889 by the American geologist Clarence Dutton.

This concept is invoked to explain how different topographic heights can exist at Earth's surface. When a certain area of Earth's crust reaches the state of isostasy, it is said to be in isostatic equilibrium. Isostasy does not upset equilibrium but instead restores it (a negative feedback). It is generally accepted that Earth is a dynamic system that responds to loads in many different ways. However, isostasy provides an important 'view' of the processes that are happening in areas that are experiencing vertical movement.

For instance, certain areas (such as the Himalayas which are in its young stage) are not in isostatic equilibrium, which has forced researchers to identify other reasons to explain their topographic heights.

Isostasy controls the regional elevations of continents and sea floors in accordance with the densities of their underlying rocks. This means that an excess of mass seen as material above sea level, as in a mountain system, is due to a deficit of mass, or low-density roots, below sea level. Consequently, high mountains have low-density roots that extend deep into the underlying mantle.

The concept of isostasy played an important role in the development of the hypothesis of plate tectonics.

In the simplest example, isostasy is the principle of buoyancy wherein an object immersed in a fluid is buoyed with a force equal to the weight of the displaced fluid. On a geological scale, isostasy can be observed where Earth's strong crust or lithosphere exerts stress on the weaker mantle or asthenosphere, which, over geological time, flows laterally such that the load is accommodated by height adjustments.

Isostatic effects of deposition and erosion:

- When large amounts of sediment are deposited on a particular region, the immense weight of the new sediment may cause the crust below to sink. A likely, when large amounts of material are eroded away from a region, the land may rise to compensate.
- An analogy may be made with an iceberg - it always floats with a certain proportion of its mass below the surface of the water. If more ice is added to the top of the iceberg, the iceberg will sink lower in the water.
- If a layer of ice is somehow sliced off the top of the iceberg, the remaining iceberg will rise. A likely, the Earth's lithosphere "floats" in the asthenosphere.

Isostatic effects of plate tectonics:

- When continents collide, the continental crust may thicken at their edges in the collision. If this happens, much of the thickened crust may move downwards rather than up as with the iceberg analogy. The idea of continental collisions building mountains "up" is consequently rather a simplification. Instead, the crust thickens and the upper part of the thickened crust may become a mountain range. However, some continental collisions are far more complex than this, and the region may not be in isostatic equilibrium, so this subject has to be treated with caution.

Post-glacial rebound effect:

- Post-glacial rebound (sometimes called continental rebound, glacial isostasy, and glacial isostatic adjustment) is the rise of land masses that were depressed by the huge weight of ice sheets during the last glacial phase, through a process known as isostasy. It affects northern Europe (especially Scotland, Estonia, and northern Denmark), Siberia, Canada, the Great Lakes of Canada and the United States, the coastal region of the US state of Maine, parts of Patagonia, and Antarctica.
- Post-glacial rebound produces measurable effects on vertical crustal motion, global sea levels, horizontal crustal motion, gravity field, Earth's rotational motion and a state of stress and earthquakes.

5. The interior of the earth can be understood only by indirect evidences as neither anyone has nor anyone can reach the interior of the earth. Elaborate.

(150 words)

Approach

1. **Explain why approaching earth's interior is not possible yet** ***(30 words)***
2. **Elaborate on direct and indirect sources** ***(100 words)***
3. **Conclusion** ***(20 words)***

Hints

The radius of the earth is 6,370 km, which makes it impossible to reach the center of the earth. Its changing interior composition and rapid increase in temperature towards its core, further limit direct observation of the earth's interior. Thus, most of the knowledge about the interior of the earth is largely based on estimates and inferences.

Three centuries ago, Newton calculated average density of earth surface. Our knowledge of what's inside the Earth has improved immensely since Newton's time. Our current information comes from many direct and indirect sources.

Direct sources:

- **Solid earth material:**
  - Obtained through mining and volcanic eruptions.
  - Besides above, scientists have taken up a number of projects to penetrate deeper depths to explore the conditions in the crustal portions. Examples- Deep Ocean Drilling Project and Integrated Ocean Drilling Project.

Indirect Sources:

- **Laboratory analysis:** Laboratory experiments on surface minerals and rocks at high pressure and temperature provide many insights into earth's interior.

- Data on the Earth's interior also come from geological observation of surface rocks and studies of the Earth's motions in the Solar System, and the flow of heat from inside the Earth.
- Through mining activities, it is known that temperature and pressure increase from the surface towards the interior of the earth.

- **Meteors:** The material and structure observed in the meteors are similar to that of the earth. They are solid bodies developed out of materials similar to our planet. Hence, when some of meteors reach earth, they become yet another source of information about the interior of the earth.
- **Gravitation force:** It is not the same at different latitudes on the surface. It is greater near the poles and less at the equator. Gravity anomalies give us information about the distribution of mass of the material in the crust of the earth.
- **Magnetic surveys:** They provide information about the distribution of magnetic materials in the crustal portion, and thus, provide information about the distribution of materials in this part.
- **Seismic activity:** It is one of the most important sources of information about the interior of the earth. For it, paths and characteristics of earthquake waves travelling through the Earth are studied.

6. Discuss the economic and strategic significance of Indian islands.

(200 words)

Approach

1. **Briefly introduce Indian islands** ***(40 words)***
2. **Discuss the economic significance of these islands** ***(60 words)***
3. **Discuss the strategic significance of these islands** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

There are two small groups of islands. One of these situated in the Bay of Bengal, off the coast of Myanmar is known as the Andaman and Nicobar Islands. The other is known as Lakshadweep and situated in Arabian Sea, off the coast of Kerala.

- **The economic significance of these islands is:**
  - The Exclusive Economic Zone (EEZ) around the islands encompasses around 0.6 million sq. km which is 30 percent of the EEZ of India. This provides a great opportunity for fisheries are exploitation of other marine resources.
  - Aquaculture is promoted in case of mud crab and lobster fattening, freshwater shrimp farming, and freshwater fish farming.
  - Tourism is one of the major developmental activities in these islands. The Andaman tropical evergreen rainforests, the beautiful silver sandy beaches, the serpentine mangrove-lines creeks, marine life abounding in rare species of plants, animals, corals, etc., provide a memorable experience to the tourists.

- Fishing and pisiculture is a big earning method for the Indian Territory of Andaman and Nicobar Islands and Lakshadweep.

- **The strategic significance of these islands is:**
  - The Andaman and Nicobar Islands straddle the busiest trade routes in the world and the onus of keeping them safe and sanitised, is one of the chief responsibilities of the Indian Navy.
  - Their southernmost point is just 150 km from Indonesia's Sumatra and their northernmost fewer than 50 km from the Coco islands controlled by Burma. In effect, they give India a foothold in south-east Asia.
  - The location suits India's grand ambition of becoming a regional naval power capable of extended operations beyond the range of shore-based support.
  - The Andaman's' natural harbours and coral reefs offer perfect locations for ships and submarines.
  - Further in case of Lakshadweep, proximity to the Indian western coast as well as to other island nations such as Sri Lanka and Maldives, nearness to busy shipping lanes, wide geographical spread, and a predominantly Muslim population all make the archipelago attractive to non-state actors. The fact that these islands could be used as safe havens or platforms for launching attacks by non-state actors cannot be denied. Hence security of islands is very important.

7. Discuss the various reasons behind the formation of "Fire Girdle of Pacific" and major landforms along it.

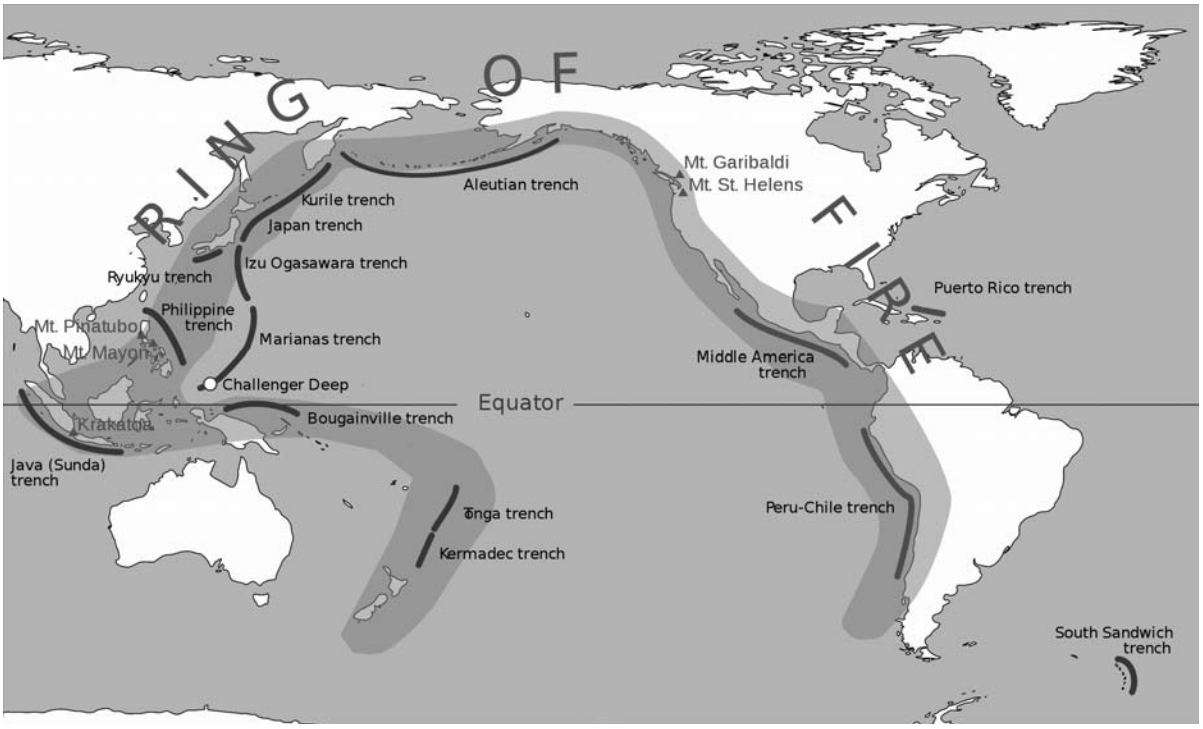
(250 words)

Approach

1. **Briefly discuss about 'Ring of Fire' and its location, size and extent.** ***(50 words)***
2. **Discuss the formation of pacific ring of fire according to plate tectonics and landforms associated with it.** ***(150 words)***
3. **Conclude with signifying importance of the region from geography point of view.** ***(50 words)***

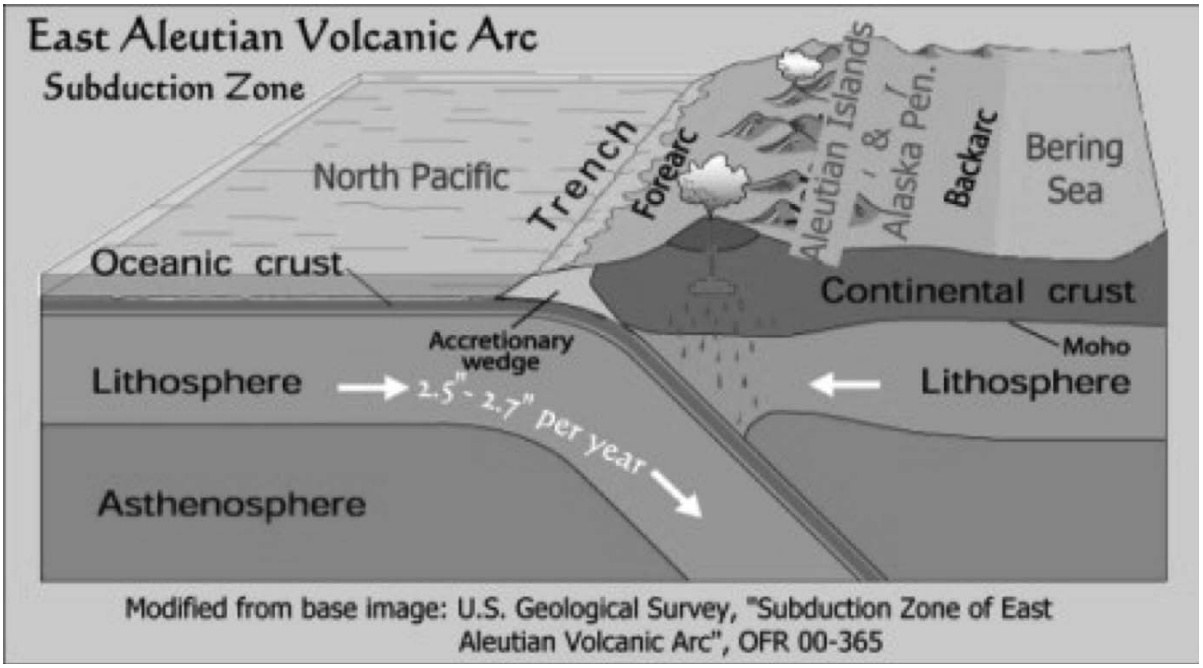
Hints

The Ring of Fire is a Pacific region home to over 452 volcanoes, including three of the world's four most active volcanoes i.e. Mount St. Helens in the USA, Mount Fuji in Japan and Mount Pinatubo in the Philippines. It has an extension of 40,000 km and appears as horse-shoe shaped rather than a ring. It is also sometimes called the circum-Pacific belt. Pacific ring of fire or the " Fire Girdle of Pacific" is an example of subduction zone volcanism which occurs where two plates are converging on one another. One plate containing oceanic lithosphere descends beneath the adjacent plate, thus consuming the oceanic lithosphere into the earth's mantle.



Formation of pacific ring of fire according to plate tectonics

- The Ring of Fire is a ring of volcanoes around the Pacific Ocean that has been formed as a result of subduction of oceanic tectonic plates beneath lighter continental plates at subduction zone.

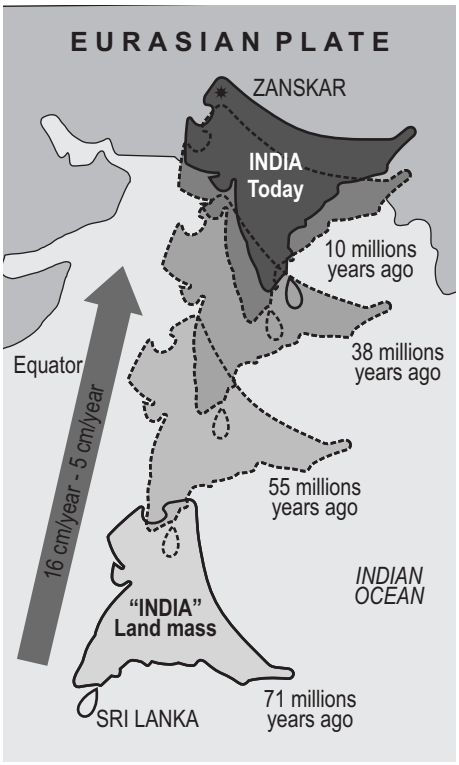


- The Ring of Fire is a direct result of plate tectonics: the movement and collisions of lithosphere plates, especially subduction in the northern portion.

- Pacific plate is moving at the rate of 6cm/year against other plates specially three major plates such as North American, Indo-Australian plate and Eurassian plate and other minor plates such as the Juan de Fuca, Cocos, Nazca, and Philippine Plates.
- Subduction zones of these plates (shown in fig) causes volcanism when oceanic crust of heavier plate goes inside the continental crust of others. These plates are destroyed under massive heat and pressure and remerge in form of volcanoes and causing earthquake.
- Series of volcanoes in form of horse-shoe shape is referred as Pacific ring of fire.

Landforms associated with Pacific ring of fire

- Due to convergence of oceanic-oceanic crusts, Island arcs and festoons are also formed along the ring of fire apart from young fold mountains such as the Andes and Rockies which are formed due to seduction of oceanic crust of a plate under continental crust of another plate. Examples of festoons are, the Aleutian Islands of Alaska, Kurlie Island and Japanese Archipelago.
- Faults such as the San Andreas Fault are also found among other features. It stretches along the central west coast of North America and is one of the most active faults on the Ring of Fire. It lies on the transform boundary between the North American Plate, which is moving south, and the Pacific Plate, which is moving north.
- The Ring of Fire is also home to hot spots, areas deep within the Earth's mantle from which heat rises. This heat facilitates the melting of rock in the brittle, upper portion of the mantle.



Conclusion:

About 90% of the world's earthquake and 82% of the world's massive earthquakes apart from major dormant and active volcanoes are concentrated in this region. World's highest active volcanic Ojos Del Salado which is located in Chile is also found in this region. Apart from it, major volcanic landforms including festoons, island arcs, Fold Mountains and faults are found in this region. The Pacific Plate, which drives much of the tectonic activity in the Ring of Fire, is cooling off which may lead to stability of the region. Due to location and extent, this region is important for research and study.

8. Discuss the Orogenesis of Himalayan Mountain ranges on the basis of plate tectonics. Elaborate with geographical evidences supporting collision of different types and nature of tectonic plates during process of orogeny.

(250 words)

Approach

1. Briefly introduce with plate tectonics theory ***(50 words)***

2. **Formation of Himalayas by the process of plate tectonics** ***(90 words)***
3. **Evidences that support the formation of Himalayas as explained by plate tectonics** ***(70 words)***
4. **Conclusion** ***(40 words)***

Hints

Plate tectonics has emerged as the most acceptable theory in modern time regarding formation of continents and oceans, Orogenesis, epeirogenesis and different other landforms. Himalayan mountains are young fold mountains and said to be still in the process of formation has been well defined by the theory of plate tectonics.

Formation of Himalayas by the process of plate tectonics

- 100 million years ago, Indian plate collided with the Eurasian plate. Before collision there was a swampy sea between the two plates called the Tethys Sea.

First stage: Collision Oceanic-Oceanic crusts and formation of festoons or Island arcs

- The oceanic crust of the Indian plate collided with the oceanic crust of the Eurassian plate and later being heavier subducted. This resulted in formation of island arc of explosive volcanic which developed in the Tethys Sea. Later they formed part of Ladakh and Tibet.

Second stage: Collision Oceanic-Continent crusts and formation of young fold mountains on margin of contienents

- Indian plate continued its march towards Eurasian plate which led to subduction of its oceanic crust into the Eurasian continental crust. This led to formation of young fold mountain on the margin of the Eurasian land mass in the form of Karakoram Range.

Third Stage: Collision of continent-continent crusts and formation of Himalayas

- Continent-Continent crusts of the Eurasians and Indian plate collided which resulted in folding of sediments of Tethy's sea. Due to folding activity, young fold mountain, the Himalayas started to rise up. There are various evidences which support this theory.

Evidences that support the formation of Himalayas as explained by plate tectonics

- Evidences of Island arcs in Drass sector of Himalayas.
- Evidences support that Karakorum ranges are of volcanic origin.
- Karewas in Kashmir valley prove that the valley was essentially a lake in the Pleistocene Epoch.

- Discovery of a hippopotamus' skull at 14,000 ft at Ladakh indicating that till recently the Himalayan region was a warm, low-lying swampy region.
- Evidence of stone-age man in the higher reaches, showing that the mountains' rapid rise was more recent than earlier believed and was even witnessed by primitive man.
- Proof that swarms of earthquakes and periods of quietude occur just before a giant earthquake strikes the region making prediction fairly accurate that Himalayas is still rising.

Conclusion:

Various evidences which support the theory of Orogenesis of Himalayan mountain ranges are in line with the process which was illustrated by the theory of plate tectonics. Predictions by the geologists about the Great Himalayan Earthquake and unconsolidated materials which leads to landslides in the Shiwalik region of Himalayas prove that the region is still tectonically active due to movement of the Indian plate towards the Eurasians plates and authenticate the plate tectonics as the most suitable theory to explain it.

9. Different physiographic divisions of India are complementary to each other and lead to socio-economic development of the nation. Explain.

(250 words)

Approach

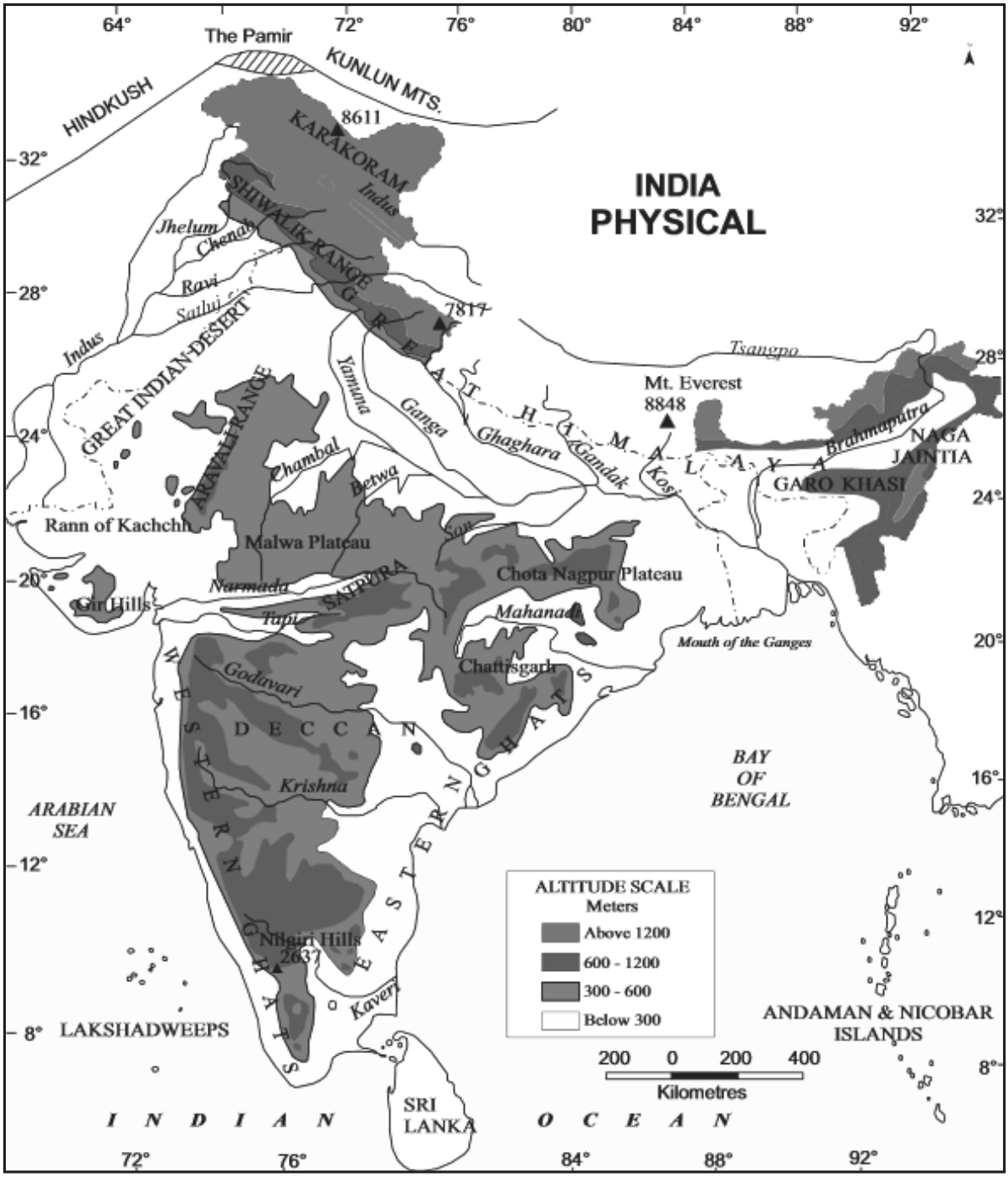
1. **Give a brief account of physiographic divisions of India** ***(40 words)***
2. **With the help of map, describe these divisions** ***(80 words)***
3. **Discuss how different physiographic divisions of India are complementary to each other and leads to socio-economic development** ***(90 words)***
4. **Conclusion** ***(40 words)***

Hints

The land of India displays great physical variation. The mainland extends to about 3214 km from north to south between the extreme latitudes. It also extends to about 2933 km from east to west between the extreme longitudes. It covers an area of 32,872,631 sq. km. Indian subcontinent is characterized by great and diversified physiographic conditions.

The physical features of India can be grouped under the following physiographic divisions:

- **The Himalayan Mountains:** The Himalayas, geologically young and structurally fold mountains stretch over the northern borders of India. These mountain ranges run in a west-east direction from the Indus to the Brahmaputra. The Himalayas represent the loftiest and one of the most rugged mountain barriers of the world. They form an arc, which covers a distance of about 2,400 Km. Their width varies from 400 Km. in Kashmir to 150 Km in Arunachal Pradesh.



- **The Northern Plains:** The northern plain has been formed by the interplay of the three major river systems, namely — the Indus, the Ganga and the Brahmaputra along with their tributaries. This plain is formed of alluvial soil. The deposition of alluvium in a vast basin lying at the foothills of the Himalaya over millions of years, formed this fertile plain. It spreads over an area of 7 lakh sq. km. The plain being about 2400 km long and 240 to 320 km broad, is a densely populated physiographic division.
- **The Peninsular Plateau:** The Peninsular plateau is a tableland composed of the old crystalline, igneous and metamorphic rocks. It was formed due to the breaking and drifting

of the Gondwana land and thus, making it a part of the oldest landmass. The plateau has broad and shallow valleys and rounded hills. This plateau consists of two broad divisions, namely, the Central Highlands and the Deccan Plateau.

- **The Indian Desert:** The Indian desert lies towards the western margins of the Aravali Hills. It is an undulating sandy plain covered with sand dunes. This region receives very low rainfall below 150 mm per year. It has arid climate with low vegetation cover.
- **The Coastal Plains:** The Peninsular plateau is flanked by stretch of narrow coastal strips, running along the Arabian Sea on the west and the Bay of Bengal on the east. The western coast, sandwiched between the Western Ghats and the Arabian Sea, is a narrow plain. It consists of three sections. The northern part of the coast is called the Konkan (Mumbai – Goa), the central stretch is called the Kannad Plain, while the southern stretch is referred to as the Malabar coast.
- **The Islands:** India has two main groups of Islands. There are 204 islands in Bay of Bengal called as Andaman and Nicobar islands and 43 islands in Arabian Sea called as Lakshadweep islands The Andaman & Nicobar island extend from north to south in Bay of Bengal

Complementarities and socio-economic utility of physiographic divisions of India

- It can be stated that physical features complement each other and make the country richer in its natural resources, thus helping the country develop.
- The northern mountains are the major sources of water and forest wealth. The northern plains are the granaries of the country. They provide the base for early civilizations.
- The plateau is a storehouse of minerals, which has played a crucial role in the industrialization of the country.
- The coastal region and island groups provide sites for fishing and port activities.
- The rivers originate in the high mountains and plateaus and drain the plains to make them inhabitable and agriculturally suitable.
- The plateaus provide the necessary minerals to assist the development of industries.
- Himalayas prevent the cold waves from north (Tibetan Pleateau), in absence of which; Gangetic-plains would have been absent. Similarly these would have destroyed the low-pressure system, which pulls the monsoon winds from the ocean.

Conclusion:

India has practically all major physical features of the earth, i.e., mountains, plains, deserts, plateaus and islands. The land of India displays great physical variation. Thus, the diverse physical features of the land have immense future possibilities of development.

10. Discuss the formation of intermontane plateaus and tectonic plateaus citing examples.

(250 words)

Approach

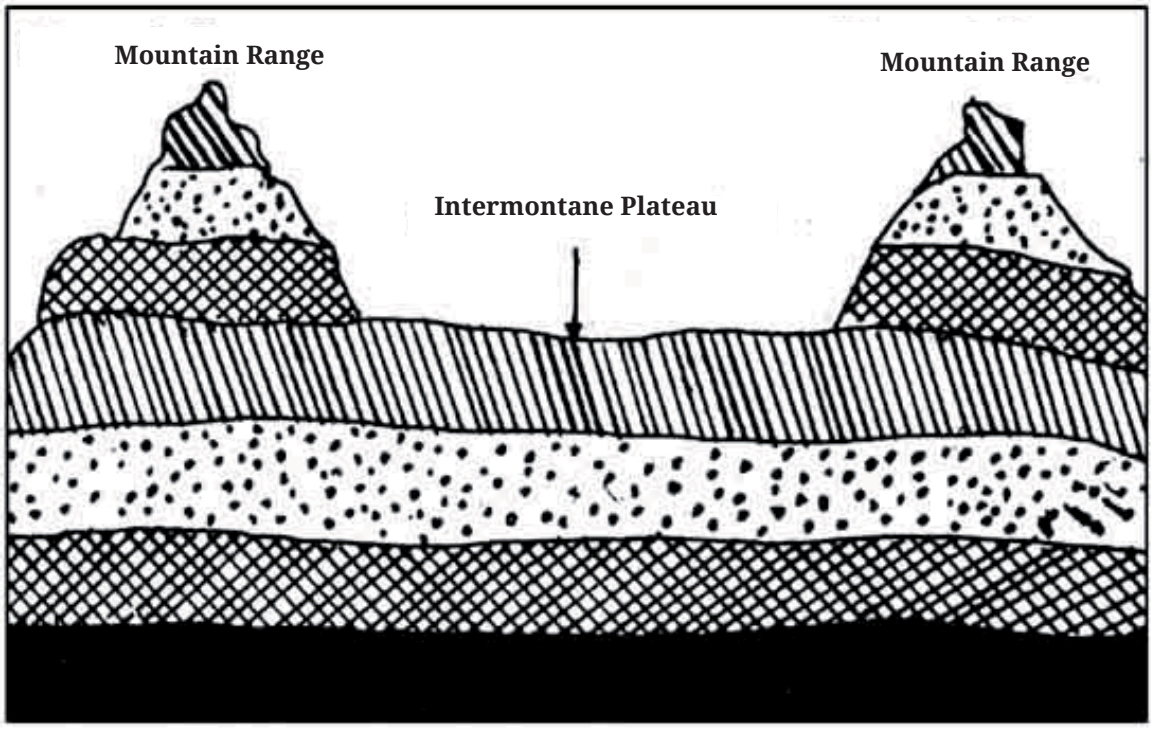
1. **Briefly discuss location and examples of intermontane and tectonic plateaus.** ***(30 words)***

2. **Discuss the formation of intermontane plateaus and tectonic plateaus with examples around the world.** ***(90 words)***

3. **Conclude with socio-economic importance of intermontane and tectonic plateaus.** ***(30 words)***

Hints

A plateau which is enclosed or surrounded by mountain ranges is known as an intermontane plateau. They borders the mountain ranges (generally fold mountains) or are partly or fully enclosed within them. The Plateau of Tibet and the Plateau of Mongolia are the two intermontane plateaus in Asia. The Plateau of Tibet is surrounded by the Kunlun Mountains in the north and the Himalayas in the south. The Plateau of Mongolia is enclosed between a number of mountains like the Sayan Mountains, Hentiyn Mountains and the Nan mountains. Similarly, Tectonic plateaus are formed from various processes that create mountain ranges such as by volcanism (Deccan Plateau), crustal shortening (thrusting of one block of crust over another, and folding occurs.



Formation of intermontane plateaus

- Many plateaus are located in or near mountain ranges, where tectonic uplift raised broad areas of flat land as a single unit. As a group, they are called intermontane plateaus. The largest plateaus on Earth formed where two tectonic plates collided.
- They are formed by folding and uplifting of flat land between the two mountains.
- Because they are lifted far above sea level, they are known as high altitude plateaus. The largest and highest is the Tibetan Plateau in South-Central Asia, which is a flat valley floor at about 15,000 feet above sea level, rimmed on the south by the Himalayas.

- The Altiplano, which literally means 'high plain,' is located in the Andes in western South America. It is the second largest high altitude plateau in the world, and it lies at an elevation above 12,000 feet.

Formation of Tectonic plateaus

- Tectonic plateaus are formed from various processes that create mountain ranges such as volcanism, crustal shortening i.e thrusting of one block of crust over another, folding and thermal expansion.
- It is formed by numerous small volcanic eruptions that slowly build up over time, forming a plateau from the resulting lava flows.
- Magma that escapes from the Earth's crust through fissures or narrow cracks reaches the surface and spreads over a large area, and later solidifies to form a plateau. These types of plateaus are typically made up of layers of lava sheets. There are two types of volcanic plateaus: lava plateaus and pyroclastic plateaus.
- Lava plateaus are formed as a result of highly fluid basaltic lava that flows through vents after numerous eruptions and are formed when volcanic eruptions are quiet eruption and lava flow is of low viscosity. Columbian snake plateau in United States is fine example of such plateau.
- Pyroclastic plateaus which are also known as ignimbrite plateaus, are formed due to large pyroclastic flowsand are essentially layers of pyroclastic, such as volcanic ash, tephra, and agglomerate that have been cemented into felsic, mafic, or tuffs. North Island Volcanic Plateau in New Zealand is fine example of this plateau.

Conclusion:

Intermontane plateaus are highest plateaus in the world. These plateaus provide habitats at high altitude and are center of transhumance i.e seasonal migration of people in search of food and pastures, due to their rich pastoral grounds. Tibetan people for example practices transhumance for their livelihood. Similarly, tectonic plateaus are rich in black soil and other minerals which make them productive regions of the world. These regions produce crops such as cotton and sugarcane. Hence, location and formation of plateaus significantly help a region to prosper in a better way.

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NOTES

SET-2: QUESTIONS

OCEANOGRAPHY

Q1. What do you mean by emergent & submergent coast? Identify the emergent and submerging coast of India and discuss their significance.

Q2. The discovery of the mid-oceanic ridges opened doors to not only plate motion but the age of the ocean floor and other geological phenomenon. Elaborate

Q3. Explain how ocean currents help in establishing global heat balance. Also explain the relationship between ocean currents and habitability of the coastal areas.

Q4. What are the factors responsible for generation of Oceanic currents? How these current affects the regional climate?

Q5. Discuss the importance of oceans and also mention some of the anthropogenic activities and human activities that had severely affected the marine life of the oceans.

Q6. Oceans are suffocating as dead zones have been quadrupled in size since 1950s. In this context, discuss the causes and effects of Ocean Dead Zones on marine ecosystem.

Q7. The oceans influence the weather from local to global scales; while changes in climate can fundamentally alter many properties of the oceans. Elaborate.

Q8. Major ocean currents are greatly influenced by the stresses exerted by the prevailing winds and Coriolis force. Discuss the forces which influence the major currents of oceans. Explain with examples why oceanic circulation pattern roughly corresponds to the earth's atmospheric circulation pattern.

Q9. Explain the movement of thermohaline circulation. Also, discuss direct and indirect influences of ocean currents on human activities.

Q10. Discuss major relief features of the ocean floor. Also, explain in brief the roles of ocean relief.

****

SET-2: ANSWERS

1. What do you mean by emergent & submergent coast? Identify the emergent and submerging coast of India and discuss their significance.

(200 words)

Approach

1. **What do you mean by emergent & submergent coast?** ***(50 words)***
2. **Identify the emergent and submergent coast of India.** ***(60 words)***
3. **Discuss their significance.** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

- The Emergent coasts are the result of local tectonic uplift or fall in the global elevation of sea level. They have rocky coastlines with cliffs and nearly flat platforms that extend inland, which were coastal plains earlier.
- Whereas submergent Coasts are those that have been flooded by ocean waters because of a relative rise in the elevation of sea level at that location. A characteristic of the submergent coast is river valleys or glacially-carved valleys that have been flooded by ocean water.
- In case of India, the west coast is an example of submergent coast. The western coastal plains are narrow in the middle and get broader towards north and south. As compared to the western coastal plain, the eastern coastal plain is broader and is an example of an emergent coast.

The significance of the coastal plains is as follows:

The west coast:

- It is a narrow indented belt and because of submergence provides natural conditions for the development of ports and harbours. Some of the important natural ports located along the west coast are Kandla, Mazagaon, Marmagao, Mangalore, Cochin, etc. The rivers flowing through this coastal plain do not form any delta. The southern part of the western coastal plain, i.e. the Malabar coast, has a distinguishing feature - 'Kayals' (backwaters) - which are used for fishing, inland navigation and are also special attraction for tourists. The western coastal plain is relatively rocky mainly formed by coarse grained soil and thus is less fertile.

The east coast:

- Being broader, it has well-developed deltas formed by the rivers flowing in to the Bay of Bengal. These include the deltas of the Mahanadi, the Godavari, the Krishna and the Kaveri. Because of its emergent nature, it has less number of ports and harbours. The continental shelf extends up to 500 km into the sea, which makes it difficult for the development of good ports and harbours. The eastern coastal plain consists of fertile alluvial soil. Hence, well developed intensive agriculture is practiced on these coastal plains. However, the eastern coastal plain is more prone to cyclone than western coastal plain.

2. The discovery of the mid-oceanic ridges opened doors to not only plate motion but the age of the ocean floor and other geological phenomenon. Elaborate

(200 words)

Approach

1. **Briefly introduce what is mid-oceanic ridge** ***(50 words)***
2. **Discuss how the discovery of the mid-oceanic ridges opened doors to not only plate motion but the age of the ocean floor and other geological phenomenon.** ***(120 words)***
3. **Conclusion** ***(30 words)***

Hints

- A mid-ocean ridge is an underwater mountain system.
- Mid-ocean ridges are geologically active, with new magma constantly emerging onto the ocean floor and into the crust at and near rifts along the ridge axes. The crystallized magma forms new crust of basalt and gabbros.
- The discovery of the mid-oceanic ridges opened doors to not only plate motion but the age of the ocean floor. The rocks making up the crust below the sea floor are youngest at the axis of the ridge and age with increasing distance from that axis.
- A mid-ocean ridge demarcates the boundary between two tectonic plates, and consequently is termed a divergent plate boundary.
- Hence the discovery of mid oceanic ridges led to the establishment of following phenomenon:
  - Occurrence of earthquakes near the mid-oceanic ridges and absence of sediments on their summits (tops).
  - Presence of active volcanoes on mid-oceanic ridges.
  - Absence of rocks older than 135 million years on the ocean floor.

3. Explain how ocean currents help in establishing global heat balance. Also explain the relationship between ocean currents and habitability of the coastal areas.

(250 words)

Approach

1. **Give a brief description of ocean currents** ***(50 words)***
2. **How ocean currents help in establishing global heat balance** ***(80 words)***
3. **Explain the relationship between ocean currents and habitability of the coastal areas** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

The world's ocean is crucial to heating the planet. While land areas and the atmosphere absorb some sunlight, the majority of the sun's radiation is absorbed by the ocean. Particularly in the tropical waters around the equator, the ocean acts as a massive, heat-retaining solar panel.

- Earth's atmosphere also plays a part in this process, helping to retain heat that would otherwise quickly radiate into space after sunset.
- Currents are movements of ocean water in a continuous flow, created largely by surface winds but also partly by temperature and salinity gradients, Earth's rotation, and tides (the gravitational effects of the sun and moon).
- Major current systems typically flow clockwise in the northern hemisphere and counter clockwise in the southern hemisphere, in circular patterns that often trace the coastlines.
- Ocean currents act much like a conveyer belt, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the tropics. Thus, currents regulate global climate, helping to counteract the uneven distribution of solar radiation reaching Earth's surface. Without currents, regional temperatures would be more extreme-super hot at the equator and frigid toward the poles-and much less of Earth's land would be habitable.
- Currents exercise other influences besides those on temperature. The pressure pattern is affected materially, as air over cold current contracts as it is cooled, and that over a warm current expands. As air cools above a cold ocean current, fog is likely to form. Frost smoke occurs over a warm current which flows into a colder region. Evaporation is greater from warm water than from cold water, adding to atmospheric moisture.
- The Gulf Stream and the North Atlantic Current ferry huge volumes of warm salty tropical water north to the Greenland coast and to the Nordic Seas. Heat radiating off of this water helps keep the countries of northwest Europe, which are at the same latitude as Labrador and Greenland, relatively comfortable places to live.

4. What are the factors responsible for generation of Oceanic currents? How these current affects the regional climate?

(250 words)

Approach

1. **Give a brief description of Oceanic currents** ***(60 words)***

2. **Discuss the factors responsible for generation of Oceanic currents** ***(120 words)***

3. **How these current affects the regional climate** ***(70 words)***

Hints

Oceanic currents are adjective movement of regular volume of water in a defined direction with an identifiable speed. These currents regulate the temperature and salinity of oceanic water and also get regulated by them. Thus they impact the climate of the region of their movement.

Following factors are responsible for their generation:

- **Set of factors related to earth's rotation:** As earth moves from west to East, oceanic water near equator tend to move from east to west. Example includes North Equatorial Current and South Equatorial Current. Earth rotation also deflect water in clockwise direction in northern hemisphere and anticlockwise in southern hemisphere under Coriolis force. Example includes Gulf Stream and North Atlantic drift in North Atlantic ocean and Brazilian current and Benguela Current in South Atlantic Ocean.
- **Set of Factor related to Atmosphere:** Frictional drag of planetary winds, rate of evaporation, heating by solar energy set the movement in oceanic waters.
- **Set of factor related to oceans:** Temperature, salinity and density variations also impact the generation of oceanic currents.
- Apart from these gravity tends to pull the piled water down and create gradient variation.
- Oceanic currents substantially influence the climate of their nearby region like west boundary currents of oceans are warm currents transfer water from lower latitude to higher latitudes. Thus increase the temperature of nearby area in higher latitude. North Atlantic drift and Norwegian current increase the temperature of coastal areas of west Europe. They also provide adequate moisture to westerlies and thus near 150 cm of precipitation in coastal region.
- East boundary currents of Oceans are cold currents; moving cold waters of higher latitude to lower latitude thus have desiccating effect in the nearby coast. Peruvian current and Canaries current increase the atmospheric stability and have desiccating effect on Atacama and Sahara desert respectively. In the region of meeting point of cold and warm currents, like Grand bank of Canada foggy conditions along with rich fishing ground develops. Oceanic currents as a part of gyre circulations distribute the oceanic temperature and maintain the latitudinal heat budget of oceans.

5. **Discuss the importance of oceans and also mention some of the anthropogenic activities and human activities that had severely affected the marine life of the oceans.**

(200 words)

Approach

1. **Brief introduction on ocean** ***(30 words)***

2. **Importance of ocean** ***(70 words)***
3. **Anthropogenic effects on ocean** ***(70 words)***
4. **Conclusion** ***(30 words)***

Hints

Other than the sun, the ocean is the most important force affecting Earth's climate. Heat exchange between the ocean and atmosphere drive atmospheric circulation over the entire planet and modify air temperature. However, the anthrogenic effects on ocean have created serious threat to the life on earth.

Importance of ocean

- **Biodiversity:** Coral reefs, salt marshes, estuaries and mangroves and sea grass beds are just a few of the ocean environments which support a large number of different species of organisms, that is, have a high biodiversity.
- **Natural resources:** The ocean floor habitat is not only known for coral reefs but very important to all the organisms that live on the bottom as well as commercially important. The continental shelves and ocean floor are home to many important minerals, including oil and natural gas.
- **Climate and weather:** The oceans interact with and affect global weather and climate.
- **Transportation:** Without commercial ships and barges, transportation of goods from place to place would be much more difficult and expensive.
- **Water cycle:** The Ocean plays an important role in the water cycle. The ocean holds about 97 per cent of the total water on the Earth.
- **Economy:** The Ocean is also vital to our economy. More than 66 per cent of the world's population lives within 100 kilometers of the coastline. Many of the foods and products that we eat, or use as medicine contain ingredients from the sea.
- **Anthropogenic effect on ocean**
- **Oil spills-** Oil floats on the surface of the ocean, so when oil spills occur, the oil tends to end up on the shore where it negatively impacts coastal wildlife and humans.
- **Sewage and trash-** Trash is one of the most, if not, the most widespread pollutants that are caused by humans. Sewage acts as a fertilizer and can be responsible for toxic plankton.
- **Storm drain and River run-off-.** Fertilizers, soap, and organic wastes will increase plankton and bacteria levels in the ocean the same way sewage does.
- **Watersheds**- When it begins to rain, watersheds are flushed into the ocean and extremely high levels of human sewage contaminate the ocean.
- **Thermal pollution-** Thermal pollution is a by-product of the ocean's use as a cooling agent. The cool ocean water taken in is released at a higher temperature.
- **Introduction of alien species is usually caused by our shipping industry.** Ships, travelling worldwide, pick up marine species both on the hulls of their ships and in ballast water
- **Scientists record yearly changes in marine animal populations that may be linked to global warming.** Since 2000 the health of the polar bear appears to be threatened due to the warming of the Arctic areas

- Since **rising sea levels** present a pressing problem not only to coastal communities but to the whole global population as well.

Humans have created definitely a massive impact on the ocean. Without the ocean, there would be dire consequences not just for humans, but for all living things that depend on it.

6. Oceans are suffocating as dead zones have been quadrupled in size since 1950s. In this context, discuss the causes and effects of Ocean Dead Zones on marine ecosystem.

(200 words)

Approach

1. **Brief introduction on dead zone that has quadrupled since 1950s** ***(40 words)***
2. **Causes and effects of Ocean Dead Zones on marine ecosystem** ***(120 words)***
3. **Conclusion** ***(40 words)***

Hints

Dead zones are areas of large bodies of water-typically in the ocean but also occasionally in lakes and even rivers-that do not have enough oxygen to support marine life. This condition is usually caused by eutrophication, an increase in chemical nutrients in the water, leading to excessive blooms of algae that deplete underwater oxygen levels. Dead zones occur around the world, but primarily near areas where heavy agricultural and industrial activity spill nutrients into the water and compromise its quality accordingly.

Numbers of ocean dead zones have increased globally. Dead zone in Gulf of Mexico is one such example. Most marine creatures cannot survive in these zones and current trends would lead to **mass extinction in the long run**, risking dire **consequences for the hundreds of millions of people who depend on the sea.**

Causes and effects of ocean dead zones on marine ecosystem:

- The open ocean has natural low oxygen areas, usually off the west coast of continents due to the way the rotation of the Earth affects ocean currents. But these dead zones have expanded dramatically, increasing by millions of square kilometers since 1950, roughly **equivalent to the area of the European Union**
- Climate change caused by fossil fuel burning is the cause of the large-scale deoxygenating, as **warmer waters hold less oxygen**. The coastal dead zones **result from fertilizer and sewage running off the land and into the seas.**
- The oceans feed more than 500 million people, especially in poorer nations, and provide jobs for 350 million people. But at least 500 dead zones have now been reported near coasts, up from fewer than 50 in 1950. This can raise serious livelihood issues in those poor nations.
- The level of oxygen in all ocean waters is falling, with 2% - 77bn tonnes - being lost since 1950. This **can reduce growth, impair reproduction and increase disease, the scientists warn.**
- Warmer waters not only hold less oxygen but also **mean marine organisms have to breathe faster, using up oxygen more quickly.**

- There are also **dangerous feed back mechanisms.** Microbes that proliferate at very low oxygen levels produce lots of nitrous oxide, a greenhouse gas that is 300 times more potent than carbon dioxide.
- In coastal regions, fertilizer, manure and sewage pollution cause algal blooms and when the algae decompose oxygen is sucked out of the water.
- Fortunately, dead zones are reversible if their causes are reduced or eliminated. As most of the Ocean deoxygenating is taking place all over the world as a result of the human footprint, therefore we need to address it globally before it is too late.

7. The oceans influence the weather from local to global scales; while changes in climate can fundamentally alter many properties of the oceans. Elaborate.

(250 words)

Approach

1. **Explain role of oceans in our ecosystem.** ***(50 words)***
2. **Discuss impacts of Oceans on weather.** ***(100 words)***
3. **Discuss how climate change impacted ocean.** ***(100 words)***

Hints

Oceans cover three quarters of the Earth's surface. It plays a vital role in the global climate system. Along with atmosphere, oceans not only regulates the earth's climate but also provides all species, including humans, a favorable environment, in which to grow and reproduce.

Impact of oceans on weather

- The ocean doesn't just store solar radiation; it also helps to distribute heat around the globe. Ocean water is constantly evaporating, increasing the temperature and humidity of the surrounding air to form rain and storms that are then carried by trade winds, often vast distances. In fact, almost all rain that falls on land starts off in the ocean. The tropics are particularly rainy because heat absorption, and thus ocean evaporation, is highest in this area.
- Ocean currents act much like a conveyer belt, transporting warm water and precipitation from the equator toward the poles and cold water from the poles back to the tropics. Thus, currents regulate global climate, helping to counteract the uneven distribution of solar radiation reaching Earth's surface.
- Weather systems, such as the monsoon in South Asia, are a direct result of the interaction between the ocean and continental masses. Water vapor that evaporates over the ocean moves over land and falls as precipitation because of ocean circulation patterns and the differential absorption of heat by the ocean and by land or air.

Impact of climate change on ocean:

- **Change in Ocean Heat**
  - Three independent analyses show that the amount of heat stored in the ocean has increased substantially since the 1950s.
  - Ocean heat content not only determines sea surface temperature, but also affects sea level and currents.
- **Change in Sea Surface Temperature**
  - Even with some year-to-year variation, the overall increase is clear, and sea surface temperatures have been consistently higher during the past three decades than at any other time since reliable observations began in the late 1800s.
- **Change in Sea Level**
  - When averaged over all of the world's oceans, sea level has risen at a rate of roughly six-tenths of an inch per decade since 1880.
  - The rate of increase has accelerated in recent years to more than an inch per decade.
  - Sea level has decreased relative to the land in parts of Alaska and the Pacific Northwest.
  - The Intergovernmental Panel on Climate Change says we can expect the oceans to rise between 11 and 38 inches (28 to 98 centimeters) by 2100, enough to swamp many of the cities along the U.S. East Coast.
- **Land Loss Along the Atlantic Coast**
  - Roughly 20 square miles of dry land and wetland were converted to open water along the Atlantic coast between 1996 and 2011. More of this loss occurred in the Southeast than in the Mid-Atlantic.
- **Coastal Flooding**
  - Flooding is becoming more frequent along the U.S. coastline as sea level rises.
  - Nearly every site measured has experienced an increase in coastal flooding since the 1950s.
  - The rate is accelerating in many locations along the East and Gulf coasts.
  - The Mid-Atlantic region suffers the highest number of coastal flood days and has also experienced the largest increases in flooding.
- **Change in Ocean Acidity**
  - The ocean has become more acidic over the past few decades because of increased levels of atmospheric carbon dioxide, which dissolves in the water.
  - Higher acidity affects the balance of minerals in the water, which can make it more difficult for certain marine animals to build their protective skeletons or shells.

Thus, as oceans and the atmosphere are completely intertwined, negotiations surrounding future climate change mitigation cannot be complete without consideration of both.

8. Major ocean currents are greatly influenced by the stresses exerted by the prevailing winds and Coriolis force. Discuss the forces which influence the major currents of oceans. Explain with examples why oceanic circulation pattern roughly corresponds to the earth's atmospheric circulation pattern.

(250 words)

Approach

1. **Introduction with reference to Ocean currents** ***(50 words)***
2. **Discuss the factors such as primary and secondary forces which influence the major currents of oceans.** ***(110 words)***
3. **Discuss the reasons for circulation pattern which roughly corresponds to the earth's atmospheric circulation pattern.** ***(90 words)***

Hints

Water is always on the move. Ocean currents are like giant conveyor belts flowing through the oceans moving huge amounts of water all the time. From cold to hot (and vice versa), oceans transport water. The major ocean currents roughly follow a common set of circular paths.

Ocean currents are like river flow in oceans. They represent a regular volume of water in a definite path and direction. Ocean currents are influenced by two types of forces namely:

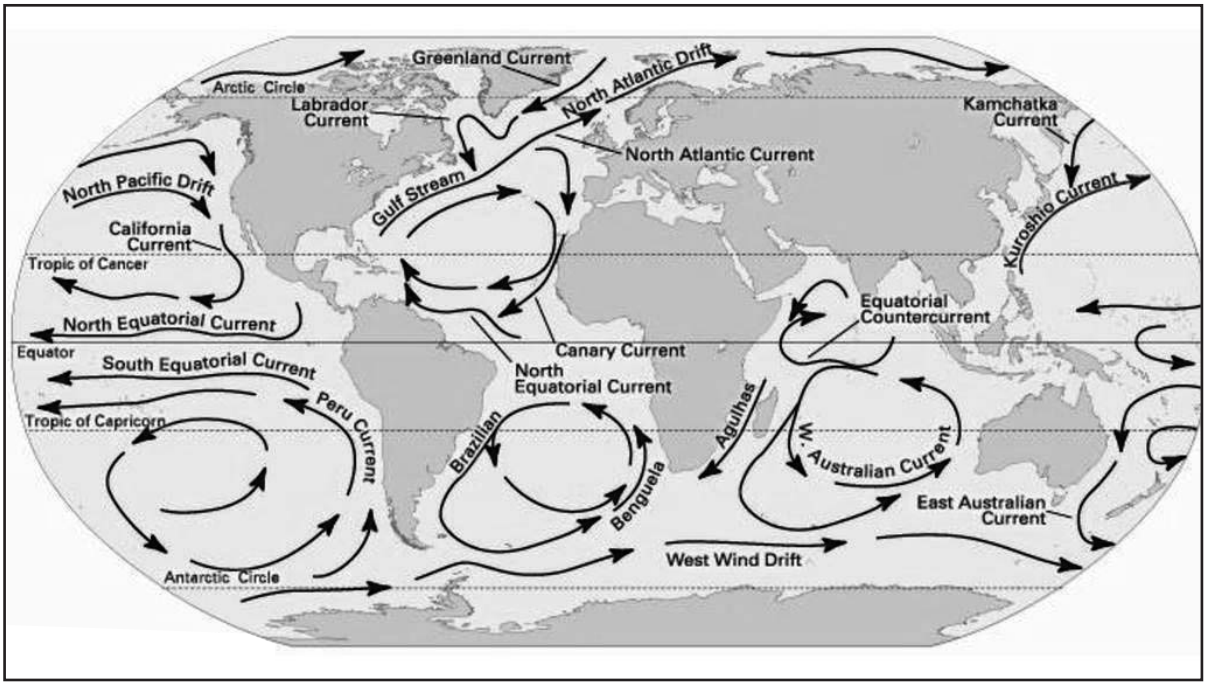
- Primary forces that initiate the movement of water;
- Secondary forces that influence the currents to flow.

The primary forces that influence the currents are:

- **Heating by solar energy**: causes the water to expand. That is why, near the equator the ocean water is about 8 cm higher in level than in the middle latitudes. This causes a very slight gradient and water tends to flow down the slope.
- **Wind:** Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course.
- **Gravity:** Gravity tends to pull the water down the pile and create gradient variation.
- **The Coriolis force**: The Coriolis force intervenes and causes the water to move to the right in the northern hemisphere and to the left in the southern hemisphere. These large accumulations of water and the flow around them are called Gyres. These produce large circular currents in all the ocean basins.

Secondary Forces Responsible For Ocean Currents

- **Differences in water density** affect vertical mobility of ocean currents. Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water.
- Denser water tends to sink, while relatively lighter water tends to rise. Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves towards the equator.
- Warm-water currents travel out from the equator along the surface, flowing towards the poles to replace the sinking cold water



The reasons for circulation pattern which roughly corresponds to the earth's atmospheric circulation pattern.

- Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course. Winds are responsible for both magnitude and direction [Coriolis force also affects direction] of the ocean currents. Example: Monsoon winds are responsible for the seasonal reversal of ocean currents in the Indian Ocean.
- The oceanic circulation pattern roughly corresponds to the earth's atmospheric circulation pattern. The sun heats water at the equator. The wind and sun make ocean currents move. At the equator, the sun is strongest heating water the most there.
- When water heats, water molecules vibrate faster and eventually move farther apart. Hot water moves to the poles. From the equator, hot water pushes outward to north and South Pole South Pole.
- At the same time, cold water from the north and south poles collide with this warm water. Water spins in a circle pattern because Earth's rotation. Because Earth spins on its axis, water flows in a circular pattern.
- Oceans in the northern hemisphere move mostly clockwise. But in the southern hemisphere, ocean currents move mostly counter-clockwise.
- Landmass and shape of coastal regions also forces currents to follow the wind pattern. E.g. less land mass around the Southern Antarctica Ocean has direct bearing on ocean currents.
- Due to lack of obstruction by landmass, currents follow the straight path. Further these currents are made furious by high speed winds.

9. Explain the movement of thermohaline circulation. Also, discuss direct and indirect influences of ocean currents on human activities.

(250 words)

Approach

1. **Briefly introduce with ocean currents** ***(50 words)***
2. **Explain the movement of Thermohaline circulation** ***(100 words)***
3. **Discuss direct and indirect influences of ocean currents on human activities** ***(100 words)***

Hints

An ocean current is a continuous, directed movement of sea water generated by a number of forces acting upon the water, including wind, the Coriolis effect, breaking waves, cabbeling, and temperature and salinity differences. Depth contours, shoreline configurations, and interactions with other currents influence a current's direction and strength. Ocean currents are primarily horizontal water movements. An ocean current flows for great distances and together they create the global conveyor belt, which plays a dominant role in determining the climate of many of Earth's regions.

Movement of Thermohaline circulation

- Deep ocean currents are driven by density and temperature gradients. This thermohaline circulation is also known as the ocean's conveyor belt. These currents, sometimes called submarine rivers, flow deep below the surface of the ocean and are hidden from immediate detection.
- The thermohaline circulation is a part of the large-scale ocean circulation that is driven by global density gradients created by surface heat and freshwater fluxes.
- Formation and movement of the deep water masses at the North Atlantic Ocean, creates sinking water masses that fill the basin and flows very slowly into the deep abyssal plains of the Atlantic. This high latitude cooling and the low latitude heating drives the movement of the deep water in a polar southward flow. The deep water flows through the Antarctic Ocean Basin around South Africa where it is split into two routes: one into the Indian Ocean and one past Australia into the Pacific.
- At the Indian Ocean, some of the cold and salty water from the Atlantic — drawn by the flow of warmer and fresher upper ocean water from the tropical Pacific — causes a vertical exchange of dense, sinking water with lighter water above. It is known as overturning. In the Pacific Ocean, the rest of the cold and salty water from the Atlantic undergoes haline forcing, and becomes warmer and fresher more quickly.
- The out-flowing undersea of cold and salty water makes the sea level of the Atlantic slightly lower than the Pacific and salinity or salinity of water at the Atlantic higher than the Pacific. This generates a large but slow flow of warmer and fresher upper ocean water from the tropical Pacific to the Indian Ocean through the Indonesian Archipelago to replace the cold and salty Antarctic Bottom Water. This is also known as 'haline forcing' (net high latitude freshwater gain and low latitude evaporation). This warmer, fresher water from the Pacific flows up through the South Atlantic to Greenland, where it cools off and undergoes evaporative cooling and sinks to the ocean floor, providing a continuous thermohaline circulation

Direct and indirect influences of ocean current on human activities

- Ocean currents have a number of direct and indirect influences on human activities. West coasts of the continents in tropical and subtropical latitudes (except close to the equator) are bordered by cool waters.
- Their average temperatures are relatively low with a narrow diurnal and annual ranges. There is fog, but generally the areas are arid.
- West coasts of the continents in the middle and higher latitudes are bordered by warm waters which cause a distinct marine climate.
- They are characterised by cool summers and relatively mild winters with a narrow annual range of temperatures.
- Warm currents flow parallel to the east coasts of the continents in tropical and subtropical latitudes. This results in warm and rainy climates. These areas lie in the western margins of the subtropical anti-cyclones.
- The mixing of warm and cold currents help to replenish the oxygen and favour the growth of planktons, the primary food for fish population. The best fishing grounds of the world exist mainly in these mixing zones.

Conclusion:

Thus oceans currents are very vital as they are responsible for moving the heat from the equator and towards the poles. As such, they maintain the natural order and balance of the climate.

10. Discuss major relief features of the ocean floor. Also, explain in brief the roles of ocean relief.

(250 words)

Approach

1. **Introduction on major ocean relief** ***(40 words)***
2. **Explain major relief features of the ocean floor such as continental shelf, abyssal Plains, abyssal hills etc.** ***(90 words)***
3. **Discuss Roles of Ocean Relief** ***(80 words)***
4. **Conclusion** ***(40 words)***

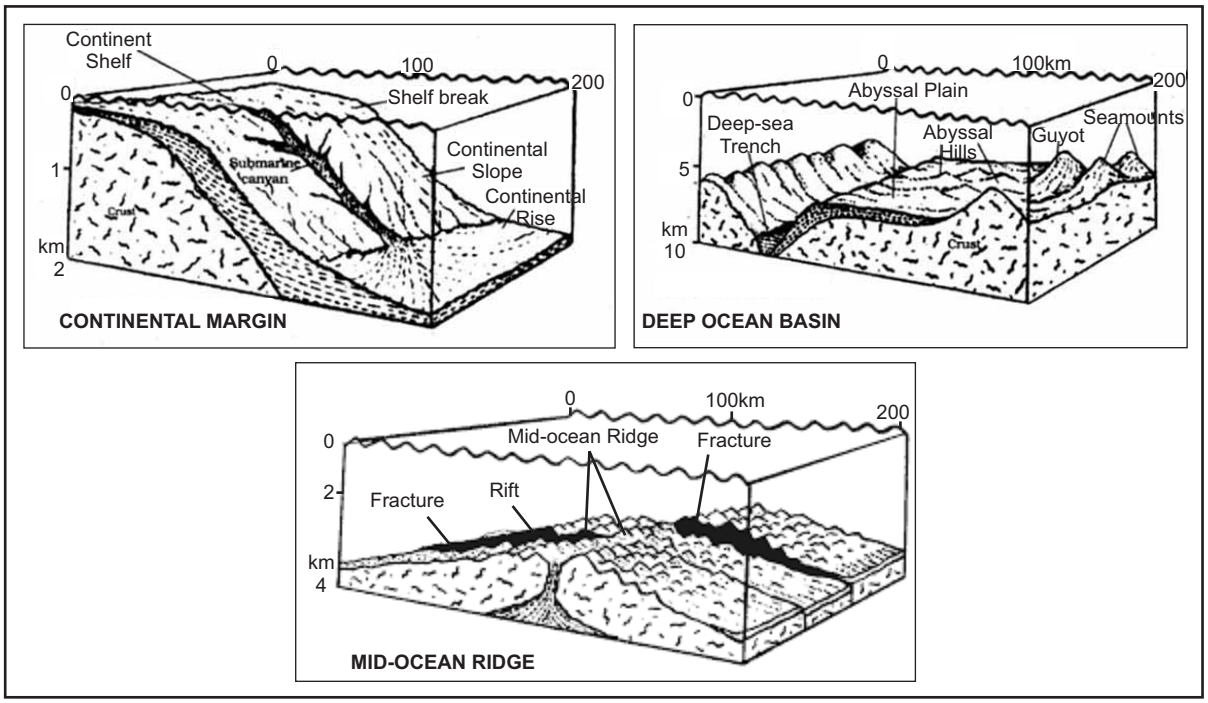
Hints

About 71% of the earth's surface is covered by water (3/5th of the Northern Hemisphere and 4/5th of the Southern Hemisphere is covered by water). Oceans contain a variety of landforms.

Ocean relief is largely due to tectonic, volcanic, erosional and depositional processes and their interactions. A major portion of the ocean floor is found between 3-6 km below the sea level. The 'land' under the waters of the oceans, that is, the ocean floor exhibits complex and varied features as those observed over the land. The floors of the oceans are rugged with the world's largest mountain ranges, deepest trenches and the largest plains

The ocean floors can be divided into four major divisions: (i) the Continental Shelf; (ii) the Continental Slope; (iii) the Deep Sea Plain; (iv) Oceanic Deeps. Besides these divisions there are also major and minor relief features in the ocean floors like ridges, hills, sea mounts, guyots, trenches, canyons, etc.

Major relief features of the ocean floor



- **Continental Shelf:** This is a gentle seaward sloping surface extending from the coasts toward s the open sea. In all, about 7.5% of the total area of the oceans is covered by the continental shelves. The shelf is formed by the drowning of a part of a continent with a relative rise in sea level or marine deposition beneath the water. The continental shelves are mostly covered by sediments of terrestrial origin. There are various types of shelves—glaciated shelf, coral reef shelf, shelf of a large river, shelf with dendritic valleys and the shelf along young mountain ranges. The shelves are of great use to man
  - Marine food comes almost entirely from them
  - They provide the richest fishing grounds
  - They are potential sites for economic minerals; already, about 20% of the world production of petroleum and gas comes from shelves
  - They are large stores of sand and gravel.
- **Continental Slope:** As the continental shelf nears its seaward edge, the gradient becomes steeper—two to five degrees. This is the site of the continental slope which descends to a depth of 3,500 metres and joins the shelf to the deep ocean floor. The site of the slope also indicates the end of the continental block. The slopes may be furrowed by canyons and trenches.
- **Continental Rise:** The continental slope gradually loses its steepness with depth. When the slope reaches a level of between 0.5° and 1°, it is referred to as the continental rise. With increasing depth the rise becomes virtually flat and merges with the abyssal plain.

- **Abyssal Plains:** Beyond the continental rise, at depths from 3,000 m to 6,000 m, lie the deep sea plains, called abyssal plains or abyssal floors. Covering nearly 40% of the ocean floor, the abyssal plains are present in all major oceans and several seas of the world. They are uniquely flat with a gradient of less than 10,000. The large supply of terrigenous and shallow water sediments buries the irregular topography to form a generally flat relief.
- **Submarine Ridges:** Submarine ridges are mountain ranges, a few hundred kilometres wide and hundreds and often thousands of kilometres in length on the floors of oceans. Running for a total length of 75,000 km, these ridges form the largest mountain systems on earth. These ridges are either broad, like a plateau, gently sloping or in the form of steep-sided narrow mountains. These oceanic ridge systems are of tectonic origin and provide evidence in support of the theory of Plate Tectonics.
- **Abyssal Hills:** These are elevated features of volcanic origin. A submarine mountain or peak rising more than 1,000 metres above the ocean floor is known as a seamount. The flat topped mountains are known as guyots. Seamounts and guyots are very common in the Pacific Ocean where they are estimated to number around 10,000.

Roles of Ocean Relief

- Ocean relief can control the motion of sea water as it has various depths and widths as well.
- The movement in ocean currents can cause many variations in both oceans and in the atmosphere.
- Ocean relief, which takes places at the bottom of the ocean, can influence navigation and fishing. At this point, the different features of ocean relief may provide different marine creatures.

Conclusion:

Mapping the characteristics of the ocean basin has been difficult for several reasons. First, the oceans are not easy to travel over; second, until recent times navigation has been extremely crude, so that individual observations have been only loosely correlated with one another; and, finally, the oceans are opaque to light—that is, the deep seafloor cannot be seen from the ocean surface. Various technologies have emerged such as Single Beam Echo-Sounders (SBES), Multibeam Echo-Sounders (MBES), Satellite-Derived Bathymetry (SDB), Light Detection and Ranging (LIDAR), etc which have made possible a finer and detailed study of ocean relief features.

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NOTES

SET-3: QUESTIONS

CLIMATOLOGY

Q1. Why total solar eclipses are rare at any particular location on the earth's continental surface? What do you understand by Bailey's Bead Effect during the Solar Eclipse? Explain the impact of solar eclipse on Earth?

Q2. What do you understand by heat waves? Analyze the locational pattern of incidences of heat waves in India. Suggest measures to tackle the pattern of heat wave.

Q3. Explain the development of local winds. How these winds influence local weather all over the world.

Q4. What do you understand by land breezes and sea breezes? Discuss how these breezes modify the urban coastal environment?

Q5. Discuss the origin, movement and characteristic of air masses and explain how air masses influence the world climate?

Q6. What are aerosols? Discuss the role played by Aerosols in the radiative forcing of climate.

Q7. Climatic controls are the factors affecting the climate of particular place. Discuss various local factors which have impact on the climate of particular region with respect to India.

Q8. Monsoon in India is curious case inspite of many studies & prediction technologies used for it. Discuss the recent developments in the prediction methodology of Monsoon. Also discuss the effect of Indian Ocean Dipole on the Monsoon in India.

Q9. Describe, how EL-Nino affects the Indian Monsoon? Also, analyze its economic impact on India and world?

Q10. Differential heating of Tibetan plateau and pressure gradient between it and Mascerene high plays an important role in pulling Monsoon winds towards Indian Sub-continent." Discuss.

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SET-3: ANSWERS

1. Why total solar eclipses are rare at any particular location on the earth's continental surface? What do you understand by Bailey's Bead Effect during the Solar Eclipse? Explain the impact of solar eclipse on Earth?

(250 words)

Approach

1. **Briefly introduce the total solar eclipses** ***(50 words)***
2. **Discuss why total solar eclipses are rare at any particular location on the earth's continental surface** ***(70 words)***
3. **Define Bailey's Bead Effect during the Solar Eclipse** ***(80 words)***
4. **Discuss the impacts of solar eclipse on Earth** ***(50 words)***

Hints

Total solar eclipse is the condition in which the moon moves between the Earth and the Sun and thus covers the entire sun. However, this phenomenon is very rare because:

- Most of the time the moon passes a little above or little below the Sun and thus is not able to cover the entire Sun.
- Even if the moon comes exactly in line with the sun, the shadow of moon is so small that it covers very little area over the earth
- Most of the time this shadow falls over the water bodies and thus humans cannot see solar eclipse over continents.
- Condition of perigee must be satisfied when sun moon and earth comes in the straight line.

Bailey's Bead Effect

Moon surface is not exactly plain and contains some mountains and canyons. When moon passes over sun during a solar eclipse, the canyons over the moon allows beads of sunlight to pass through the moon's periphery. This phenomenon in which bead of light of the sun is seen during solar eclipse is called Bailey's Bead Effect

Impact of Solar Eclipse on earth

- Researchers who studied an eclipse across Europe in 1999 found that the event lowered air temperatures by as much as 5°F across the path of totality.
- This brief dip in air temperatures also affected local wind speed and direction

2. What do you understand by heat waves? Analyze the locational pattern of incidences of heat waves in India. Suggest measures to tackle the pattern of heat wave.

(250 words)

Approach

1. **What do you understand by heat waves** ***(50 words)***
2. **Analyze the locational factors for heat waves** ***(150 words)***
3. **Suggest measures to tackle the pattern of heat wave** ***(50 words)***

Hints

- Heat waves is a condition of sustained abnormally high temperatures, more than normal maximum temperatures especially in northern western parts of India during the pre-monsoon period from April to June, which may sometimes get extended to July. Indian Meteorological department declared 40 degree C and 30 degree C as normal maximum temperatures for plains and hilly areas, and a deviation of 5 degree C on positive side is declared as severe heat wave.
- Haryana, Chandigarh, Delhi, Rajasthan, Gangetic West Bengal, Odisha, Marathwada, Vidarbha, Telangana, Rayalaseema and Tamil Nadu are most to heat waves impact.

Locational factors for heat waves:

- Since India is a tropical country with monsoon type of climate, its interior regions face high temperature situations during summer periods before the onset of monsoon.
- As sun moves northwards after March equinox, central India heats up during April and north-west India during May. This heat is transferred to other eastern regions through advection and resulting into heat wave condition in these areas also.
- Anti-cyclone conditions in Bay of Bengal prevent the extension of maritime influence in the coastal regions and leading to rise in temperature there also.
- Regions of North West India like Western UP, Haryana, and Rajasthan where it is given name 'loo' face regular heat waves;
- Interior regions of other states like Odisha, Andhra Pradesh, and West Bengal also face heat wave conditions.
- In recent years because of global warming effect, frequent el-Nino the events of heat waves have increased and in the year 2015 more than 2000 people died because of heat stroke, mostly in the regions of Telangana and Andhra Pradesh.

Measures to tackle the pattern of heat waves:

- Heat wave is a natural phenomenon and human has very little control over it. They can design adaptive and mitigative strategies to tackle negative health effects from it.
- Limiting climate change and global warming, which is resulting into extreme weather events should be the long term strategy.

- Short term measures which can be taken are: closing schools, issuing health advisories to keep away from sun, keeping oneself hydrated and ensuring availability of sufficient amounts of water, treat heat-stroke patients as emergency cases and make necessary arrangements for ensuring immediate medical treatment to ensure that negative health effects get minimized.

3. Explain the development of local winds. How these winds influence local weather all over the world.

(200 words)

Approach

1. **Give a brief description of local winds** ***(50 Words)***
2. **Give a detailed description of their types and how they influence local** ***(50 Words)***
3. **Weather all over the world.** ***(150 words)***

Hints

Local winds refer to a variety of mesoscale circulations other than thunderstorms produced by the topographical peculiarities or local temperature differences.

The main types of local winds are: Sea breezes and land breezes, Anabatic and Katabatic winds, and Hot and Cold winds.

- **Sea Breezes:** Land masses are heated by the sun more quickly than the sea in the daytime. The air rises, flows out to the sea, and creates a low pressure at ground level which attracts the cool air from the sea. This is called sea breeze. Cumulus clouds tend to form as the warm air rises over the land to about 500-1500m. Air in sea breezes is moist compared to the air over land. Wind speeds from sea breezes can be about 4-8m/s but can be even stronger. Coastal areas don't have extreme temperatures owing to sea breezes.
- **Land breezes:** Land breezes occur at night, when the land is cooler than the sea. This is because, as the air cools in the night time (as there is less heating from the sun), it contracts. Pressure is higher over the land than the sea. This causes the air to flow from the land to the sea which is known as land breeze. Cumulus clouds from where there is rising air. Land sea breeze fronts tend to only affect a small area in comparison to the much larger effect of sea breezes. Wind speeds are also lower at 2-3m/s.
- **Anabatic winds (Valley Breeze):** This wind is caused by thermal processes. Anabatic (upslope) winds occur over slopes which are heated by the sun. Air in contact with slopes gets warmed, expands upward and cools and sinks over neighbouring valleys. Anabatic winds are usually slow, at only 1-2m/s. Due to formation of cumulus clouds, occasional afternoon showers may be produced.
- **Katabatic Winds (Mountain Breeze):** Katabatic winds occur over slopes which are cooled. Katabatic winds occur where air in contact with sloping ground is colder than air at the same level away from the hillside over the valley. Katabatic winds are nocturnal phenomena in most parts of the world as there is surface cooling, especially when there is little cloud. Katabatic wind speeds don't typically exceed 3-4 m/s. However, where the ground is covered with snow or ice, katabatic winds can occur at any time with speeds often reaching 10 m/s, or even more if funnelling through narrow valleys occurs. Katabatic winds may lead to the formation of frost, mist and radiation fog in valleys.

Hot local winds:

- **Chinook winds** occur when air is forced over a mountain range. Warm air rises over the Sierra Nevada in California, for example, because it is pushed eastward by the westerly winds. The air cools as it rises and precipitates. The air is now dry. It sinks down the far side of the mountains and may create strong winds. These Chinook winds are relatively warm. If there is snow, the winds may melt it quickly which gives it the name 'snow-eater' and helps in spring farming. These winds also prove helpful in ranching as it clears snow from grasslands. Similar wind is called Foehn in Alps region and Norwester in New Zealand.
- **Santa Ana winds** are responsible for many large fires in Southern California. The air is forced downhill through the deserts of the Southwest. It blows westward toward the ocean. The air is blocked by the mountains. So it is funnelled rapidly through the mountain passes. If a fire starts, it spreads quickly. The result is large-scale devastation. Similar winds are called Yamo in Japan, Zonda in Argentina and Tramontane in central Europe.
- **Desert Winds:** High summer temperatures on the desert create high winds and dusty storms. Strong winds in the desert can pick up dust and blow it around. A dust storm known as '**haboob'** forms in the downdrafts on the front of a thunderstorm. These are called Sirocco in Sahara, Khamsin in Egypt and Simoom in Asian deserts. Similar winds in Spain are called Leveche and in Australia they are known as Brick fielder.
- **Harmattan:** It is another dry, dusty wind which blows from Sahara desert towards Guinea coast where the weather is already extremely hot and humid. The dry wind has an evaporating effect which makes it cooler for the inhabitants. That's why it is called "the doctor". Similar winds are called Black roller in North America, Shamal in Gulf region.
- **Cold local winds:** There are certain local winds which are cold and dust-laden or cold and raw. These local winds occur under different conditions. Some of the cold air-mass type winds are discussed below.
- **Mistral:** Mistral is a cold wind that blows into the western Mediterranean basin from higher elevations to the north. These winds are of common occurrence during winter months. They are extremely cold and dry. Mistral descends from the high Auvergne Plateau to the Rhone Valley on the southern coast of France. Similar winds in South America are called Pampero.
- **Bora:** In the region of eastern shore of the Adriatic Sea, a cold, dry north-easterly wind blowing down from the mountains is called bora. These down-slope winds are warmed by their descent, but even then they are colder than those along the coastal lowlands. This type of wind is often associated with the passage of an extra-tropical cyclone. Bora-type winds bring unusual and prolonged subfreezing temperatures along the coastal lowlands during winter. These winds occur specially during the winter. At times, they may attain hurricane force at the foot of mountains and may cause tremendous property damage. Similar winds also occur on the northern Black Sea coast, in Japan, northern Scandinavia and Novaya Zemlya.
- **Blizzard:** It is a violent and extremely cold wind laden with dry snow picked up from the ground. Blizzard represents a severe weather condition characterized by very low temperatures, strong winds, and a great amount of snow. These cold winds hay subfreezing temperatures and carry abundant supply of ice-crystals and snow. Such blizzards are common occurrence in the Antarctic. Wind velocity, on occasions, reaches 120 km to 160 km per hour and the temperature is as low as -7° Celsius. Such winds in central Siberia are called as Buran and in Russian Tundra as Purga.

4. What do you understand by land breezes and sea breezes? Discuss how these breezes modify the urban coastal environment?

(200 words)

Approach

1. **Briefly introduce land breezes and sea breezes** ***(50 words)***
2. **Discuss how these breezes modify the urban coastal environment** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

- In the day, when the sun is up, the land heats up very quickly and the air above it warms up a lot more than the air over the water. The warm air over the land is less dense and begins to rise. Low pressure is created.
- The air pressure over the water is higher with cold dense air, which moves to occupy the space created over the land. The cool air that comes along is called a sea breeze.
- In the night, the reverse happens. The land quickly loses its' heat whiles the water retains its' warmth. This means the air over the water is warmer, less dense and begins to rise. Low pressure is created over the water. Cold and dense air over the land begins to move to the water surface to replace the warmer rising air. The cool breeze from the land is called a land breeze.
- A typical sea breeze may penetrate 50 km or more inland, though its strength depends on the terrain over which it travels. The sea breeze can provide relief from oppressive hot weather, trigger thunderstorms, provide moisture for fog and may result in either improved or reduced air quality near Earth's surface.
- The highly variable winds near the coast may sweep pollutants out to sea on a land breeze but then bring them back with the sea breeze. The variations in sea breeze circulation also have distinct effect on the pollutant transport and dispersion mechanisms in the coastal urban areas.
- The urban heat island (UHI) forms a strong convergence zone in the centre of the city and thereby accelerates the sea-breeze front toward the centre of the city. The presence of the urban region increases the sea-breeze propagation speed.

5. Discuss the origin, movement and characteristic of air masses and explain how air masses influence the world climate?

(200 words)

Approach

1. **Briefly introduce the air masses** ***(50 words)***
2. **Discuss the origin, movement and characteristic of air masses** ***(60 words)***
3. **Explain how air masses influence the world climate** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

Three-dimensional homogenous mass of air over a large area having homogeneity in characteristics like temperature and moisture is called air masses.

- **Origin**: the genesis of air masses is co-related to specific locations of earth surface which are called as source area. Air masses originates when atmospheric conditions remain stable over an extensive area for fairly ling period so that air lying over that area attains the temperature and moisture characteristics of the ground surface. Thus, air masses evolve much stronger characteristics during winters. These air masses over source area are called as barometric air masses.
- **Movement:** Once formed an air mass is seldom stationary over the source region, rather it moves to other areas under the influence of prevailing wind. During its movement air masses induce weather affectivity in the new areas and also modify its own characteristics. The modified air mass is called as baro-clinic air mass.

Characteristics and influence over world weather:

Air masses are primarily classified on basis of latitudinal location and prevailing relief. There are five major source regions. These include 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). Tropical air masses are warm and polar air masses are cold.

- **Continental Polar Air Masses (CP):** Source regions of these air masses are the Arctic basin, northern North America, Eurasia and Antarctica. These air masses are characterized by dry, cold and stable conditions. The weather during winter is frigid, clear and stable. During summer, the weather is less stable with lesser prevalence of anti-cyclonic winds, warmer landmasses and lesser snow. Southern extension of these air masses creates grim winters in USA and China through Blizzards and Purgas. Under influence of westerlies these form arctic front in USA and China causing favourable winter precipitation however squall line as tornados are specifically associated with USA.
- **Maritime Tropical Air Masses (MT):** The source regions of these air masses include the oceans in tropics and sub-tropics such as Mexican Gulf, the Pacific and the Atlantic oceans. These air masses are warm, humid and unstable. The weather during winter has mild temperatures, overcast skies with fog. During summer, the weather is characterized by high temperatures, high humidity, cumulous clouds and convectional rainfall.
- **Maritime Polar Air Masses (MP):** The source region of these air masses is the oceans between 40° and 60° latitudes. These are actually those continental polar air masses which have moved over the warmer oceans, got heated up and have collected moisture. The conditions over the source regions are cool, moist and unstable. These are the regions which cannot lie stagnant for long. The weather during winters is characterized by high humidity, overcast skies and occasional fog and precipitation. During summer, the weather is clear, fair and stable.
- **Continental Tropical Air Masses (CT):** The source-regions of the air masses include tropical and sub-tropical deserts of Sahara in Africa, and of West Asia and Australia. These air masses are dry, hot and stable and do not extend beyond the source. They are dry throughout the year.

- The air masses carry atmospheric moisture from oceans to continents and cause precipitation over landmasses. They transport latent heat, thus removing the latitudinal heat balance. Most of the migratory atmospheric disturbances such as cyclones and storms originate at the contact zone between different air masses and the weather associated with these disturbances is determined by characteristics of the air masses involved.

6. What are aerosols? Discuss the role played by Aerosols in the radiative forcing of climate.

(200 words)

Approach

1. **Briefly introduce aerosols and radiative forcing of climate** ***(50 words)***
2. **Discuss the role played by Aerosols in the radiative forcing of climate** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

- Apart from trace gases, the atmosphere contains a variety of liquids and solids that exist as dispersed phases in the air. They are collectively called aerosols. An aerosol is considered a two-phase system consisting of solid or liquid particles and the gas (air) they are suspended in. Aerosols result from both natural and anthropogenic sources. Examples are dust particles generated by wind erosion of surface soils, agricultural activities, sea salt and wave breaking over oceans. Other sources include generation via chemical reactions in the atmosphere. For example, sulphate aerosols are generated by oxidation of sulphur dioxide in atmospheric moisture; particles are generated in automobile exhaust and incomplete combustion of fossil fuels in power plants. The aerosols have a direct radiative forcing effect on climate because they scatter and absorb solar and infrared radiation in the atmosphere.
- **Radiative forcing** is the process through which about 30 per cent of sunlight reaching the Earth's surface is reflected back into space as invisible infrared light. Aerosols generated by human activities reflect infrared light generated by reflected sunlight, thereby trapping it in the atmosphere. This alters radiative forcing, resulting in climate change. Recent studies have identified aerosol emission, particularly black carbon emission from industrializing countries like India and China, as emission control targets for mitigating climate change.
- Aerosols interact both directly and indirectly with the Earth's radiation budget and climate. As a direct effect, the aerosols scatter sunlight directly back into space. As an indirect effect, aerosols in the lower atmosphere can modify the size of cloud particles, changing how the clouds reflect and absorb sunlight, thereby affecting the Earth's energy budget.
- Aerosols also can act as sites for chemical reactions to take place (heterogeneous chemistry). The most significant of these reactions are those that lead to the destruction of stratospheric ozone. During winter in the Polar Regions, aerosols grow to form polar stratospheric clouds. The large surface areas of these cloud particles provide sites for chemical reactions to take place. These reactions lead to the formation of large amounts of reactive chlorine and, ultimately, to the destruction of ozone in the stratosphere. Evidence now exists that shows similar changes in stratospheric ozone concentrations occur after major volcanic eruptions, like Mt. Pinatubo in 1991, where tons of volcanic aerosols are blown into the atmosphere.

7. Climatic controls are the factors affecting the climate of particular place. Discuss various local factors which have impact on the climate of particular region with respect to India.

(200 words)

Approach

1. **Briefly introduce the factors affecting the climate of particular place** ***(100 words)***
2. **Discuss various local factors which have impact on the climate of particular region with respect to India.** ***(100 words)***

Hints

The climate of any particular place is influenced by a host of interacting factors. These include latitude, elevation, nearby water, ocean currents, topography, vegetation, and prevailing winds. The global climate system and any changes that occur within it also influence local climate.

Various local factors which affect climate of India are:

- **Location and Latitudinal Extent:**
  - The mainland of India extends roughly from 8°N to 37°N and the Tropic of Cancer of passes through the middle of the country.
  - Areas south of the Tropic of Cancer are closer to the equator and experience high temperature throughout the year.
  - The northern parts on the other hand lie in the warm temperature zone. Hence, they experience comparatively low temperatures. Some places record considerably low temperatures particularly in winter. Water bodies comprising the Arabian Sea and the Bay of Bengal surround the peninsular India and make climatic conditions mild along the coastal areas.
- **Distance from the Sea:**
  - Areas near the coast have equable or maritime climate. On the contrary, interior locations are deprived of the moderating influence of the sea and experience extreme or continental climate. For example, the annual range of temperature at Kochi does not exceed 3°C whereas it is as high at 20°C at Delhi. Similarly, the amount of annual rainfall at Kolkata is 119 cm which falls to a low of 24 cm at Bikaner.
- **The Northern Mountain Ranges:**
  - India is separated from the rest of Asia by the impenetrable wall of the Himalayan mountain ranges. These ranges protect India from the bitterly cold and dry winds of Central Asia during winter. Further, these mountain ranges act as an effective physical barrier for rain bearing south-west monsoon winds to cross the northern frontiers of India. Thus, the Himalayan mountain ranges act as a climatic divide between the Indian Sub-continent and Central Asia.

- **Physiography:**
  - Physiography of India has a great bearing on major elements of climate such as temperature, atmospheric pressure, direction of winds and the amount of rainfall. In fact, physical map of India is very closely related to the climatic conditions of the country. Places located at higher altitude have cool climate even though they are located in the peninsular India, i.e., Ooty.
  - Several hill stations and the Himalayan ranges are much cooler than the places located in the Great Plain of North India. The greatest control of physiography in the peninsular India is seen in the distribution of rainfall. The south-west monsoon winds from the Arabian sea strike almost perpendicular at the Western Ghats and cause copious rainfall in the Western Coastal plain and the western slopes of the Western Ghats.
  - On the contrary, vast areas of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu lie in rain shadow or leeward side of the Western Ghats and receive scanty rainfall.
- **Monsoon Winds:**
  - The most dominating factor of the Indian climate is the 'monsoon winds' as a result of which it is often called the monsoon climate. The complete reversal of the monsoon winds brings about a sudden change in the seasons—the harsh summer season suddenly giving way to eagerly awaited monsoon or rainy season.
- **Tropical Cyclones and Western Disturbances:**
  - Tropical cyclones originate in the Bay of Bengal and Arabian Sea and the influence large parts of the peninsular India. Majority of the cyclones originate in the Bay of Bengal and influence the weather conditions during the south-west monsoon season. Some cyclones are born during the retreating monsoon season, i.e., in October and November and influence the weather conditions along the eastern coast of India.
  - The western disturbances originate over the Mediterranean Sea and travel eastward under the influence of westerly jet stream. They influence the winter weather conditions over most of Northern plains and Western Himalayan region.

8. Monsoon in India is curious case inspite of many studies & prediction technologies used for it. Discuss the recent developments in the prediction methodology of Monsoon. Also discuss the effect of Indian Ocean Dipole on the Monsoon in India.

(250 words)

Approach

1. **Briefly introduce the Monsoon in India** ***(50 words)***
2. **Discuss the recent developments in the prediction methodology of Monsoon** ***(70 words)***
3. **Discuss the effect of Indian Ocean Dipole on the Monsoon in India** ***(80 words)***
4. **Conclusion** ***(50 words)***

Hints

- Indian Summer Monsoon Rainfall amounts to more than 80% of the annual rainfall over India and the dependence of agriculture, drinking water and energy production on it makes it the lifeline for a large fraction of the world's population. However, predicting it has been a curious case inspite of the various technological developments.
- With times, many new technologies and studies were done to predict the monsoon with greater accuracy. But most of them have failed to predict it to an accurate level.
- Recently government has launched the National Monsoon Mission. The researchers used wire walkers (wave-powered vehicles that can sample water at various depths), buoys, gliders and towed platforms-equipped with data-collecting sensors-to compile information about the Bay of Bengal's water and air temperature, atmospheric moisture, and mixtures and movements of fresh and salt water-all factors contributing to monsoon activity.
- The new model enables a forecast to be made 40 days earlier than previously, and allows scientists to update their predictions halfway through the June-September monsoon season, a time that is crucial for Indian summer crops.

Effect of Indian Ocean Dipole on the Monsoon in India

- Indian Ocean Dipole is an atmosphere-ocean coupled phenomenon in the tropical Indian Ocean (like the El Nino is in the tropical Pacific), characterised by a difference in sea-surface temperatures.
- Ocean Dipole is simply the periodic oscillation of sea surface temperatures, from 'positive' to 'neutral' and then 'negative' phases. If the sea surface temperature of the western end rises above normal (0.4°C) and becomes warmer than the eastern end, it leads to a positive IOD. This condition is favourable for the Indian Monsoon as it causes a kind of barrier in the eastern Indian Ocean and all the south-westerly winds blow towards the Indian sub-continent.
- Accordingly, the waters in the eastern Indian Ocean cools down, which tends to cause droughts in adjacent land areas of Indonesia and Australia.
- Conversely, during a negative IOD period the waters of the tropical eastern Indian Ocean are warmer than water in the tropical western Indian Ocean. This results in increased rainfall over parts of southern Australia.
- The IOD affects the climate of Southeast Asia, Australia and other countries that surround the Indian Ocean Basin. The Indian Monsoon is invariably influenced by the IOD.
- A Positive IOD is said to be beneficial for the Monsoon, by pushing precipitation towards India. And a Negative IOD has been found during a couple of drought years.

9. Describe, how EL-Nino affects the Indian Monsoon? Also, analyze its economic impact on India and world?

(200 words)

Approach

1. **Briefly introduce EL-Nino** ***(40 words)***
2. **How EL-Nino affects the Indian Monsoon** ***(60 words)***

3. Analyze its economic impact on India and world ***(60 words)***

4. Conclusion ***(40 words)***

Hints

El Nino is periodic phenomenon that causes the global climatic conditions to reverse temporarily.

- It causes the oceanic water temperature to rise above normal for an average of one year and impacts the wind patterns that cause rain into territorial regions across the globe.
- In India, south west monsoon, that is responsible for heavy rain, weakens and as a result impacts the rainfall patterns.
- Moreover, El Nino conditions usually coincide with a period of weak monsoon and rising temperatures in India, which adversely affects India's agricultural sector, increases domestic food prices, and adds to inflation and inflation expectations. It causes the abnormality like flood and drought and impact the agrarian economy of India.
- The production of crops that are based on monsoon results into deficit and crop failure become very common. It causes food inflation to high and GDP to low.
- The drought conditions cause water table to go below normal level. Water becomes scarce for daily use, livestock, fisheries, irrigation and power generation.
- But it's not always El Nino that has adverse impact on Indian monsoon. India ocean dipole and southern oscillation also contribute to its intensity.
- **Economic Impact**
- El Nino has both positive and negative impacts. North and South American continents gets abundant rain fall because of trade laden winds and western coasts becomes a rich fishing zones due to upwelling and suitable condition for growth of nutrient rich marine resources.
- But as the situation reverses the winds get weak and fishing ground is decreased that causes an increase in the demand with supply constraints. This pushes the prices of fishing industry affecting world market and directly affecting the consumers and related business.
- However, El Nino impacts whole globe. More particularly eastern pacific region, Australia, South East Asia and Indian heartland. In Australia, it causes flood conditions and damage of crops.
- The rainfall redistribution, rearranges the world economic conditions.
- El-Nino has a devastating effect on consumers as it raises the price of food basket that is agriculture based. El Nino can affect commodity prices and the macro-economy of different countries.
- It can constrain the supply of rain-driven agricultural commodities; reduce agricultural output, construction, and services activities; create food-price and generalized inflation; and may trigger social unrest in commodity-dependent poor countries that primarily rely on imported food.
- El-Nino speculations affect SENSEX reading and based on that there is high rate of vulnerability in the market.
- The El Nino effect is found to be most severe in the Asia and Pacific region. For instance, it causes hot and dry summers in southeast Australia; increases the frequency and severity of bush fires; reduces wheat exports, and drives up global wheat prices.

10. Differential heating of Tibetan plateau and pressure gradient between it and Mascerene high plays an important role in pulling Monsoon winds towards Indian Sub-continent." Discuss.

(200 words)

Approach

1. **Briefly discuss the important role played by easterly cold jet stream in Indian Monsoon.** ***(50 words)***
2. **Discuss Formation of Easterly Jet Stream due to differential heating of Tibetan plateau and its impact on monsoon.** ***(150 words)***
3. **Briefly conclude with the impact of break in Indian dipole due to El-Nino impact on Indian Monsoon and low moisture content at Mascrene high.** ***(50 words)***

Hints

Differential heating of Tibetan plateau during summer season due to shift of sun's vertical rays leads to formation of a cold jet stream called easterly jet stream, which plays a pivotal role in formation of coupling from Mascrene high and further in formation of Indian Ocean dipole. Itb vn is an important element of dynamic monsoon formation and a force behind its movement towards Indian mainland.

Formation of Easterly Jet Stream due to differential heating of Tibetan plateau and its impact on monsoon

- During winter season the Tibetan plateau is occupied by high pressure system and in upper troposphere it is dominated by Westerlies which brings western disturbance in the form of moisture from Mediterranean Sea and sheds it in northern India.
- But with the advent of summer when the sun crosses the tropics and heats up the Tibetan plateau, a low pressure centre is created over it and Westerlies shifts north of the Himalayas.
- Easterly Jet Stream is produced in upper troposphere due to heating up of Tibetan Plateau.
- During the same time a high pressure system develops off-coast of Kenya near Madagascar called Mascrene high.
- Due to low pressure over Tibetan Plateau high pressure exits in the upper troposphere and Easterly Jet Stream starts to flow towards low pressure created in upper troposphere at Mascrene high.
- This wind descends down at Mascrene high and picks of moisture and flows towards the Indian Mainland in the form of Monsoon winds.
- This system along with similar system with Mascrene high and Western Pacific Pool leads to formation of Indian Ocean Dipole.
- The excess moisture from west pacific pool near north-eastern Australia is supplied to the Mascrene high and from there to Indian mainland along with monsoon.

Conclusion:

The moisture content at Mascrene high Basin becomes low during the event of El-Nino due to breaking of Indian Ocean Dipole, thus causes less rainfall in Indian Sub-continent. Hence, pressure anomaly between the Mascrene high and the Tibetan Plateau plays an important role in formation and intensity of South-West monsoon.

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NOTES

SET-3.1: QUESTIONS

CLIMATOLOGY

Q1. Analyze whether the monsoon rains play a role in reducing air pollution in Indian cities. State the reasons why air pollution has increased in Indian cities post monsoon and winter.

Q2. Give a detailed account of different type of atmospheric circulations. Explain the associated mechanism and their influence on global weather and climate.

Q3. 'It is desirable to consider relationships between climate and human settlement in different climatic regions of the world'. Illustrate.

Q4. Discuss the genesis and impact of western disturbances and highlight its role in influencing the India's climate and agriculture during winters.

Q5. Gulf Dust storm is considered as one of the contributing factors (apart from stubble burning) behind the smog that had smothered Delhi and its neighborhood, Elaborate on the factors that increase dust storm and analyze its impacts?

Q6. Discuss the formation of air mass and its types, also, explain the general circulation of wind. In what way do these air mass influence general circulation of atmosphere on Earth?

Q7. El-Nino Southern Oscillation always affects Indian Ocean dipole adversely causing socio-economic problems in the sub-continent. Analyze.

Q8. Apart from thermal gradient factor other factors such as relief, orography and upper air circulation is responsible for onset of monsoon in Indian sub-continent. Elucidate.

Q9. List out factors that determines climate of India, also explain the role of Tibetan Plateau on Indian Monsoon.

Q10. Components of climate system are unique in composition. These key components combinedly interact to make up a climate region. Explain key components of Climate system and how these components interact?

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SET-3.1: ANSWERS

1. Analyze whether the monsoon rains play a role in reducing air pollution in Indian cities. State the reasons why air pollution has increased in Indian cities post monsoon and winter.

(250 words)

Approach

1. **Give a brief description of monsoon rains** ***(50 words)***
2. **Monsoon rains reduce pollution level in Indian cities** ***(70 words)***
3. **Reasons why air pollution has increased in Indian cities post monsoon and in winter** ***(80 words)***
4. **Conclusion** ***(50 words)***

Hints

Monsoon rains reduce pollution level in Indian cities:

- Monsoon air is cleaner than air during other seasons
- Clear, smog-free skies
- Rain can "wash" out particles from the air
- Rain also helps by making dust particles stick to the ground
- For particles that have settled on the ground or other surfaces, rain prevents them from being kicked up when cars or people drive by.
- Possibility that gaseous CO2 "dissolves in water, "thus once it is released into the air by cars, etc, it might be "washed away" by rain rather than staying in the atmosphere indefinitely or until sequestered by plant respiration
- China has used artificial rainfall as a smog deduction measure in their air pollution plan.
- **Reasons why air pollution has increased in Indian cities post monsoon and in winter:**
- **Low surface temperature:**
- Due to lower surface temperature, air including dust particles don't ascend up and remain near surface causing smog

- The decreased temperatures during winter causes an atmospheric phenomenon called temperature inversion not allowing the polluted air to raise above, keeping it close to ground

- **Post monsoon effect:**
  - Rain plays a significant role in washing off dust particles like PM 2. 5, 10 or even Carbon dioxide, Sulphur dioxide by removing it from atmosphere which cease to exist after monsoon
- **Anthropogenic reasons:**
  - Use of biomass to keep warm
  - Harvest season leads to the burning of biomass And agriculture waste which leads to the release of PM 2. 5 and other harmful gases like CO, Sulphur di oxide.
  - Festivals like Diwali, Lohri placed during winter season also augment the situation
- **Climatic Conditions:**

In winter surface temperature and wind speed is low resulting accumulation of particles near earth surface.

- **Urbanization:**
  - Rapid increase in urbanization has resulted in the reduction of green space
  - Increased no. of vehicles in the recent year.
  - Landlocked cities suffer from crippling pollution as these are at distant from sea effect.
- **Deficiency in policy making:**
  - Fewer regulations on the manufacturing of crackers i. e. with more chlorite and sulphate and also Chinese crackers which use more if these two chemicals leads to more pollution during festivities.

2. Give a detailed account of different type of atmospheric circulations. Explain the associated mechanism and their influence on global weather and climate.

(150 words)

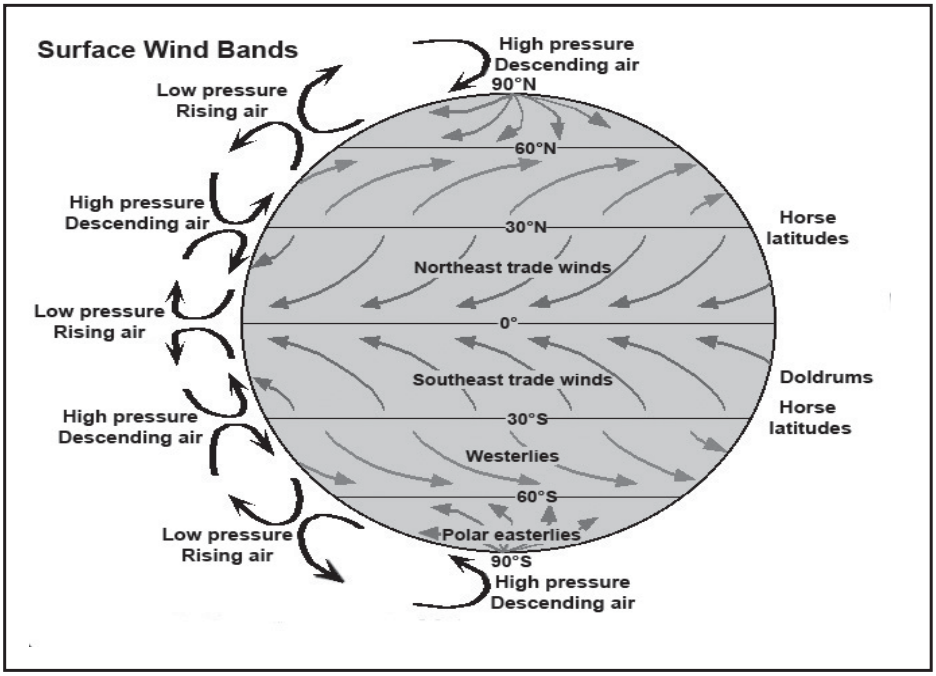
Approach

1. **Overview of wind circulation** ***(30 words)***
2. **Details on the different cells that influence circulation** ***(120 words)***

Hints

The circulation of wind in the atmosphere is driven by the rotation of the earth and the incoming energy from the sun. Wind circulates in each hemisphere in three distinct cells which help transport energy and heat from the equator to the poles. The winds are driven by the energy from the sun at the surface as warm air rises and colder air sinks.

- **Hadley Cell:**
  - The winds, after being heated due to very high temperature at the equator ascend upwards up to the height of 8-12 km.
  - Then these winds diverge northward and southward or say pole ward.
  - The surface winds in the name of trade winds blow from subtropical high-pressure belt to equatorial low-pressure belt in order to replace the ascending air at equator.



  - The upper air moving pole ward descends near 30°-35° latitude to cause subtropical high-pressure belt.
  - Thus, one complete cell of air circulation is formed. This is called Hadley Cell.
- **Polar Front Cell:**
  - Here westerlies blow from subtropical high-pressure belt to sub polar low-pressure belt (60°-65° latitude).
  - The winds ascend near 60°-65° latitude and diverge in opposite direction (pole ward and equator ward).
  - These winds again descend near horse latitudes (30°-35°) to reinforce subtropical high-pressure belt.
  - Thus, one complete cell is formed.
  - Here regularity and continuity of westerlies are frequently disturbed by temperate cyclones and anti-cyclones.
- **Polar Cell:**
  - It involves the atmospheric circulation prevailing between 60° and poles.
  - Cold winds also known as polar easterlies blow from polar high-pressure areas to sub polar or mid latitude low pressure belt.
  - These polar winds converge with warm westerlies near 60°-65° latitudes and form polar front which becomes center for the origin of temperate cyclones.
  - The winds ascend upwards due to rotation of the earth at sub polar low-pressure belt and after reaching some height they turn pole ward and equator ward.
  - The pole ward upper air descends at the poles and reinforces the polar high pressure.

3. 'It is desirable to consider relationships between climate and human settlement in different climatic regions of the world'. Illustrate.

(200 words)

Approach

1. **Overview of climate and human settlements** ***(50 words)***
2. **Different types of climates and their impact on human settlements** ***(150 words)***

Hints

The development of civilization and the urbanization in various parts of the world are influenced by climatic conditions present in those respective areas. Some of the examples can be as follows

Hot & Humid climate

This region lies between 10 to 15 degree north and south of the equator and characterized by high mean annual temperature, low daily range of temperature and high annual rainfall, hyper humidity.

In order to minimize the stress of inhospitable weather conditions the house design should be such that it may reduce the receipt of solar radiation, may provide proper ventilation for incoming fresh air and outgoing polluted air, may increase the existing ventilation capacity, may provide escape for waterlogging and floods due to daily heavy rainfall, maximum shade etc.

The roof, wall and plinths of buildings are climatically designed to get rid of oppressive heat, to allow maximum sheltered breeze, to allow water shedding of rainfall etc. The houses of rural people are built according to pavilion type of architecture wherein the platform of the houses is raised by a few meters above the ground so that the structure may be protected from flooding, waterlogged and damp ground surface. Roofs are thatched and are of dome shaped with steep angle for shedding the rainwater. The walls of building are porous to allow the breeze to penetrate them and enter the inside portion so that cooling effect is maximized. The buildings are separated by wide gaps in order to get more breezes.

Hot and arid climate

This region lies between 15° to 30° in both the hemisphere on the western part of the continents. It is characterized by high mean annual temperature (30°to 35°C) but maximum temperature can past beyond 48°C but temperature during night can come down up to 10° to 15°C, very low humidity and precipitation.

Such climatic conditions necessitate construction of special types of buildings to minimize the receipt of solar radiation during hot summer months and maximize the same during winter months, to provide maximum shades to the walls and streets, to minimize the indoor heat, to provide protection from sandstorms etc. In the view of such conditions the buildings are closely spaced and streets are narrowed so that maximum shade may be available to the walls and streets, the walls are thick so that they may protect the indoor environment of the buildings from becoming too hot, the building plan follows compact geometry, the courtyards are provided

with green plants to absorb more heat and to provide cool environment, light colored building materials are used so that the walls and the roofs may reflect more solar radiation. The building plan is such that the transfer of solar heat into the building during the daylight is delayed. Thus, the relatively longer time lag between the gain of solar radiation during daylight and its transfer into the buildings makes the nights warmer in the building and hence the problem of sudden drop in night temperature is solved to some extent.

Seasonal climatic regions

Varying climatic building strategies are followed in the regions having seasonal regime of climate E.g. Savanna, Monsoon, Mediterranean etc. Buildings in these regions have to face two problems viz. (i) during the rainy seasons mainly at the time of heavy rainstorms the roofs of the buildings should be such that rainwater may be shed off easily but there should be sufficient provision for effective ventilation to escape from humid conditions. (ii) during dry hot summer season more, intense solar radiation makes the indoor and outdoor environment unbearable.

The houses are made either dome shaped or cone shaped so that the rainwater may find the quick escape during heavy rain spells. The primitive construction involved the use of muds, grasses, animal skins and plant leaves for roofs, tree branches and bamboos for basic structures but presently masonry materials such as cement blocks, irons etc. are used for the construction of houses. In India the combinations of heat and humidity have large spatial variations in India due to its large areal coverage both latitudinal and longitudinally and hence we find vast variations in building construction materials and architectural designs. In north-east India having high annual rainfall the buildings are constructed on raised platform of woods while roofs are made up of iron, cement and asbestos sheets and are very sloppy so that rainwater is quickly disposed of. The rural houses in West Bengal have thatched sloppy roofs mainly of conical shape due to heavy rain. The houses in rural areas of UP have mud flat roofs due to low annual rainfall. The houses in TN and Kerala are thatched sloppy roofs.

The Mediterranean region is also characterized by seasonal regime of climate i.e. warm dry summers and cold wet winters and hence building designs of houses in rural areas have the admixture of house designs of warm arid areas and cool wet areas.

Cold Climatic Regions

In the cold climatic regions, the building planners have to make provisions, in their building designs, for maximum heat gain and maximum protection from gusty cold powdery winds. Thus, the house design is such that it minimizes the exposure of the building to high velocity cold winds, maximizes gain of heat from solar radiations and minimizes radiation loss of heat. The buildings are small and compact with minimum outer surface area so that heat loss can be minimized. The building materials are such that they have high insulating capacity. The exteriors of the buildings are darkened so that reflection of solar radiation from the outer walls becomes minimum, while absorption of solar heat becomes maximum.

4. Discuss the genesis and impact of western disturbances and highlight its role in influencing the India's climate and agriculture during winters.

(200 words)

Approach

1. Brief introduction on western disturbance ***(20 words)***

2. **Genesis of western disturbance** ***(70 words)***
3. **Its role in influencing the India's winter climate and agriculture** ***(80 words)***
4. **Conclusion** ***(30 words)***

Hints

A Western Disturbance is an extra-tropical that brings sudden winter rain to the north-western parts of the Indian subcontinent. It is a non-monsoonal precipitation pattern driven by the Westerlies.

Genesis of western disturbance:

- Western Disturbance **originates in the Caspian Sea or the Mediterranean Sea** as extra-tropical cyclones. They gradually travel across the middle-east from Iran, Afghanistan and Pakistan to enter the Indian sub-continent
- A high-pressure area over Ukraine and neighbourhood consolidates, causing the intrusion **of cold air from Polar Regions towards an area of relatively warmer air with high moisture.** This generates favourable conditions for cyclo-genesis in the upper atmosphere, which promotes the formation of an eastward-moving extra-tropical depression.
- Travelling at **speeds up to 43 km/h** the disturbance moves towards the Indian subcontinent until the Himalayas inhibits its development, upon which the depression rapidly weakens. The Western Disturbances are embedded in the mid-latitude Subtropical Westerly Jet.

Its role in influencing the India's winter climate and agriculture:

- Western disturbances are usually associated with cloudy sky, higher night temperatures and unusual rain.
- Excessive precipitation due to western disturbances can cause crop damage, landslides, floods and avalanches.
- Over the Indo-Gangetic plains, they occasionally bring cold wave conditions and dense fog. These conditions remain stable until disturbed by another western disturbance.
- When western disturbance moves across northwest India before the onset of monsoon, a temporary advancement of monsoon current appears over the region.
- Winter rainfall is also important for other aspects of economic development like tourism. Winter rainfall cause snowfall in Jammu & Kashmir and Himachal Pradesh.

Effect on agriculture:

- Precipitation during winter season has great importance in agriculture particularly for the rabbi crops. Rabi crops includes wheat, barley, mustard, sesame, and peas. Water intensive sugarcane, the major cash crop of middle Gangetic plain is also planted in this period also required large amount of water.
- One of the major characteristics of winter rainfall is it is in the drizzle form and the drizzle gives enough time to soil to observe the water and increase the water table and also the agricultural productivity.
- The cloudy weather and rains also reduce the night temperature and it preventing crop from extreme cold and frost

- Thus, although beneficial, western disturbances are causing problems in agriculture output of India, due to climate change all over world. In the past few years, western disturbances have been linked to disasters. This year hailstorm and rains in Gujarat, MP, UP and Rajasthan has caused severe damage to cotton, mango, wheat and gram crops. It has weakened economic conditions of farmers in these states.

5. Gulf Dust storm is considered as one of the contributing factors (apart from stubble burning) behind the smog that had smothered Delhi and its neighborhood, Elaborate on the factors that increase dust storm and analyze its impacts?

(200 words)

Approach

1. **Introduce dust storms and current instances of dust storms in northern India.** ***(50 words)***
2. **Elaborate on factors contributing to it, especially to its increase instances.** ***(70 words)***
3. **Enlist aspects of life it Impacts.** ***(80 words)***

Hints

Dust storms are common meteorological hazards in arid and semi-arid regions. It is caused by thunderstorms - strong pressure gradients associated with cyclones -which increase wind speed over a wide area. These strong winds lift large amounts of sand and dust from bare, dry soils into the atmosphere, transporting the hundreds to thousands of kilometers away.

Recently, Delhi was hit by a high intensity dust storm, which emerged in Iraq, Kuwait and Saudi Arabia. Dust storms are common phenomenon during summers in northern India, but it is rarely of this scale. As per experts, instances of dust storm are likely to increase in future owing to increasing desertification and climate change.

Forming of dust storms:

- Dust Particles:
  - Around 40% of aerosols in the troposphere are dust particles from wind erosion.
  - Between 500 million and 5 billion tons of dust move around the planet every year.
  - The average lifetime of dust particles in the atmosphere ranges from a few hours to more than 10 days.
  - Once released from the surface, dust particles are raised to higher levels of the troposphere by turbulent mixing and convective updrafts.
- **Wind:**
  - Dust particles are transported by winds for lengths of time, depending on their size and meteorological conditions, before being pulled back down to the surface again.
  - As larger particles sediment more quickly than smaller ones, there is a shift toward smaller particle sizes during transport.

Dust storm in Delhi:

- **General occurrence:**
  - The Arabian Sea tends to be at its warmest during the pre-monsoon. The region around Pakistan is also warm during pre-monsoon days. During last 2 years, temperature during this time has peaked to 50 degrees centigrade.
  - The pressure difference between the Arabian Sea and Pakistan creates wind anomalies that add to the westerly winds blowing into India and carrying the desert dust.
- **Confluence of multiple factors this year:**
  - **Climatic conditions:** An unusually early low-pressure trough was created extending from Nagaland into Haryana contributed to widespread thunderstorms. Further, a high-pressure zone over Delhi and its neighborhood and the absence of strong winds kept pollutants trapped close to the surface.
  - **Availability of more dust:** With weak monsoon in the last few years, there were large swaths of land supplying more dust. Stubble burning by few north Indian states added to it.

Impacts:

- **On agriculture:** It causes loss of top soil and plant tissues. It reduces crop yields by burying seedlings, and reducing photosynthetic activity.
- **On human health:** Dust particles are minuscule, thus, can enter human body and infiltrate natural defence system, causing respiratory problems like asthma and dust pneumonia. Dust storms also carry other harmful substances like arsenic, fertilizers, pesticides and viruses, leading to allergy outbreaks.
- **On daily functioning:** Disrupts outdoor activities and affects transportation as it can reduce visibility to near zero. Outdoor economical works, schools, offices are usually closed during its occurrence. In a recent case, it halted the war against IS.
- **On lives and property:** It the past it has resulted into high mortality. It also causes destruction of properties and other mechanical breakdowns and breakages.
- **On water quality:** Indirect dust deposit impacts include filling irrigation canals, affecting river and stream water quality.
- **On solar power plants:** It affects output of solar plants especially those that rely on direct solar radiation. Dust deposits on solar panels are a main concern of plants operators. Keeping the solar collectors dust-free to prevent particles from blocking incoming radiation requires time and labour.

6. Discuss the formation of air mass and its types, also, explain the general circulation of wind. In what way do these air mass influence general circulation of atmosphere on Earth?

(250 words)

Approach

1. **Define air mass and its process of formation** ***(40 words)***

2. **Explain the term - general circulation of atmosphere on Earth** ***(80 words)***
3. **Give a detailed structure of how air mass influences general circulation of atmosphere on Earth. Explain the three Cell Model** ***(90 words)***
4. **Conclusion** ***(40 words)***

Hints

An air mass is a large volume of air in the atmosphere that is mostly uniform in temperature and moisture. Air masses can extend thousands of kilometers in any direction, and can reach from ground level to the stratosphere—16 kilometers (10 miles) into the atmosphere.

Formation of Air mass

- The zones from which air masses grow are called "source regions." These are generally tracts of ocean, desert or snow-covered plains. The large surfaces with uniform temperatures and humidity, where air masses originate are called source regions. Uneven warming and cooling of the earth's surface by the Sun gives rise to air masses.
- When winds move air masses, they carry their weather conditions (heat or cold, dry or moist) from the source region to a new region. When the air mass reaches a new region, it might clash with another air mass that has a different temperature and humidity. This can create a severe storm.
- Meteorologists identify air masses according to where they form over the Earth. There are four categories for air masses: arctic, tropical, polar and equatorial. Arctic air masses form in the Arctic region and are very cold.
- Tropical air masses form in low-latitude areas and are moderately warm. Polar air masses take shape in high-latitude regions and are cold. Equatorial air masses develop near the Equator, and are warm.
- Air masses are also identified based on whether they form over land or over water. Maritime air masses form over water and are humid. Continental air masses form over land and are dry.

General circulation of wind in the atmosphere on Earth

The circulation of wind in the atmosphere is driven by the rotation of the earth and the incoming energy from the sun. Wind circulates in each hemisphere in three distinct cells which help transport energy and heat from the equator to the poles. The winds are driven by the energy from the sun at the surface as warm air rises and colder air sinks.

Climate and general circulation of the atmosphere are related to:

- Energy balance
- Transport processes
- The three cell model

Energy Balance: It is related to the balance of the incoming solar radiation and the outgoing terrestrial radiation emitted by the earth. Over the globe, the energy balance is nearly balanced when averaged over a year (incoming equals outgoing). When averaged over a latitude band, incoming radiation is a surplus in the tropics and deficit of radiation is found in the polar regions due the outgoing terrestrial radiation being larger than the absorbed solar radiation

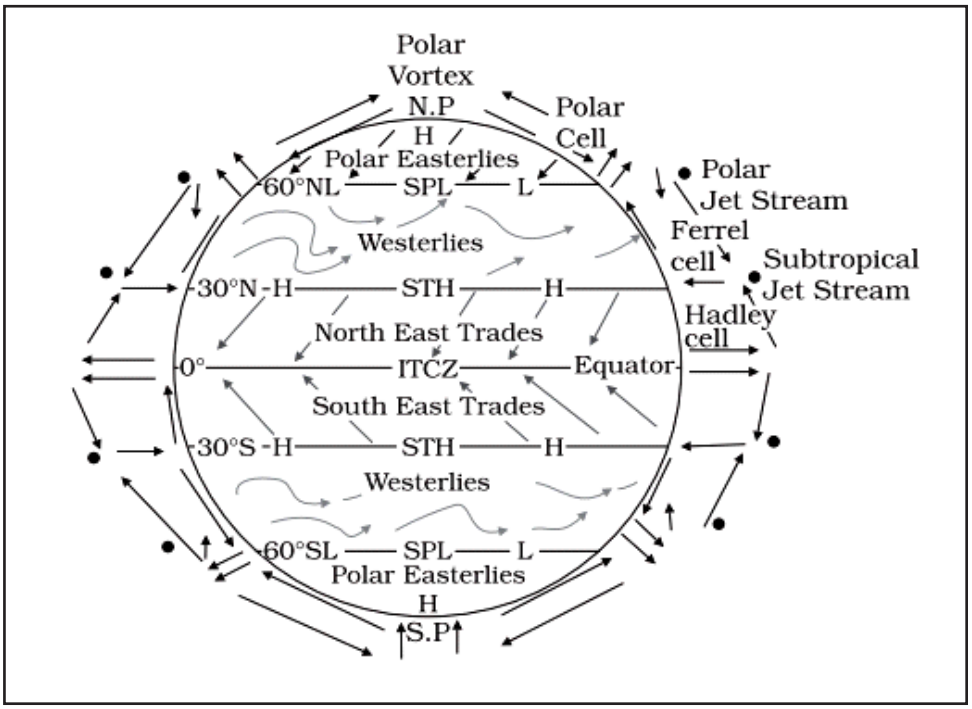
Transport Process: compensate for the surplus and deficit of radiation in different regions of the globe, atmospheric and oceanic transport processes distribute the energy equally around the earth. This transport is accomplished by atmospheric winds and ocean currents.

Hadley Cell

- The intense incoming solar radiation in the equatorial region creates rising air. The rising air cools condenses and forms a region of intense clouds and heavy precipitation. This area is calling the Inter-Tropical Convergence Zone (ITCZ) and corresponds regions over which the tropical rain forests are found.
- The ITCZ moves north and south following the sun during the year. Because the stratosphere is stable, rising air that reaches the tropopause moves pole ward. By the time the air moving northward reached about 30 N it has become a westerly wind (it is moving to the east) due to the Coriolis force. Because of conservation of angular momentum, the pole ward moving air increases speed.
- The increased speed and the Coriolis force are responsible for the subtropical jet. This pole ward moving air piles up (notice on a globe how lines of constant longitude converge) forming an area of high pressure at the surface--the subtropical highs.
- Some of the air sinks toward the surface. Subsidence inhibits cloud formation and this is the reason many large deserts are found near 30N and 30S. Once the sinking air reaches the ground, some flows to the equator, turning west (in the northern hemisphere) as it goes due to the Coriolis force. This surface air forms the trade winds that blow steadily from the northeast in the northern hemisphere and southeast in the southern hemisphere.

How air mass influence general circulation of atmosphere on Earth

This can be understood by carefully studying the general circulation of atmosphere on Earth using Three Cell Model:



Ferrel Cell

- Some of the diverging air at the surface near 30N moves pole ward and is deflected to the east by the Coriolis force resulting in the prevailing westerly winds at the surface. At about 60N the air rises cools and condenses and forms clouds and precipitation. This is the general region of the polar front. Some of this rising air returns equator ward.

Polar Cell

- Sinking air at the poles warms and results in a high pressure over the poles. At the surface, the pole ward moving air gets pulled to the right by the Coriolis force (in the northern hemisphere) forming the polar easterly winds.
- The cold polar air meets with the warm subtropical air moving pole ward and forms the boundary between these two air masses known as the polar front. The warm air from the subtropics pushes up over the cold equator ward moving polar air.
- This polar front is the source of much of the changing weather in the US, particularly in fall, winter and spring. The large temperature contrast results in the polar front jet stream in the vicinity of the polar front.

Conclusion:

As discussed, when winds move air masses in the process of general circulation of atmosphere, they carry their weather conditions (heat or cold, dry or moist) from the source region to a new region. When the air mass reaches a new region, they clash with another air mass that has a different temperature and humidity. Apart from transferring relative heat and moisture in the form of rain and storms, these air mass normalize the weather of the particular location.

7. El-Nino Southern Oscillation always affects Indian Ocean dipole adversely causing socio-economic problems in the sub-continent. Analyze.

(250 words)

Approach

1. **Briefly discuss the spell of El-Nino, its characteristics and impact on India.** ***(40 words)***
2. **Discuss the formation of El Niño-Southern Oscillation and its socio-economic impact on India.** ***(150 words)***
3. **Conclude with effective measures to counter the vagaries of monsoon and mitigate the impacts of events such as ENSO.** ***(60 words)***

Hints

El Niño-Southern Oscillation or ENSO is a climate pattern that occurs across the tropical Pacific Ocean on average every two to five years, but over a period which varies from three to seven years, and is known as "quasi-periodic." ENSO is best-known for its association with floods, droughts and other weather disturbances in many regions of the world, which vary with each event. It generally impacts the Indian monsoon adversely and leads to drought like condition in India.

Formation of El Niño-Southern Oscillation

- ENSO is composed of an oceanic component, called El Niño (or La Niña, depending on its phase), which is characterized by warming or cooling of surface waters in the tropical eastern Pacific Ocean, and an atmospheric component, the Southern Oscillation, which is characterized by changes in surface pressure in the tropical western Pacific.
- Warm water replaces the cold, nutrient-rich surface water of the Humboldt Current near Peruvian coast.
- The Southern Oscillation is the atmospheric component of El Niño. It is an oscillation in air pressure between the tropical eastern and the western Pacific Ocean waters.
- During El-Nino event this system is reversed due to creation of low pressure at Peruvian coast caused due to warm ocean current. Replaced water goes to the eastern pacific causing creation high pressure. This event reverses the walker circulation.
- Due to reversal of walker circulation, Western Pacific pool is isolated from the Indian Ocean dipole and moisture which was transported to Mascrene high is seized.
- This generally leads to deficiency in moisture in south-west monsoon causing deficiency in rainfall in Indian sub-continent.

Socio-Economic implications of El-Niño

- El-Nino adversely impacts south-west monsoon hence causes agricultural drought to metrological drought in Indian sub-contienent.
- Kharif crop is adversely impacted due to weak monsoon and overall agricultural production decreases.
- Retreating Monsoon which aides Rabi crops is also impacted due to this event causing further reduction in poverty.
- However, rainfall due to western disturbance aides better agriculture productivity in northern India.

Conclusion:

ENSO impacts the Indian agricultural productivity in many ways and also causes socio-economic distress as India is primarily an agricultural country and 52% of Indian agriculture is dependent upon monsoon rainfall. However, diversification of canal network, water conservation practices, analysis of soil by moisture mapping and optimal use of water through drip irrigation has assisted in reducing dependency on monsoon. These steps will also assist in mitigating the impact of El-Nino in different ways.

8. Apart from thermal gradient factor other factors such as relief, orography and upper air circulation is responsible for onset of monsoon in Indian sub-continent. Elucidate.

(250 words)

Approach

1. **Briefly discuss the development in study and factors associated with monsoon.** ***(50 words)***

2. **Discuss different dynamic factors influencing monsoon apart from thermal contrast.** ***(150 words)***

3. **Conclude briefly with global phenomenon which impacts monsoon.** ***(50 words)***

Hints

Initially, monsoon was thought to be the product of thermal contrasts between the land and ocean but gradually various other factors started to be associated with monsoon such as influence of relief, orography and upper air circulation. These factors together summed up and made it a dynamic phenomenon which is characterized by reversal of ocean currents and monsoon winds over the Indian Ocean.

Different dynamic factors influencing monsoon apart from thermal contrast

- Traditional concepts of monsoon were based on thermal contrast i.e differential heating of land and sea which caused creation of pressure gradients between the two.
- This led to flow of monsoon winds from center of high pressure to the center of low pressure which reversed during winter and summer called winter and summer monsoon respectively.
- However, later different factors were identified which lead to development and establishment of monsoon over the Indian sub-continent.

Intercontinental Convergence Zone and impact of air masses:

- It is meeting point of north-east and south-east trade wind which shifts north and south of the equator with change in season. It shifts northward when the sun shines at tropic of cancer and towards south when tropic of cancer shines at tropic of Capricorn.
- Due to shift of ITCZ towards north during summer in northern hemisphere, area around Tibetan plateau becomes a low pressure zone attracting the monsoon winds towards it. This monsoon wind is called south-west monsoon.
- Break in monsoon is also influenced by high pressure trough, which sometimes establishes above the Bay of Bengal.

Upper Air circulation and the Jet streams

- Burst of monsoon also depends upon the upper air circulation as due to shift in westerly Jet Stream towards north during summer, the low latitude upper air trough shifts from 90ºE to 80º E which attracts the monsoon towards Indian sub-continent.
- Apart from westerly jet stream, the monsoon is also impacted by the Easterly jet stream which blows 13 km above the ground over peninsular India.
- When westerly jet stream shifts northward during summer, easterly jet stream takes its course and establishes over southern Himalayas.
- Easterly get stream is formed due to heating of Tibetan plateau and rising hot air cools down in the upper atmosphere and starts to blow towards low pressure formed in the upper troposphere above Mascrene high pressure zone.
- Further, there has been considerable impact of Phinlander Jet stream or Somali jet stream on Indian monsoon.

Physiography:

- Physiography of Indian sub-continent plays an important role in rainfall pattern of the Indian sub-continent. It strikes almost perpendicular to the western side of the Western Ghats causing heavy rainfall.
- Similarly, funnel shaped Meghalayan plateau compels the monsoon wind to rise over it making it the wettest place on the planet. Similarly, parallel ranges of Aravallis do not obstruct the monsoon.
- Secondly, the monsoon rainfall is an Orographic rainfall. Hence, Himalayas and other mountain ranges including Western Ghats play an important role its establishment over Indian sub-continent.

Conclusion:

Apart from regional factors various global phenomenon such as El-Nino southern oscillation and Julian-Medellion Oscillation also impacts the Indian monsoon. Hence, it can be said that Indian monsoon is more than the product of thermal contrast as thought previously. Hence, it is a product of various factors such as orography, thermal contrast and upper air circulation including and impacted by global weather phenomenon such as El-Nino and La-Nina.

9. List out factors that determines climate of India, also explain the role of Tibetan Plateau on Indian Monsoon.

(250 words)

Approach

1. **Briefly start with introducing climate and type of Indian Climate.** ***(30 words)***
2. **List the factors determining the climate in India** ***(60 words)***
3. **List the factors Related to Air Pressure and Wind** ***(70 words)***
4. **Role of Himalayas and Tibetan Plateau** ***(60 words)***
5. **Conclusion** ***(30 words)***

Hints

Climate is an important element of the physical environment of mankind. The climate of India belongs to the 'tropical monsoon type' indicating the impact of its location in tropical belt and the monsoon winds. Although a sizeable part of the country lying north of the Tropic of Cancer falls in the northern temperate zone but the shutting effects of the Himalayas and the existence of the Indian Ocean in the south have played significant role in giving India a distinctive climatic characteristics.

India's climate is controlled by a number of factors which can be broadly divided into two groups factors related to location and relief, and factors related to air pressure and winds. Let us discuss them one by one:

Factors determining the climate in India

Factors related to Location and Relief

- **Latitude:** As Tropic of Cancer passes through the central part of India in east-west direction, the northern part of the India lies in sub-tropical and temperate zone and the part lying south of the Tropic of Cancer falls in the tropical zone. The tropical zone being nearer to the equator, experiences high temperatures throughout the year with small daily and annual range.
- **The Himalayan Mountains:** The lofty Himalayas in the north along with its extensions act as an effective climatic divide. The towering mountain chain provides an invincible shield to protect the subcontinent from the cold northern winds. These cold and chilly winds originate near the Arctic Circle and blow across central and eastern Asia. The Himalayas also trap the monsoon winds, forcing them to shed their moisture within the subcontinent.
- **Distance from the Sea**: With a long coastline, large coastal areas have an equable climate. Areas in the interior of India are far away from the moderating influence of the sea. Such areas have extremes of climate. On the other hand, the seasonal contrasts in weather at places in the interior of the country such as Delhi, Kanpur and Amritsar affect the entire sphere of life.
- **Altitude**: Temperature decreases with height .Due to thin air, places in the mountains are cooler than places on the plains.
- **Relief:** The physiography or relief of India also affects the temperature, air pressure, direction and speed of wind and the amount and distribution of rainfall. The windward sides of Western Ghats and Assam receive high rainfall during June-September whereas the southern plateau remains dry due to its leeward situation along the Western Ghats.

Factors Related to Air Pressure and Wind

To understand the differences in local climates of India, following three factors determine the climate in India:

- Distribution of air pressure and wind on the surface of the earth.
- Upper air circulation caused by factors controlling global weather and the inflow of different air masses and jet streams.
- Inflow of western cyclones generally known as disturbances during the winter season and tropical depressions during the south-west monsoon period into India, creating weather conditions favorable to rainfall.

Role of Himalayas and Tibetan Plateau

In 1970s, it was found that Tibet plateau plays a crucial role in initiating the monsoon circulation. The plateau of Tibet extends over an area of about 4.5 million sq. km. The average height of these highlands is 4000 m. Due to its enormous height it receives 2-3 degree C more insolation than the neighbouring areas. Heating of these areas leads to a clockwise air circulation in the middle troposphere and two-wind streams originate from this area. One of these wind streams blow southward and develops into the tropical easterly jet stream (TEJ). The other stream blows in an opposite direction towards the North Pole and becomes the westerly jet stream over Central Asia.

- The vast mountain range also act as a tall barrier, preventing cold, dry air in the northern latitudes from entering the subcontinent and subduing the warm, moisture-laden winds from the oceans that drive the monsoon.

- Tibet Plateau plays a crucial role in initiating the Monsoon circulation over the Indian subcontinent. The summer time heating of the Plateau of Tibet was the most important factor in the causation and maintenance of the Monsoonal circulation. The Plateau of Tibet affects the atmosphere in two ways-
  - Acting as a physical barrier
  - Acting as a high level heat source
- In the mid October, when the Plateau becomes very cold, proves to be the most important factor in causing the advance of the westerly jet south of the Himalayas by bifurcating it into two parts.
- The summer time heating of the Tibetan Plateau makes it a high level heat source. This heat engine produces a thermal anticyclone over this region during summer in the middle part of troposphere. Winds coming out of this anticyclone in a clockwise movement over plateau give birth to easterly jet streams which flow from East to West on the southern side of this upper air anticyclone.
- These upper air easterlies descend into the permanent high pressure area formed over the southern Indian Ocean and intensifies the high pressure area already present there. It is from this high pressure cell that the onshore winds start blowing towards the thermally induced low pressure area, developed in the northern part of the Indian subcontinent. After crossing the equator these surface winds change direction and become South-West monsoon.

Conclusion:

In a developing country like India climatic characteristics have a dominant role in affecting the economic pattern, way of life, mode of living, food preferences, costumes and even the behavioural responses of the people. It is now believed that the differential heating of sea and land alone can't produce the monsoon circulation. Apart from it, recent concept of monsoon rely heavily on the role of Himalayas and Tibetan plateau as a physical barrier and a source of high-level heat and circulation of upper air jet streams in the troposphere.

10. Components of climate system are unique in composition. These key components combinedly interact to make up a climate region. Explain key components of Climate system and how these components interact?

(250 words)

Approach

1. **Briefly introduce with explaining about the climate** ***(20 words)***
2. **Explain key components of Climate system.** ***(40 words)***
3. **Explain how key components of Climate make up a Climatic region. Mentions points like transfers heat energy and moisture across the Earth, the Earth's hydrosphere, etc.** ***(70 words)***
4. **Conclusion** ***(20 words)***

Hints

Climate is a measure of the average pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. Climate is different from weather, in that weather only describes the short-term conditions of these variables in a given region.

Earth's climate is a complex system with a number of key components, all of which play important roles:

- The atmosphere (including its various layers)
- The hydrosphere (oceans, lakes and rivers)
- The cryosphere (snow and ice)
- The lithosphere (soils and rocks) and
- The biosphere (living things)

How do key constituents of Climate make up a Climatic Region?

- The earth's atmosphere, which is a mixture of many different gases, surrounds the earth and extends upwards for more than a hundred kilometers. The atmosphere consists mainly of Oxygen (78%), Oxygen (21%) and Argon, Carbon Dioxide, and traces of Helium, Hydrogen (1%). Ozone Beyond this height atmospheric gases are present in very low concentrations. The proportion of gases changes at different levels in the atmosphere.
- The atmosphere also transfers heat energy and moisture across the Earth. Incoming solar radiation (insolation) is redistributed from areas in which there is a surplus of heat (the equator) to areas where there is a heat deficit (the North and South Pole). This is achieved through a series of atmospheric convection cells.
- In the stratosphere the chlorine atoms from the CFCs react with ozone molecules, destroying the protective ozone layer. Each CFC molecule can destroy hundreds or thousands of ozone molecules.
- In contrast to stratospheric ozone, the ozone in the troposphere has a toxic and corrosive effect. UV radiation from the Sun which escapes the stratospheric ozone layer and makes it to the earth's surface combines with the exhaust from cars to produce toxic chemicals and ozone gas at ground level, this is called photochemical smog.
- Photochemical smog is harmful to human health, damages buildings, and affects plants and animals. The ozone gas created this way does not move up into the stratosphere and offers no sign of UV protection.
- The Earth's hydrosphere is made up of all the water on the planet that can be stored in the oceans, rivers, streams, groundwater, or water vapor (excludes glaciers and ice-sheets). It is in constant movement, transferring water and heat throughout the atmosphere in the form of water vapor and precipitation. The oceans, which cover more than 70% of the earth's surface, play a fundamental and complex role in regulating climate.
- The oceans are able to absorb twice as much solar energy as the atmosphere and land combined. Ocean currents transport this heat from the equator toward the Poles. In the past, long-term, natural oscillations in the oceans' capacity to store and transport heat have led to global temperature changes. Future climate changes—whether natural or human-induced—will also be strongly influenced by the powerful dynamics of the seas.

- The lithosphere is a part of the climate system that is made up of the solid rock, soil, and minerals of Earth's crust. Together with the hydrosphere, the exposed lithosphere absorbs higher-energy radiation from the Sun, coverts it into thermal energy, and then emits the energy back as lower-energy infrared radiation.
- The energy emitted and reflected by the lithosphere as infrared radiation is trapped in the troposphere by greenhouse gasses in the atmosphere. The amount reflected depends on the albedo at the surface, forests absorb a lot more than savannah, and ice reflects still more. The lithosphere determines what vegetation grows on the surface (due to topography and surface nutrients), so it plays a small part played in short term climatic effects on the earth.

Conclusion:

Hence, as illustrated, these components are constantly interacting and adjusting to both internal and external factors. It is the continuous alterations to these components that produce the environmental conditions that we experience within a climatic zone.

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NOTES

SET-4: QUESTIONS

BIO GEOGRAPHY

Q1. Soil is a dynamic medium in which many chemical, physical and biological activities go on constantly. Soil is a result of decay; it is also the medium for growth. Elaborate.

Q2. Discuss the importance of soil forming factors in determining the soil types in different parts of India. Elaborate with suitable examples.

Q3. India has various relief features, landforms, climate realms and vegetation types and these have contributed in the development of various types of soil in India. Elaborate. Also, suggest measures to protect the soil degradation in India.

Q4. Why is soil important? Briefly explain the factors responsible for and the stages of soil formation.

Q5. Discuss causal factors behind soil erosion. What conservation activities can be taken to reverse these phenomena?

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SET-4: ANSWERS

1. Soil is a dynamic medium in which many chemical, physical and biological activities go on constantly. Soil is a result of decay; it is also the medium for growth. Elaborate.

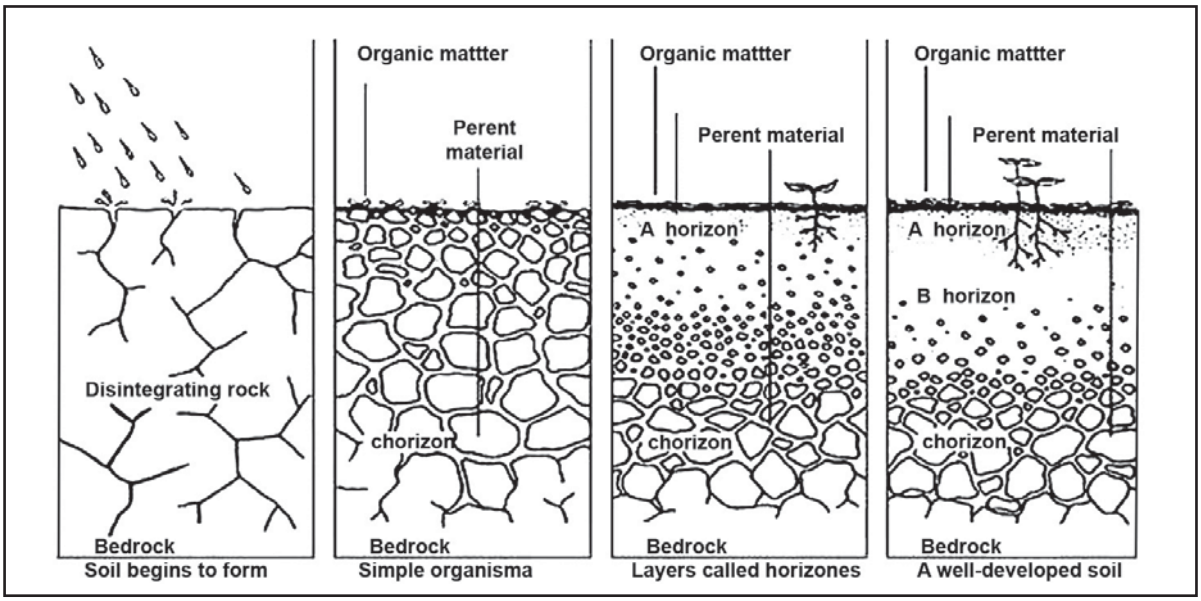
(150 words)

Approach

1. **Brief introduction on feature of soil** ***(30 words)***
2. **Elaborate on soil formation** ***(100 words)***
3. **Conclusion** ***(20 words)***

Hints

Soil is the mixture of rock debris and organic materials which develop on the earth's surface. Various agents of weathering and gradation act upon the parent rock material to produce a thin layer. It has many characteristics that fluctuate with the seasons. Biological activity is slowed or stopped if the soil becomes too cold or too dry. Organic matter increases when leaves fall or grasses die.



The major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life-forms and time. In addition, human activities too largely affect formation of soil. Given its complexity and strong internal connectedness, it is considered an ecosystem by soil ecologists.

Process of Soil Formation:

Weathering mantle forms the basic input for soil. Weathered deposits get colonized by bacteria and other plant bodies like mosses and lichens. The dead remains of these micro-organisms and plants help in humus accumulation.

Factors controlling the formation of soils:

- **Parent Material:** Parent material is a passive control factor in soil formation. Nature and rate of weathering and depth of weathering mantle are important considerations under parent materials.
- **Topography:** Topography is another passive control factor. The influence of topography is felt through the amount of exposure of a surface covered by parent materials to sunlight and the amount of surface and sub-surface drainage over and through the parent materials.
- **Climate:** Climate is an important active factor in soil formation. The climatic elements involved in soil development are: (i) moisture in terms of its intensity, frequency and duration of precipitation -evaporation and humidity; (ii) temperature in terms of seasonal and diurnal variations.
- **Biological Activity:** The vegetative cover and organisms that occupy the parent materials from the beginning and also at later stages help in adding organic matter, moisture retention, nitrogen etc. Dead plants provide humus, the finely divided organic matter of the soil.
- **Time:** It is also an important controlling factor in soil formation. The length of time the soil forming processes operate, determines maturation of soils and profile development.
- Thus, soil is a changing and developing body. It becomes adjusted to conditions of climate, landform and vegetation and changes internally when these controlling conditions change.

2. Discuss the importance of soil forming factors in determining the soil types in different parts of India. Elaborate with suitable examples.

(200 words)

Approach

1. **Characteristics of soil** ***(40 words)***
2. **Factors that form soil** ***(40 words)***
3. **Detailed discussion on each factor** ***(120 words)***

Hints

Soil is the thin surface layer on the earth and is very important natural resource of India because agricultural production is basically on the fertility of soils.

The rich, deep fertile soils of the ganga plain, especially its delta and coastal plains of Kerala support high density of population through agricultural prosperity on the other hand, the shallow and the coarse-grained soils of Telangana and Rajasthan support only a small population because these soils do not provide a base for prosperous agriculture.

Importance of soil forming factors in determining the soil types in different parts of India

In Indian conditions, there is wide diversity with respect to geographical conditions such as Physiography, climate and Vegetation. Consequently, sols display a wide variety of physical and chemical characteristics. In India, soil formation is mainly related to the parent rock material, surface relief, climate and natural vegetation, Animals, insects and man also play an important role in soil formations. Some of the important factors of soil formation are mentioned as follows:

Parent Material:

The material for soil formation is mainly derived from the rocks and is termed as the parent material by the scientists. The parent material determines the coloration of the soil, its mineral composition and texture. India possess a great variety of parent material which is generally categorized into some of the following classes

- Ancient crystalline and metamorphic rocks
  - The surface rocks are exposed to the process of weathering and suffer decay and decomposition. In this process, the rocks are converted into fine grains and provide a base for the soil formation the ancient, crystalline and metamorphic rocks constitute greater part of the peninsular regions. These rocks are basically granites, gneisses and schist's which are rich in ferromagnetism materials. such rocks give is largely due to the presence of Iron oxide,
- Cuddapah the vindhyan rocks
- These rocks have weathered to give calcareous and argillaceous soils. These soils are native.
- Deccan traps

These rocks are composed of basalt, Basalt are quite rich in titanium, magnetite, aluminum and magnesium consequently the weathering of these rocks has given to soils of darker colour. The soils of the northern plain of India have been largely derived from the depositional work of the Himalayan rivers. This depositional work has been continuing for thousands of years. These are alluvial fertile soils consisting of fine silts and clay. These soils have little relation with original rocks on the other hand, the soils of peninsular plateau are generally coarse grained and are closely related to the parent rock. The peninsular soils are generally less fertile.

Relief:

Relief influences the process of soil formation in many ways, the most being the slope of the land. Steep Slope encourages the swift flow of water and Hindus the process of soil formation the areas of low relief or gentle slope generally experience deposition and have deep soils because of this reason there are thick layers of fertile alluvial soils in the northern plains of India. Whereas soils are generally shallow is the plateau area.

Climate:

Climate is the single most important factor is soil formation most important climate factors affecting soil formation are the amount of temperature and rainfall. For example, in the areas of the heavy rainfall and high temperature, the soils are red or lateritic. Torrential rainfall during the rainy season washes the upper soil and leaches the material into deeper horizon. During the dry summer season, the evaporation exceeds precipitation and through capillary action iron and aluminum oxides are transported to the surface making the soil red. In the areas of alternate wet & dry climate, the leached material which goes deep down in the horizon in the broughup and the blazing sun bakes the top soil so that it resembles a brick. Therefore, this soil is called lateritic which literally means brick.

In arid and semi-arid regions evaporation always exceeds precipitation which makes soils are widely spread in the extreme western part of the country. In the cold climates of the Himalayan region, the process of vegetation decay is very slow and the soils formed under such circumstances are acidic in nature.

Hot summer and low rainfall develop black soil as is found in some parts of Tamilnadu irrespective of the parent rock in Rajasthan, both granite and sandstone give birth to sandy soil under arid climate. This soil is poor in organic matter.

Natural vegetation

Natural vegetation reflects the combined effects of relief and climate. The type of vegetation, the decayed leaf material adds much needed humus to soil thereby increasing its fertility. The densely forested areas contain some of the best soils in India. There is a close relationship between the vegetation types and soil types in India.

3. India has various relief features, landforms, climate realms and vegetation types and these have contributed in the development of various types of soil in India. Elaborate. Also, suggest measures to protect the soil degradation in India.

(250 words)

Approach

1. **Give a brief Introduction on factors affecting the formation of soil.** ***(40 words)***
2. **Explain how various physical features such as role of Himalayas, Deccan plateau and rainfall that have contributed in the development of various types of soil in India.** ***(90 words)***
3. **Discuss measures to protect the soil degradation in India.** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

Soil is the mixture of rock debris and organic materials which develop on the earth's surface. The major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life-forms and time. Besides these, human activities also influence it to a large extent. Components of the soil are mineral particles, humus, water and air. The actual amount of each of these depend upon the type of soil.

Various physical features that have contributed in the development of various types of soil in India are:

Role of Himalyas and Rivers :

- The Himalayas and rivers combinedly worked in the formation of siols, these two feautres are responsible for the formation of alluvial plains of India. Alluvial soils are widespread in the northern plains and the river valleys. They are depositional soils, transported and deposited by rivers and streams.
- Through a narrow corridor in Rajasthan, they extend into the plains of Gujarat. In the Peninsular region, they are found in deltas of the east coast and in the river valleys. The alluvial soils vary in nature from sandy loam to clay. They are generally rich in potash but poor in phosphorous. These soils are more loamy and clayey in the lower and middle Ganga plain and the Brahamaputra valley. The sand content decreases from the west to east.

Role of Deccan plateau:

- Deccan plateau is lavatic in origin. This lava is responsible for the formation of black soil in deccan plateau .Black soil covers most of the Deccan Plateau which includes parts of Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh and some parts of Tamil Nadu.
- In the upper reaches of the Godavari and the Krishna, and the north. Western part of the Deccan Plateau, the black soil is very deep. These soils are also known as the 'Regur Soil' or the 'Black Cotton Soil'. The black soils are generally clayey, deep and impermeable. They swell and become sticky when wet and shrink when dried. So, during the dry season, these soil develop wide cracks. Thus, there occurs a kind of 'self ploughing'

Role of Rainfall:

- The areas which receives high rainfall .This high rainfall has resulted in leaching of minerals like lime and silica. This lead to formation of laterite soil by high rainfall . The laterite soils develop in areas with high temperature and high rainfall. These are the result of intense leaching due to tropical rains.
- With rain, lime and silica are leached away, and soils rich in iron oxide and aluminium compound are left behind. Humus content of the soil is removed fast by bacteria that thrives well in high temperature. These soils are poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess. Hence, laterites are not suitable for cultivation;

Role of high temperature and evaporation and lack of orographic rain:

- Conditions like high temperature and low rainfall results into the formation of Arid soil. Arid soils range from red to brown in colour. They are generally sandy in structure and saline in nature. In some areas, the salt content is so high that common salt is obtained by evaporating the saline water. Due to the dry climate, high temperature and accelerated evaporation, they lack moisture and humus. Nitrogen is insufficient and the phosphatecontent is normal.
- Lower horizons of the soil are occupied by 'kankar' layers because of the increasing calcium content downwards. Arid soils are characteristically developed in western Rajasthan, which exhibit characteristic arid topography. These soils are poor and contain little humus and organic matter .

Role of Forest:

- Forest soils are formed in the forest areas where sufficient rainfall is available. The soils vary in structure and texture depending on the mountain environment where they are formed. They are loamy and silty on valley sides and coarse-grained in the upper slopes. In the snow-bound areas of the Himalayas, they experience denudation, and are acidic with low humus content.

- The soils found in the lower valleys are fertile. It is evident from the foregoing discussions that soils, their texture, quality and nature are vital for the germination and growth of plant and vegetation including crops. Soils are living systems.

Measures to protect the soil degradation in India:

- If soil erosion and exhaustion are caused by humans; by corollary, they can also be prevented by humans. Nature has its own laws of maintaining balance. Nature offers enough opportunities for humans to develop their economy without disturbing the ecological balance. Soil conservation is a methodology to maintain soil fertility, prevent soil erosion and exhaustion, and improve the degraded condition of the soil. Soil erosion is essentially aggravated by faulty practices.
- The first step in any rational solution is to check open cultivable lands on slopes from farming .If at all the land is to be used for agriculture, terraces should carefully be made. Over-grazing and shifting cultivation in many parts of India have affected the natural cover of land and given rise to extensive erosion. It should be regulated and controlled by educating villagers about the consequences.
- Contour bunding, Contour terracing, regulated forestry, controlled grazing, cover cropping, mixed farming and crop rotation are some of the remedial measures which are often adopted to reduce soil erosion.
- Efforts should be made to prevent gully erosion and control their formation. Finger gullies can be eliminated by terracing. In bigger gullies, the erosive velocity of water maybe reduced by constructing a series of check dams. Special attention should be made to control headward extension of gullies. This can be done by gully plugging, terracing or by planting cover vegetation.
- In arid and semi-arid areas, efforts should be made to protect cultivable lands from encroachment by sand dunes through developing shelter belts of trees and agro-forestry. Lands not suitable for cultivation should be converted into pastures for grazing. Experiments have been made to stabilise sand dunes in western Rajasthan by the Central Arid Zone Research Institute (CAZRI).

Conclusion:

The Central Soil Conservation Board, set up by the Government of India, has prepared a number of plans for soil conservation in different parts of the country. These plans are based on the climatic conditions, configuration of land and the social behaviour of people. Even these plans are fragmental in nature. Integrated land use planning, therefore, seems to be the best technique for proper soil conservation. Lands should be classified according to their capability; land use maps should be prepared and lands should be put to right uses. The final responsibility for achieving the conservation of land will rest on the people who operate on it and receive the benefits.

4. Why is soil important? Briefly explain the factors responsible for and the stages of soil formation.

(150 words)

Approach

1. Define 'soil' and its importance for Human Civilization ***(20 words)***

2. **Explain the factors responsible for soil formation** ***(40 words)***
3. **Give a detailed account of the stages of Soil formation.** ***(70 words)***
4. **Conclusion** ***(20 words)***

Hints

Soil is unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants. Soil is one of the most important and essential natural resources. It offers plants physical support, air, water, temperature moderation, nutrients, and protection from toxins. Soils provide readily available nutrients to plants and animals by converting dead organic matter into various nutrient forms.

Soil is a dynamic medium in which many chemical, physical and biological activities go on constantly. Soil is a result of decay, it is also the medium for growth. It is a changing and developing body. It has many characteristics that fluctuate with the seasons. It may be alternatively cold and warm or dry and moist. Biological activity is slowed or stopped if the soil becomes too cold or too dry. Organic matter increases when leaves fall or grasses die.

Why is Soil Important?

- Soil provides ecosystem services critical for life: soil acts as a water filter and a growing medium; provides habitat for billions of organisms, contributing to biodiversity; and supplies most of the antibiotics used to fight diseases.
- Humans use soil as a holding facility for solid waste, filter for wastewater, and foundation for our cities and towns. Finally, soil is the basis of our nation's agro ecosystems which provide us with feed, fiber, food and fuel.

Factors of soil formation

Soils are formed through the interaction of five major factors: time, climate, parent material, topography and relief, and organisms. The relative influence of each factor varies from place to place, but the combination of all five factors normally determines the kind of soil developing in any given place.

- **Time:** The formation of soils is a continuing process and generally takes several thousand years for significant changes to take place.
- Climate, particularly temperature, precipitation and frost action have a profound influence on the soil forming processes which occur within a region. The kind of climate largely determines the nature of the weathering processes that will occur and the rates of these chemical and physical processes. It directly affects the type of vegetation in an area which in turn will affect those soil forming processes related to vegetation.
- Parent material is the unconsolidated mineral and organic deposits in which soils are developing. It determines the mineralogical composition and contributes largely to the physical and chemical characteristics of the soil. The kind of parent material also influences the rate at which soil forming processes take place.
- **Topography and Relief:** The shape of the land surface, its slope and position on the landscape, greatly influence the kinds of soils formed. Soils that developed on higher elevations and sloping areas are generally excessively drained or well drained. Permeability of the soil material; as well as the length, steepness, and configuration of the slopes, influence the kind of soil that is formed in an area.

All living organisms actively influence the soil forming process. These organisms include bacteria, fungi, vegetation and animals. Their major influence is the effect on the chemical and physical environment of the soils.

Stages of Soil formation

- Soil formation or pedogenesis depends first on weathering. It is this weathering mantle (depth of the weathered material) which is the basic input for soil to form.
- First, the weathered material or transported deposits are colonized by bacteria and other inferior plant bodies like mosses and lichens. Also, several minor organisms may take shelter within the mantle and deposits.
- The dead remains of organisms and plants help in humus accumulation. Minor grasses and ferns may grow; later, bushes and trees will start growing through seeds brought in by birds and wind.
- Plant roots penetrate down, burrowing animals bring up particles, and mass of material becomes porous and sponge-like with a capacity to retain water and to permit the passage of air and finally a mature soil, a complex mixture of mineral and organic products forms.

Conclusion:

Soil is our life support system. Soil plays a vital role in the Earth's ecosystem without which human life would be very difficult. Hence, it is important to focus on soil Conservation which is a combination of practices used to protect the soil from degradation

5. Discuss causal factors behind soil erosion. What conservation activities can be taken to reverse these phenomena?

(250 words)

Approach

1. **Define the term - soil erosion** ***(50 words)***
2. **Discuss causal factors like deforestation, farming, etc. behind soil erosion** ***(70 words)***
3. **Explain the conservation activities taken to reverse these phenomena.** ***(90 words)***
4. **Conclusion** ***(40 words)***

Hints

Soil erosion is a naturally occurring process that affects all landforms. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage.

Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition. Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere "on-site" where it builds up over time or is carried "off-site" where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes.

Soil erosion can be a slow process that continues relatively unnoticed or can occur at an alarming rate, causing serious loss of topsoil. Soil compaction, low organic matter, loss of soil structure, poor internal drainage, Salinization and soil acidity problems are other serious soil degradation conditions that can accelerate the soil erosion process.

Causal factors of soil erosion

The agents of soil erosion are the same as the agents of all types of erosion: water, wind, ice, or gravity. Running water is the leading cause of soil erosion, because water is abundant and has a lot of power. Wind is also a leading cause of soil erosion because wind can pick up soil and blow it far away.

- **Deforestation**-Activities that remove vegetation, disturb the ground, or allow the ground to dry are activities that increase erosion.
- **Farming:** Agriculture is probably the most significant activity that accelerates soil erosion because of the amount of land that is farmed and how much farming practices disturb the ground. Farmers remove native vegetation and then plow the land to plant new seeds. Because most crops grow only in spring and summer, the land lies fallow during the winter. Tractor tires make deep grooves, which are natural pathways for water. Fine soil is blown away by wind.
- **Grazing** : Grazing animals wander over large areas of pasture or natural grasslands eating grasses and shrubs. Grazers expose soil by removing the plant cover for an area. They also churn up the ground with their hooves. If too many animals graze the same land area, the animals' hooves pull plants out by their roots. A land is overgrazed if too many animals are living there.
- **Logging and Mining:** Logging removes trees that protect the ground from soil erosion. The tree roots hold the soil together and the tree canopy protects the soil from hard falling rain. Logging results in the loss of leaf litter, or dead leaves, bark, and branches on the forest floor. Leaf litter plays an important role in protecting forest soils from erosion.
- **Construction:** Constructing buildings and roads churns up the ground and exposes soil to erosion. In some locations, native landscapes, such as forest and grassland, are cleared, exposing the surface to erosion.

Conservation activities taken to reverse this phenomena

- Soil conservation is the prevention of soil loss from erosion or reduced fertility caused by over usage, acidification, Stalinization or other chemical soil contamination.
- Many different techniques have been invented throughout the years with the aim of preserving the nutrient level of the soil and preventing erosion:
  - Contour Plowing involves plowing grooves into the desired farmland, then planting the crop furrows in the grooves and following the contours. It is a very effective way for farmland on slopes to prevent run off and improve crop yields.
  - Terracing is a method of carving multiple, flat leveled areas into hills. Steps are formed by the terraces which are surrounded by a mud wall to prevent run off and hold the soil nutrients in the beds.
- **Keyline Design** – A more enhanced version of Contour Plowing, maximum water retention is achieved by taking into account all the watershed properties when making the contour lines. The Keyline refers to a topographic feature linked to water flow. This allows the water runoff to run directly into an existing water channel, and prevent soil erosion caused by the water.

- Rows of tall trees are used in dense patterns around the farmland and prevent wind erosion. Evergreen trees can provide year round protection but deciduous trees can be adequate as long as foliage is apparent during the seasons when the soil is bare.
- Cover crops such as turnips and radishes are rotated with cash crops in order to blanket the soil all year- round and produce green manure that replenishes nitrogen and other critical nutrients. Using cover crops can also suppress weeds.
- **Agrostological Measures** – Planting grass in heavily eroded areas is called an agrostological measure. Ley farming practices cultivating grass in rotation with regular crops to increase the nutrient level in the soils. When the grass is harvested it can be used as fodder for cattle.
- **No till farming** – This is the method of growing crops year round without changing the topography of the soil by tilling or contouring.
- **Dry Farming –** In areas with a very low amount of rainfall, crops which require very little water should be grown, this will lead to the preservation of the natural levels of moisture and nutrients in the soil.
- **Salinity Management** – When water evaporates from the soil, it leaves behind its salt. This can lead to damage to the soil and nutrient loss. Using humic acids can prevent this or growing crops like saltbush can rejuvenate the soils and replace lost nutrients. High levels of salt in the soil can often be caused by changes made to the water table by damming and other causes.
- **Green Manures** – Green manures are a few different crops that can be grown, not for produce or food usage, but grown in order to fertilize the farm land on which it grows. This method can improve the soil structure and suppress the growth of weeds.

Conclusion:

Soil conservation is an active ongoing process. It is a combination of practices used to protect the soil from degradation. It involves treating the soil as a living ecosystem, meaning returning organic matter to the soil on a continual basis.

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NOTES

SET-5: QUESTIONS

IMPORTANT GEOPHYSICAL PHENOMENA

Q1. Why Himalayas are more prone to earthquakes than Western Ghats? Locate the various seismic highways in India by drawing a map of India & discuss the mechanism of propagation of earthquake inside the earth surface.

Q2. "A different kind of Tsunami waves hit Java and Sumatra Islands which was not detected by Tsunami Early warning system". Discuss different factors behind origin of Tsunami and innovation required in early warning system to detect different types of Tsunamis.

Q3. Volcanoes are classified on the basis of nature of eruption and the form developed at the surface. Elaborate. Also, discuss the volcanic land forms?

Q4. Discuss the intrusive landform of igneous intrusion in volcanic region while enumerating their examples.

Q5. What do you understand by extra-tropical cyclone? How the extra-tropical cyclones are developed. Explain the impact of these cyclones on the weather of different regions?

Q6. How tropical cyclone is different from temperate cyclones? What are the necessary conditions for formation of tropical cyclones?

Q7. Why Bay of Bengal region is regularly affected by tropical cyclones? Examine why despite the regular occurrence, the region lacks the advance planning and institutional infrastructure.

Q8. Discuss the concept of fronts. In what way are the fronts related to cyclones? Present a comparative distinctiveness of a tropical cyclone with that of an extra-tropical cyclone.

Q9. A map of India reveals that the North-Eastern region of our country is most prone to floods. What are the reasons for the routine occurrence of floods in these regions? How can the same be controlled?

Q10. Briefly evaluate the impact of structural and non-structural initiatives taken for controlling the floods in India?

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SET-5: ANSWERS

1. Why Himalayas are more prone to earthquakes than Western Ghats? Locate the various seismic highways in India by drawing a map of India & discuss the mechanism of propagation of earthquake inside the earth surface.

(250 words)

Approach

1. **Briefly introduce Earthquake & Why Himalayas are more prone to earthquakes than Western Ghats** ***(70 words)***
2. **Locate the various seismic highways in India by drawing a map of India** ***(60 words)***
3. **Discuss the mechanism of propagation of earthquake inside the earth surface** ***(60 words)***
4. **Conclusion** ***(60 words)***

Hints

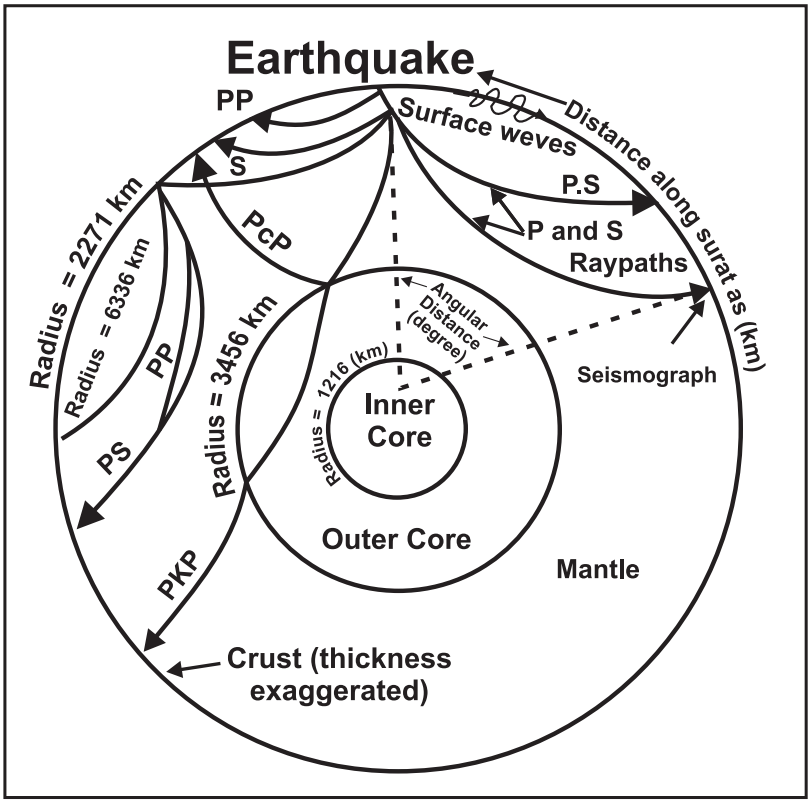
An earthquake can be defined as a sudden violent shaking of the ground as a result of movements in the earth's crust or volcanic action. These earthquakes result from a series of earth movements brought about by a sudden release of energy during the tectonic activities in the earth's crust.

- India is prone to almost all natural disasters ranging from earthquakes, landslides, tsunami, drought, floods, and cyclones due to its varied physiographic.
- The Himalayas and the Western Ghats have been formed by the plate movements and are prone to a variety of disasters including earthquakes and landslides. However, the Himalayas have more chances of earthquakes when compared to Western Ghats. The reasons are:
- The Himalayas are Young – tertiary mountains whereas Western Ghats are Older-block Mountain.
- Himalayas has not yet reached its isostatic equilibrium which makes it more prone to frequent earth quakes but on the other hand Western Ghats are located on stable part of Indian plate and the chances of colliding of plates in this region are less when compared to Himalayas.
- Indian plate is moving northwards and subsiding under Eurasian plate, 5-10 cm a year. This leads to rising of Himalayas every year whereas Moving of Indian plate does not affect Western Ghats. This also affects the earthquakes that come in the region.

- Unplanned growth of houses in the hill areas increases the damage and the loss that occurs due to the disasters in the region whereas limiting the damage in Western Ghats.
- Thus, the main reason for more earthquakes in the Himalayas is due to proneness to more plate movements and due to instability of the Himalayan Mountains.
- The map given depicts the different seismic zones of India.

Mechanism of propagation of earthquake inside the earth surface

- Earthquake waves are basically of two types — body waves and surface waves.
- Body waves are generated due to the release of energy at the focus and move in all directions travelling through the body of the earth. The body waves interact with the surface rocks and generate new set of waves called surface waves. These waves move along the surface. The velocity of waves changes as they travel through materials with different densities. The denser the material, the higher is the velocity. Their direction also changes as they reflect or refract when coming across materials with different densities.



- As the waves move or propagate, they cause vibration in the body of the rocks through which they pass. P-waves vibrate parallel to the direction of the wave. This exerts pressure on the material in the direction of the propagation. As a result, it creates density differences in the material leading to stretching and squeezing of the material. Other three waves vibrate perpendicular to the direction of propagation. The direction of vibrations of S-waves is perpendicular to the wave direction in the vertical plane. Hence, they create troughs and crests in the material through which they pass. Surface waves are considered to be the most damaging waves.

2. "A different kind of Tsunami waves hit Java and Sumatra Islands which was not detected by Tsunami Early warning system". Discuss different factors behind origin of Tsunami and innovation required in early warning system to detect different types of Tsunamis.

(250 words)

Approach

1. **Briefly discuss about Indonesian Tsunami which hit the Island nation in 2018 .** ***(50 words)***
2. **Discuss causes and factors behind the formation of Tsunami waves.** ***(80 words)***
3. **Discuss the Indonesian Tsunami which remained undetected by Early warning System of the nation, causes and mitigation strategy.** ***(70 words)***
4. **Conclude with note that how will it strengthen disaster risk reduction framework in line with Sendai Framework for Disaster Risk Reduction by 2030.** ***(50 words)***

Hints

There were massive Tsunami waves which hit Java and Sumatra Island of Indonesia in 2018 and were undetected. Tsunami waves that hit the coast was somewhere between 100 to 149 meters tall and affected the shores of the two islands of the country. But, most important thing that occurred during this period was that it went unnoticed by the Tsunami Early Warning System which was deployed to detect tsunami waves after the Tsunami that hit the island nation in 2004.

Causes and factors behind the formation of Tsunami waves

- A tsunami is a large ocean wave that is caused by sudden motion on the ocean floor. This sudden motion could be an earthquake, a powerful volcanic eruption, or an underwater landslide. The impact of a large meteorite could also cause a tsunami.
- Most tsunamis are caused by earthquakes generated in a subduction zone in large oceans and seas. It is an area where an oceanic plate is being forced down into the mantle by plate tectonic forces.
- The friction between the subducting plate and the overriding plate is enormous. This friction prevents a slow and steady rate of subduction and instead the two plates become "stuck."
- The stuck plate continues to descend into the mantle, the motion causes a slow distortion of the overriding plate, which ultimately stores energy.
- After decades, the stuck plates are released after exceeding a limit and moves back in the previous position causing massive under-current causing generation of Tsunami waves.
- The moving wave begins travelling out from where the earthquake has occurred. Some of the water travels out and across the ocean basin, and at the same time, water rushes landward to flood the recently lowered shoreline.

The Indonesian Tsunami which remained undetected by Early warning System

- The Tsunami which occurred in Indonesia was due to massive eruption of the Mount Anak Karkatao which erupted violently and unloaded its sediments, debris and volcanic material into it and a part of mountain also rolled into the sea.
- This led to formation of water ripples which ultimately formed huge Tsunami waves on reaching shores.

Innovation required in early warning system

- Indonesia's Tsunami early warning system which was completed in 2008 after it was commissioned aftermath of Tsunami in 2004.
- It consists of seismographic sensors, buoys, tidal gauges and GPS, all the instruments were concentrated to detect tsunami originating from submarine earthquakes.
- None of these measures were able to adequately predict the scale of tsunami which was caused by landslide and a nearly undetected earthquake, which reached heights of 20 feet.
- These systems primarily focus on earthquakes generated in a subduction zone and do not consider other factors such as landslide and volcanic eruption.
- Hence, this early warning system must be equipped with tidal gauges which can detect ripples due to landslides and volcanic eruptions too.

Conclusion:

Indonesian tsunami killed more than 1200 people and caused destruction of coastal infrastructure, property and affected livelihood of millions. Geologists and scientists across the world must focus on other causes of the Tsunamis and innovate ideas to tackle them. This will strengthen disaster risk reduction framework and help to mitigate the challenges posed by disasters. It will also help in fulfilling the goals set by Sendai Framework for Disaster Risk Reduction by 2030.

3. Volcanoes are classified on the basis of nature of eruption and the form developed at the surface. Elaborate. Also, discuss the volcanic land forms?

(200 words)

Approach

1. **Brief introduction on volcanoes** ***(40 words)***
2. **Classification of volcano** ***(80 words)***
3. **Volcanic land forms** ***(80 words)***

Hints

A volcano is a rupture on the crust from where gases, ashes and/or molten rock material - lava - escape to the ground. Once it starts moving towards the crust or it reaches the surface, it is referred to as lava. The material that reaches the ground includes lava flows, pyroclastic debris, volcanic bombs, ash and dust and gases such as nitrogen compounds, Sulphur compounds and minor amounts of chlorine, hydrogen and argon.

A volcano is called an active volcano if the materials mentioned are being released or have been released out in the recent past. In India, Barren Island (Andaman and Nicobar Islands) has the only active volcano of the country. Recently, population of a part of Hawaiian island was evacuated due to massive lava eruption.

Major types of volcanoes are as follows:

- **Shield Volcanoes:** Barring the basalt flows, the shield volcanoes are the largest of all the volcanoes on the earth. The Hawaiian volcanoes are the most famous examples. These volcanoes are mostly made up of basalt, a type of lava that is very fluid when erupted. For this reason, these volcanoes are not steep.
- **Composite Volcanoes:** These volcanoes are characterized by eruptions of cooler and more viscous lavas than basalt. These volcanoes often result in explosive eruptions.
- **Caldera:** These are the most explosive of the earth's volcanoes. They are usually so explosive that when they erupt they tend to collapse on themselves rather than building any tall structure.
- **Flood Basalt Provinces:** These volcanoes outpour highly fluid lava that flows for long distances. Some parts of the world are covered by thousands of sq. km of thick basalt lava flows. The Deccan Traps from India, presently covering most of the Maharashtra plateau, are a much larger flood basalt province.
- **Mid-Ocean Ridge Volcanoes:** These volcanoes occur in the oceanic areas. There is a system of mid-ocean ridges more than 70,000 km long that stretches through all the ocean basins.

Volcanic landforms:

- **Intrusive Forms:** The lava that is released during volcanic eruptions on cooling develops into igneous rocks. The cooling may take place either on reaching the surface or also while the lava is still in the crustal portion.
- **Batholiths:** A large body of magmatic material that cools in the deeper depth of the crust develops in the form of large domes. They appear on the surface only after the denudational processes remove the overlying materials. They cover large areas, and at times, assume depth that may be several km.
- **Laccoliths:** These are large dome-shaped intrusive bodies with a level base and connected by a pipe-like conduit from below. It resembles the surface volcanic domes of composite volcano, only these are located at deeper depths.
- **Lapolith, Phacolith and Sills:** As and when the lava moves upwards, a portion of the same may tend to move in a horizontal direction wherever it finds a weak plane. It may get rested in different forms.

4. Discuss the intrusive landform of igneous intrusion in volcanic region while enumerating their examples.

(200 words)

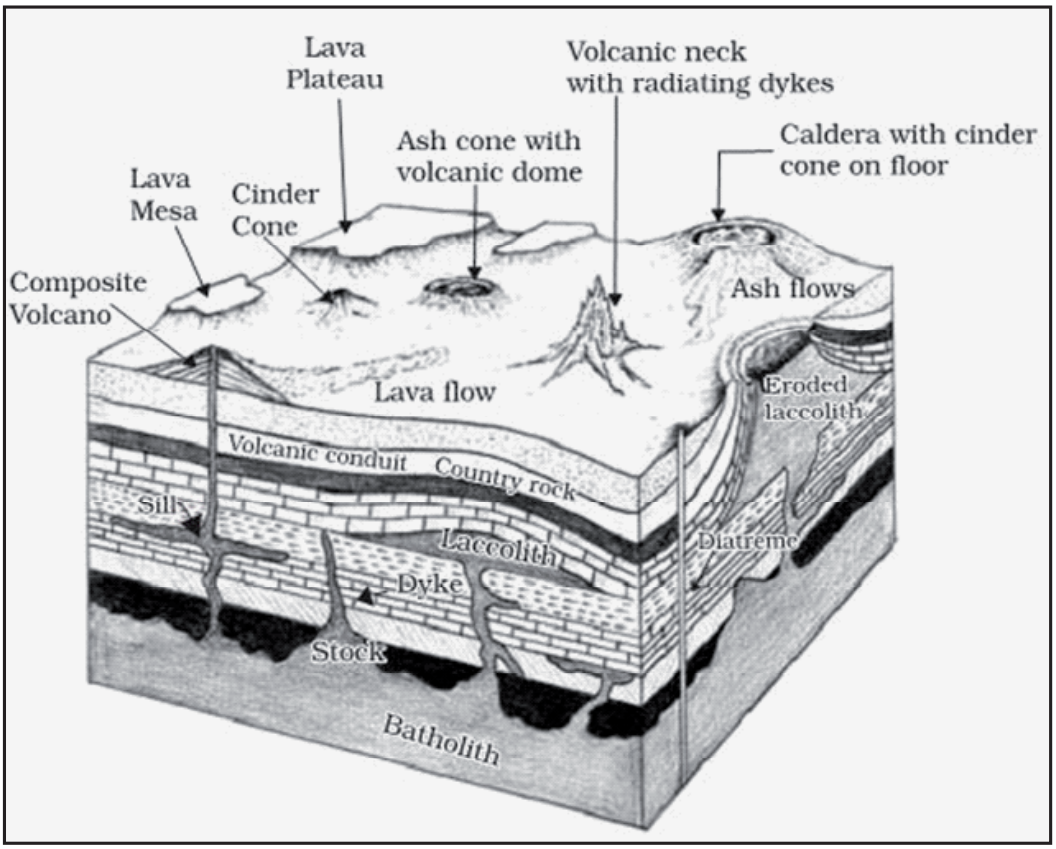
Approach

1. **Briefly introduce intrusive landforms.** ***(50 words)***
2. **Elaborate on various intrusive landforms with examples around the world.** ***(150 words)***

Hints

The landforms formed due to the solidification of lava either inside or outside the earth surface are known as volcanic landform. When molten magma thrusting its way up to the surface cools and solidifies within the earth crust, it results into intrusive landform development.

The resultant landforms is determined based on the strength and fluidity of magma, the type of cracks, faults and joints that it penetrates and bedding plain of rock strata.



Major types of igneous intrusive landform:

- **Batholiths:** These are large rock masses formed due to cooling down and solidification of hot magma inside the earth. They appear on the surface only after the denudation processes remove the overlying materials. Batholiths form the core of huge mountains and may be exposed on surface after erosion. These are granitic. This is the case on Dartmoor and on the Isle of Arran.
- **Laccoliths:** These are large dome-shaped intrusive bodies connected by a pipe-like conduit from below. These are basically intrusive counterparts of an exposed domelike batholith. The Karnataka plateau is spotted with dome hills of granite rocks. Most of these, now exfoliated, are examples of laccoliths or batholiths.
- **Lapolith:** As and when the lava moves upwards, a portion of the same may tend to move in a horizontal direction wherever it finds a weak plane. It may get rested in different forms. In case it develops into a saucer shape, concave to the sky body, it is called Lapolith. Example includes Bushveld lopolith of Transvaal, South Africa.

- **Phacolith:** A wavy mass of intrusive rocks, at times, is found at the base of synclines or at the top of anticline in folded igneous country. Such wavy materials have a definite conduit to source beneath in the form of magma chambers (subsequently developed as batholiths). These are called the Phacoliths. Example:Corndon Hill, England.
- **Sills:** These are solidified horizontal lava layers inside the earth. The near horizontal bodies of the intrusive igneous rocks are called sill or sheet, depending on the thickness of the material. The thinner ones are called sheets while the thick horizontal deposits are called sills. Examples include the Great Whin Sill and Drumadoon on the Isle of Arran. Both sills and dykes are commonly made up of dolerite.
- **Dykes:** When the lava makes its way through cracks and the fissures developed in the land, it solidifies almost perpendicular to the ground. It gets cooled in the same position to develop a wall-like structure. Such structures are called dykes. These are the most commonly found intrusive forms in the western Maharashtra area. These are considered the feeders for the eruptions that led to the development of the Deccan traps.

5. What do you understand by extra-tropical cyclone? How the extra-tropical cyclones are developed. Explain the impact of these cyclones on the weather of different regions?

(200 words)

Approach

1. **Give a brief description of extra-tropical cyclone** ***(50 words)***
2. **How the extra-tropical cyclones are developed** ***(60 words)***
3. **Explain the impact of these cyclones on the weather of different regions** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

An extra-tropical cyclone is a storm system that primarily gets its energy from the horizontal temperature contrasts that exist in the atmosphere. They typically form on a boundary between a warm and a cold air mass associated with an upper troposphere jet stream. Their circulations affect the entire troposphere over a region 1000 km or more. Extra tropical cyclones tend to develop with a particular life cycle. The Low pressure centre moves roughly with the speed of the 500 mb wind above it. Extra-tropical cyclones (also known as mid-latitude or bar clinic storms) are low pressure systems with associated cold fronts, warm fronts, and occluded fronts.

An extra-tropical cyclone tends to focus the temperature contrasts into 'frontal zones' of particularly rapid horizontal temperature change. Found in regions between 35Ú and 65Ú latitudes in both hemispheres where warm, moist and light tropical air masses converge with cold and dense polar air masses.

Under such convergence and due to Coriolis Effect, a wedge is developed around which both warm and cold fronts develop. With increase in Coriolis force, the amplitude of the frontal waves increases, thus developing the depression into a fully developed cyclone.

Life cycle of the cyclone:

- Initial stage
- Incipient stage
- Mature stage
- Occlusion stage

Weather conditions:

- **Arrival of cyclone:** Wind velocity slows down, air pressure decreases; halo is produced by cirrus clouds. As cyclone is about to reach, temperature increases suddenly and wind direction is changed.
- **Warm frontal precipitation:** slow and prolonged shower by nimbostratus clouds.
- **Warm sector:** Wind direction changes again, sky becomes cloudless and clear.
- **Cold front:** marked decrease in temperature, heavy precipitation by cumulonimbus clouds.
- **Cold sector:** Sky becomes cloudless and clear, temperature decreases sharply and air pressure increases.

6. How tropical cyclone is different from temperate cyclones? What are the necessary conditions for formation of tropical cyclones?

(200 words)

Approach

1. **Give a brief description of cyclones** ***(50 words)***
2. **How tropical cyclone is different from temperate cyclones** ***(100 words)***
3. **Discuss the necessary conditions for formation of tropical cyclones** ***(50 words)***

Hints

Cyclone is a system of winds or large scale air mass rotating inwards to an area of low barometric pressure, with an anti clock wise (northern hemisphere) or clockwise (southern hemisphere) circulation. Depending upon latitudinal location these can be classified into tropical and temperate cyclones. Cyclones influence the weather and climate of the region.

Major difference between Tropical and temperate cyclones are:

- **Latitude**: Tropical cyclone is confined between 5 to 30 degree north and south of the equator, whereas temperate cyclone originates between 30 to 60 degree north and south of the equator.
- **Originating element:** Temperature and Coriolis force plays vital role in the origin of tropical cyclone. In case of temperate cyclone, it is front genesis plays important driving force.
- **Types of cloud associated**: Wide range of clouds is associated with the temperate cyclone. While in the case of tropical cyclone the cloud composition is mainly dominated by cumulonimbus clouds.

- **Rainfall and lifetime**: In tropical cyclones, it rains heavily but does not last beyond a few hours. If the cyclone stays at a place, the rainfall may continue for few days generally not more than a week. While In a temperate cyclone, rainfall is slow and continues for many days, sometimes even 2-3 weeks.
- I**sobars**: In tropical cyclones isobars are complete circles and the pressure gradient is steep while in temperate cyclones Isobars are usually 'V' shaped and the pressure gradient is low.
- **Area covered**: Temperate cyclone covers large area as compared to tropical cyclone.
- **Source of origin:** Tropical cyclone generally originates over water surface but the temperate cyclone originates over mid-latitude land mass.
- **Direction of flow:** Temperate cyclone generally flows eastward movement (west -> east) but there is no as such fixed movement pattern in case of tropical cyclone. Tropical cyclone generally takes the path from sea to land.
- **Numbers**: Tropical cyclone is of singular characteristic, whereas temperate cyclone flows in family.
- **Eye:** Eye is a typical feature in case of tropical cyclone, where as in temperate cyclone there is no such concept of 'EYE' associated with it.

Necessary conditions for formation of tropical cyclones include:

- Water temperatures of at least 26.5 °C down to a depth of at least 50 m, so that it may cause the overlying atmosphere to be unstable enough to sustain convection and thunderstorms.
- Rapid cooling with height, so that it may cause release of the heat of condensation that powers a tropical cyclone.
- High humidity
- Low amounts of wind shear as high shear is disruptive to the storm's circulation.
- A distance from the Equator is necessary, which should be at least 555 km or 5° of latitude, so that it allows the Coriolis Effect to deflect winds blowing towards the low pressure centre and creating a circulation. Because the Coriolis effect initiates and maintains tropical cyclone rotation, tropical cyclones rarely form or move within about 5° of the equator, where the Coriolis effect is weakest.
- A pre-existing system of disturbed weather.
- Tropical cyclones have disastrous impact on the coastal area thus an early warning system, resilient infrastructure and efficient rescue and rehabilitation is required in affected areas.

7. Why Bay of Bengal region is regularly affected by tropical cyclones? Examine why despite the regular occurrence, the region lacks the advance planning and institutional infrastructure.

(250 words)

Approach

1. **Brief introduction on Bay of Bengal area and tropical cyclones** ***(40 words)***
2. **Reasons for regular tropical cyclones in the Bay of Bengal region** ***(70 words)***

3. Reasons for lack of planning and institutional infrastructure ***(100 words)***

4. Conclusion ***(40 words)***

Hints

Indian subcontinent with a long coastline of 8041 kilometers is exposed to nearly 10 per cent of the world's tropical cyclones. Of these, the frequency is more in the Bay of Bengal than in the Arabian Sea, the ratio being is 4:1.On an average, five to six tropical cyclones form every year, of which two or three could be severe.

Severity of tropical cyclone: Tropical cyclones occur in the months of May-June and October-November. It is characterized by destructive winds, torrential rainfall and storm surges. As exceptional level of rainfall and storm surge inundates into inland areas, resulting into flood, tropical cyclones disrupts normal life by causing loss of lives and property, eroding beaches and embankments, destroying vegetation and reducing soil fertility.

Factors contributing to frequent tropical cyclones in Bay of Bengal region:

- **Sea Surface Temperatures:** The ideal temperature is around 25-27 degrees Celsius. This temperature helps to sustain the moisture and provide enough force to the cyclone. Bay of Bengal is relatively warmer compared to Arabian Sea and the average sea surface temperature is higher. It is known, warmer east coast attracts more cyclones.
- **Wind shear**: For a tropical cyclone like the ones in Bay of Bengal to form, it is required to have a relatively lower vertical wind-shear. This effectively means that lower the difference in the speed of the wind with respect to altitude, greater will be the chance of formation of a cyclone.
- **Additional influx of moisture from South China Sea:** It is often seen, when Bay of Bengal experiences a cyclone or a depression, South China Sea is experiencing a typhoon. The leftover moisture and the remnants of the typhoon are passed on to Bay of Bengal.
- **Terrain of the Coromandel Coast:** The East Coast does not have any strong mountain range to block or atleast reduce the ferocity of the winds. The West Coast has the Western Ghats close by. Cyclones with greater wind-power need greater room to blow-over. If there are no mountains, then the impact is significantly higher.

Lack of planning and infrastructural institution:

- Historically, from the British period onwards, disaster management in India is largely **confined to post-disaster relief works.** It is more about management than prevention.
- One-third of the population in India lives in the coastal area. Most of them are **marginalized people who are ill-prepared and unable to cope** up with disaster.
- The agencies that deal with disaster are found wanting in implementing their responsibilities; there **is no coordination among various sectors and agencies;** there is no proper control structure; there is lack of communication and information at critical moments.
- The **unplanned and substandard infrastructure** combined with poor implementation of planning, relief and rehabilitation measures increases the human, physical and economic losses sustained during and after a disaster.

- **Lack of awareness** of people about the impact and magnitude of the disaster.
- Mining and other industries in the ecologically sensitive area, lack of compliance with zoning and building regulation codes is increasing the death toll.

Global phenomenon: As a complex natural phenomenon, even developed countries sometimes fail to handle such disasters. **In the United States, major hurricanes** have caused more damage to human society and ecosystems than any other natural disasters.

Steps taken in India:

India has taken few commendable steps to reduce the impact of destruction from cyclone in recent years. Due to increased awareness and tracking of Cyclone, the death toll has been reduced substantially. For example, severe cyclones Hudhud and Phailin claimed lives but the toll might have been higher. It was reduced due to the early warning and evacuation of the population from the cyclone-hit areas.

Thus, Nature is unpredictable. Natural disasters come without warning. India should be ready with preventive and precautionary measures to mitigate and deflect the destruction caused by cyclones.

8. Discuss the concept of fronts. In what way are the fronts related to cyclones? Present a comparative distinctiveness of a tropical cyclone with that of an extra-tropical cyclone.

(250 words)

Approach

1. **Define the term - 'fronts' and 'cyclones'** ***(60 words)***
2. **Explain the relationship of fronts with the Cyclones in both northern and southern hemispheres** ***(120 words)***
3. **Write in brief comparative distinctiveness of a tropical cyclone with that of an extra-tropical cyclone.** ***(70 words)***

Hints

Air masses form over large surfaces with uniform temperatures and humidity, called source regions. Low wind speeds let air remain stationary long enough to take on the features of the source region, such as heat or cold. When two different air masses meet, the boundary zone between them is called a front. The process of formation of the fronts is known as frontogenesis. There are four types of fronts: (a) Cold; (b) Warm; (c) Stationary; (d) Occluded. When the front remains stationary, it is called a stationary front. When the cold air moves towards the warm air mass, its contact zone is called the cold front, whereas if the warm air mass moves towards the cold air mass, the contact zone is a warm front.

If an air mass is fully lifted above the land surface, it is called the occluded front. The fronts occur in middle latitudes and are characterised by steep gradient in temperature and pressure. They bring abrupt changes in temperature and cause the air to rise to form clouds and cause precipitation. Fronts are the typical features of mid latitudes weather (temperate region 30° – 65° N and S). They are uncommon in tropical and polar regions.

A cyclone is a large scale air mass that rotates around a strong center of low atmospheric pressure (counterclockwise direction north of the Equator and in a clockwise direction to the south). Cyclones are characterized by inward spiraling winds that rotate about a zone of low pressure.

Relationship of fronts with the Cyclones

- There is a systemic relationship between cyclones and fronts, in that the cyclones are usually associated with waves along fronts—primarily cold fronts. Cyclones come into being or intensify because pressure falls more rapidly at one point than it does in the surrounding area. Cyclogenesis can occur anywhere, but in middle and high latitudes, it is most likely to occur on a frontal trough.
- Every front, however, is associated with a cyclone. Fronts move with the counterclockwise flow associated with Northern Hemisphere cyclones and clockwise with the flow of Southern Hemisphere cyclones. The middle latitudes are regions where cold and warm air masses continually interact with each other. This interaction coincides with the location of the polar front.
- When the polar front moves southward, it is usually associated with the development and movement of cyclones and with outbreaks of cold polar air. The cyclonic circulation associated with the polar front tends to bring polar air southward and warm moist tropical air northward.
- Every moving cyclone usually has two significant lines of convergence distinguished by thermal properties. The discontinuity line on the forward side of the cyclone where warm air replaces cold air is the warm front; the discontinuity line in the rear portion of the cyclone where cold air displaces warm air is the cold front.

Differences between Tropical and extra tropical cyclone:

- The extra tropical cyclones have a clear frontal system which is not present in the tropical cyclones. They cover a larger area and can originate over the land and sea. Whereas the tropical cyclones originate only over the seas and on reaching the land they dissipate.
- The extra tropical cyclone affects a much larger area as compared to the tropical cyclone.
- The wind velocity in a tropical cyclone is much higher and it is more destructive.
- The extra tropical cyclones move from west to east but tropical cyclones, move from east to west.
- Tropical cyclone are Confined to 10 – 30 N and S of equator. While extra tropical cyclones Confined to 35 – 65 N and S of equator. More pronounced in Northern hemisphere due to greater temperature contrast.
- In tropical cyclone, Heavy but does not last beyond a few hours. If the cyclone stays at a place, the rainfall may continue for many days. In a temperate cyclone, rainfall is slow and continues for many days, sometimes even weeks.

9. A map of India reveals that the North-Eastern region of our country is most prone to floods. What are the reasons for the routine occurrence of floods in these regions? How can the same be controlled?

(250 words)

Approach

1. **Briefly introduce Why North-Eastern region of our country is most prone to floods** ***(60 words)***
2. **Discuss reasons for the routine occurrence of floods in these regions** ***(150 words)***
3. **Suggested measures to control** ***(40 words)***

Hints

The North-eastern region has abundant water resources. One-third of India's runoff flows from the Northeast through the Brahmaputra and the Barak River. It is also clear that the abundant water resources impose severe distress and costs on the region through frequent flooding and that this needs to be managed to improve economic development.

Floods affect an annual average of 0.8 million hectares of land, but in some years they affect more than 4 million hectares of Assam's total area of 7.54 million hectares. Main reasons for reoccurring floods in North-eastern India are-

Excessive rainfall in North-eastern India as compare to other part of country, which create havoc situation during rainy seasons.

Brahmaputra River and Barak River is flowing through ramp valley. With Himalayas on one side and Meghalaya hills on other. This valley is formed by flood plains of Brahmaputra which is narrow of about 50 km wide. Brahmaputra and its tributaries bring huge flow of water to this narrow plain and spreads in narrow plain inundating area.

Also large amount of soil erosion in this area has led to siltation of rivers leading to uplift of river beds. It results in excessive flow of water outside river channel. Second, the 1950 earthquake, which delivered unusually large quantities of bed sediment, raised Brahmaputra riverbed levels throughout Assam, by up to 3 meters at the upstream end.

Also large population is concentrated in narrow flood plains (which are fertile) which increases their chances of getting affected by floods.

Embankments are only partially effective for numerous reasons:

- They can contain only floods up to a certain magnitude.
- They usually have gaps where tributary streams enter the embanked river.
- They are susceptible to failure from river erosion or geotechnical instability.
- They are often inadequately maintained due to lack of funding.
- They may be deliberately breached in order to release water impounded behind them.
- Another occasional cause of devastating flooding that may occur with little or no warning is the sudden breaching of temporary dams formed by landslides in the upper reaches of tributaries.
- Other contributory factors to the flooding include inadequate maintenance of flood embankments, excessive encroachment into vulnerable areas of the floodplain, and incomplete infrastructure. These mainly result from insufficient funding and increasing population density.

The flooding problem in this region can be controlled through following methods:

- Stopping deforestation and enhancing afforestation to solve problem of siltation
- Stopping zoom cultivation which highly practiced in this area by tribals which is main cause of deforestation and soil erosion
- Where ever feasible river straightening and desiltation should be promoted
- Since this area is most prone to earthquake, as for as possible dams should be avoided. But while going for new dams in case of necessity, establishing standards and specifications for the construction, operation, and maintenance of such dams and other projects is of extreme importance.
- Preparing a master plan for the control of floods and bank erosion and improvement of drainage in the Brahmaputra valley, taking into account irrigation, hydropower, navigation, and other beneficial uses, and indicating, as far as possible, the works and other measures that may be undertaken for such development.

The Ministry of Development of North Eastern region also contributing to control flood Management through various plans:

- During XI Plan, a total of 100 projects of Assam, with estimated cost of Rs. 996.14 crore and eligible central share of Rs. 896.50 crore were approved under Flood Management Programme and the central assistance of Rs. 744.90 crore was released up to 31-03-2012. This included an amount of Rs 3.96 crore towards spill over works of X Plan.
- Out of 100 projects approved during XI Plan, 77 projects have been completed as on 31-03-2012.
- On request of the State Government of Assam, further central assistance of Rs. 2.51 crore has been released during FY: 2013-14 of XII Plan, for completion of on-going projects approved during XI Plan under FMP. Thus the total central assistance of Rs. 747.41 crore had been released to Assam Govt. under FMP during XI and XII Plans for the on-going works.
- Brahmaputra Board to restore original flow channels of Dibang and Lohit.
- Protection of Majuli Island from floods and erosion
- The NE region endowed with an enormous water resources potential that accounts for about 34 percent of the country's total water wealth and about 37 percent of its total hydropower potential. The per capita and per hectare availability of water in this region is the highest in the country. However, less than 5 percent of the existing potential of the region has so far been tapped for societal use. Thus, programme implementation is the need of hour today.

10. Briefly evaluate the impact of structural and non-structural initiatives taken for controlling the floods in India?

(200 words)

Approach

1. **Briefly introduce the Scenario related to floods in India** ***(40 words)***
2. **Evaluate the impact of structural and non-structural initiatives taken for controlling the floods in India** ***(60 words)***
3. **Discuss the measures need to be taken for its control** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Flood occurs when a river overflows its banks and spread out over the bordering flood pain. India is the most flood affected country in the world next only to Bangladesh. In spite of the fact that floods are a natural disaster, if often turns out to be social disaster as the people who are severely affected are generally the people because they live on the periphery of human habitat.

The most flood prone basins in the country are those of Ganga in Uttar Pradesh, Bihar and West Bengal the Brahmaputra in Assam and the Baitarani the Brahmani and Subarnarekha basins in Orissa. Sometimes floods occur also in Andhra Pradesh, Rajasthan, Haryana and Gujarat.

The rivers of north and central India are prone to frequent floods during the monsoon season.

Why flood occurs:

- Flood occurs when the surface runoff is high, drainage water is blocked by landslides, or excessive silt is deposited in the river beds.
- Flash floods in arid areas are associated with cyclonic storms. The coastal belt of India floods with the occurrence of cyclones.
- Sea coasts and river estuaries experience flood when the sea level rises or a bore from the sea enters the rivers.
- In urban areas, the excessive runoff of storm water drains leads to flooding of low-lying areas.

General Flood Management Measures practiced in India:

The engineering measures for flood control which bring relief to the flood prone areas by reducing flood flows and thereby the flood levels are –

- **An artificially created reservoir behind a dam across a river:** Reservoirs can moderate the intensity and timing of the incoming flood. They store the water during periods of high discharges in the river and release it after the critical high flow condition is over, so as to be ready to receive the next wave. Their effectiveness in moderating floods would depend on the reservoir capacity available at that time for absorbing the flood runoff and their proximity to the likely damage centre. They are operated with a carefully planned regulation schedule which takes into account both the safety of the dam and related structures and the safe carrying capacity of the lower reaches of the river in their present condition.
- **By diversion of a part of the peak flow** to another river or basin, where such diversion would not cause appreciable damage.

By constructing a parallel channel by passing a particular town/reach of the river prone to flooding :

- Some of the states are proposing channelization of rivers, at least in certain reaches, in the context of tackling the extensive meandering problems of the rivers, activating navigational channels and training these rivers into their original courses. While venturing to channelize rivers, thought must be given in allowing the river certain freedom to flow and right of way to pass its flood waters and silt load within its natural waterway. The dynamic nature of the rivers should be appreciated and preventive measures planned accordingly instead of pinning down the river by channelizing.

- **Diversion of Flood Waters:** Diversion of flood waters takes a part of the flood discharge to another basin or to the same basin downstream of the problem area or to a depression where it could be stored for subsequent release. This measure can be used to manage unusual floods around cities as in the case of flood spill channel near Srinagar and also in the lower reaches of a river near the sea as in the case of Krishna Godavari drainage scheme.

The engineering methods of flood protection, which do not reduce the flood flow but reduce spilling, are:

- **Embankments which artificially raise the effective river bank and thereby prevent spilling: Embankments** (including ring bunds and town protection works) confine the flood flows and prevent spilling, thereby reducing the damage. These are generally cheap, quick and most popular method of flood protection and have been constructed extensively in the past. These are reported to have given considerable protection at comparatively low costs, particularly in the lower reaches of large rivers.
- Channel and drainage improvement works, which artificially reduce the flood water level so as to keep the same, confined within the river banks and thus prevent spilling.

Administrative / Non-structural Measures:

- Facilitating timely evacuation of the people and shifting of their movable property to safer grounds by having advance warning of incoming flood i.e. flood forecasting, flood warning in case of threatened inundation.
- Discouraging creation of valuable assets/settlement of the people in the areas subject to frequent flooding i.e. enforcing flood plain zoning regulation.

Initiatives should be taken for controlling the impact of floods in the country:

- Introduce better flood warning systems
- **Modify homes and businesses to help them withstand floods**
- **Construct buildings above flood levels**
- **Tackle climate change**
- **Increase spending on flood defences**
- **Protect wetlands and introduce plant trees strategically**
- **Restore rivers to their natural courses**
- **Introduce water storage areas**
- **Improve soil conditions**
- **Put up more flood barriers**

Providing absolute protection to all flood prone areas against all magnitude of floods is neither practically possible nor economically viable. Such an attempt would involve stupendously high cost for construction and for maintenance. Hence a pragmatic approach in flood management is to provide a reasonable degree of protection against flood damages at economic cost through a combination of structural and non-structural measures.

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NOTES

SET-5.1: QUESTIONS

IMPORTANT GEOPHYSICAL PHENOMENA

Q1. Give an account of the distribution of flood-prone areas of India and the initiatives taken for controlling the impact of floods in the country.

Q2. Unlike other natural disasters, human beings play an important role in the genesis as well as spreading of floods. In the light of above statement, bring out the major differences in nature of floods occurring in the western and eastern part of the country.

Q3. Volcanoes have huge bearing on various landforms on the surface of earth. Elaborate. Also, discuss various extrusive and intrusive landforms associated with volcanism.

Q4. Explain the distribution pattern of temperate cyclones. Why is the distributional pattern of these cyclones very distinct particularly in the northern hemisphere?

Q5. Discuss the Orogenesis of Himalayan Mountain ranges on the basis of plate tectonics. Elaborate with geographical evidences supporting collision of different types and nature of tectonic plates during process of orogeny.

Q6. Why is the Bay of Bengal more prone to cyclones as compared to Arabian Sea? Explain the reasons for changing pattern of cyclonic activities in Arabian Sea.

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SET-5.1: ANSWERS

1. Give an account of the distribution of flood-prone areas of India and the initiatives taken for controlling the impact of floods in the country.

(250 words)

Approach

1. **Give a brief description of the distribution of flood-prone areas of India** ***(50 words)***
2. **Flood Management Measures practiced in India** ***(80 words)***
3. **Suggest initiatives taken for controlling the impact of floods in the country** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

Flood occurs when a river overflows its banks and spread out over the bordering flood pain. India is the most flood affected country in the world next only to Bangladesh. In spite of the fact that floods are a natural disaster, if often turns out to be social disaster as the people who are severely affected are generally the people because they live on the periphery of human habitat.

The most flood prone basins in the country are those of Ganga in Uttar Pradesh, Bihar and West Bengal the Brahmaputra in Assam and the Baitarani the Brahmani and Subarnarekha basins in Orissa. Sometimes floods occur also in Andhra Pradesh, Rajasthan, Haryana and Gujarat.

The rivers of north and central India are prone to frequent floods during the monsoon season.

Why Flood Occurs:

- Flood occurs when the surface runoff is high, drainage water is blocked by landslides, or excessive silt is deposited in the river beds.
- Flash floods in arid areas are associated with cyclonic storms. The coastal belt of India floods with the occurrence of cyclones.
- Sea coasts and river estuaries experience flood when the sea level rises or a bore from the sea enters the rivers.
- In urban areas, the excessive runoff of storm water drains leads to flooding of low-lying areas.

General Flood Management Measures practiced in India:

The engineering measures for flood control which bring relief to the flood prone areas by reducing flood flows and thereby the flood levels are –

- **An artificially created reservoir behind a dam across a river:** Reservoirs can moderate the intensity and timing of the incoming flood. They store the water during periods of high discharges in the river and release it after the critical high flow condition is over, so as to be ready to receive the next wave. Their effectiveness in moderating floods would depend on the reservoir capacity available at that time for absorbing the flood runoff and their proximity to the likely damage centre. They are operated with a carefully planned regulation schedule which takes into account both the safety of the dam and related structures and the safe carrying capacity of the lower reaches of the river in their present condition.
- **By diversion of a part of the peak flow** to another river or basin, where such diversion would not cause appreciable damage.
- **By constructing a parallel channel** by passing a particular town/reach of the river prone to flooding:
- Some of the states are proposing channelization of rivers, at least in certain reaches, in the context of tackling the extensive meandering problems of the rivers, activating navigational channels and training these rivers into their original courses. While venturing to channelize rivers, thought must be given in allowing the river certain freedom to flow and right of way to pass its flood waters and silt load within its natural waterway. The dynamic nature of the rivers should be appreciated and preventive measures planned accordingly instead of pinning down the river by channelizing.
- Diversion of Flood Waters: Diversion of flood waters takes a part of the flood discharge to another basin or to the same basin downstream of the problem area or to a depression where it could be stored for subsequent release. This measure can be used to manage unusual floods around cities as in the case of flood spill channel near Srinagar and also in the lower reaches of a river near the sea as in the case of Krishna Godavari drainage scheme.

Initiatives taken for controlling the impact of floods in the country

- Flood management does not aim at total elimination or control of floods or providing total immunity from the effects of all magnitudes of floods.
- It is a multipronged strategy ranging from modifying the floods by means of structural measures to learning to live with the floods by means of other non-structural measures is well within pragmatic realism in flood management.
- An efficient flood management is a special case of water management and requires a most holistic approach as it involves the management of thousands of micro-watersheds in both the catchment and the flood prone areas.

Several other Initiatives in order to deal with floods

- Policy Statement 1954
- High-Level Committee on Floods – 1957
- Policy Statement of 1958
- National Flood Commission (Rashtriya Barh Ayog) 1980
- Expert Committee to Review the Implementation of the Recommendations of National Flood Commission – 2003 (R Rangachari Committee)

National Water Policy (1987/2002/2012)

Providing absolute protection to all flood prone areas against all magnitude of floods is neither practically possible nor economically viable. Such an attempt would involve stupendously high cost for construction and for maintenance. Hence a pragmatic approach in flood management is to provide a reasonable degree of protection against flood damages at economic cost through a combination of structural and non-structural measures.

2. Unlike other natural disasters, human beings play an important role in the genesis as well as spreading of floods. In the light of above statement, bring out the major differences in nature of floods occurring in the western and eastern part of the country.

(250 words)

Approach

1. **Briefly introduce the nature of floods** ***(50 words)***
2. **Role of human beings in the genesis as well as in spreading of floods** ***(70 words)***
3. **Highlight the major differences in nature of floods occurring in the western and eastern part of the country** ***(80 words)***
4. **Conclusion** ***(50 words)***

Hints

Floods are a recurrent phenomenon, which cause huge loss of lives and damage to livelihood systems, property, infrastructure and public utilities. It is a cause for concern that flood related damages show an increasing trend. The average annual flood damage in the last 10 years period from 1996 to 2005 was Rs. 4745 crore as compared to Rs. 1805 crore, the corresponding average for the previous 53 years. This can be attributed to many reasons including a steep increase in population, rapid urbanization growing developmental and economic activities in flood plains coupled with global warming.

Role of human beings in spreading of floods

Landslides and floods due to deforestation, unscientific land use and construction activities in fragile areas are some of the disasters that are the results of indirect human actions.

- Inundation of land and human settlements by the rise of water in the channels and its spill over presents the condition of flooding.
- Indiscriminate deforestation, unscientific agricultural practices, disturbances along the natural drainage channels and colonisation of flood-plains and river-beds are some of the human activities that play an important role in increasing the intensity, magnitude and gravity of floods

An unusual weather phenomenon explains why eastern and western India are flooding

- There are two low pressure areas over the Bay of Bengal and the Arabian Sea at the same time.
- Unusual formation of the monsoon trough, an area of low pressure that generates intense rainfall. Low pressure regions develop frequently over the Bay of Bengal and move West or North West, drawing rain to the northern regions of the country

States like Rajasthan, Gujarat, Haryana and Punjab are also getting inundated in recent decades due to flash floods. This is partly because of the pattern of the monsoon and partly because of blocking of most of the streams and river channels by human activities.

Assam, West Bengal, Orissa and Bihar are among the high flood-prone states of India. Apart from these, most of the rivers in the northern states like Punjab and Uttar Pradesh are also vulnerable to occasional floods. Floods in these states mainly caused due to a storm surge (in the coastal areas), high intensity rainfall for a considerably longer time period, reduction in the infiltration rate and presence of eroded material in the water due to higher rate of soil erosion.

3. Volcanoes have huge bearing on various landforms on the surface of earth. Elaborate. Also, discuss various extrusive and intrusive landforms associated with volcanism.

(150 words)

Approach

1. **Introduction about volcanoes.** ***(20 words)***
2. **Explain how volcanoes have huge bearing on various landforms on surface of earth. Discuss the process of formation of volcanoes** ***(60 words)***
3. **Explain various associated extrusive and intrusive landforms** ***(50 words)***
4. **Conclusion** ***(20 words)***

Hints

A volcano is a vent in the earth's crust through which molten material erupts suddenly from a magma chamber below the surface .Due to very high temperature, some rocks slowly melt and turn into a thick flowing matter known as magma. The magma rises and gets collected in magma chambers which eventually pushes through fissures and vents in the earth's surface.

Volcanoes have huge bearing on various landforms on surface of earth.

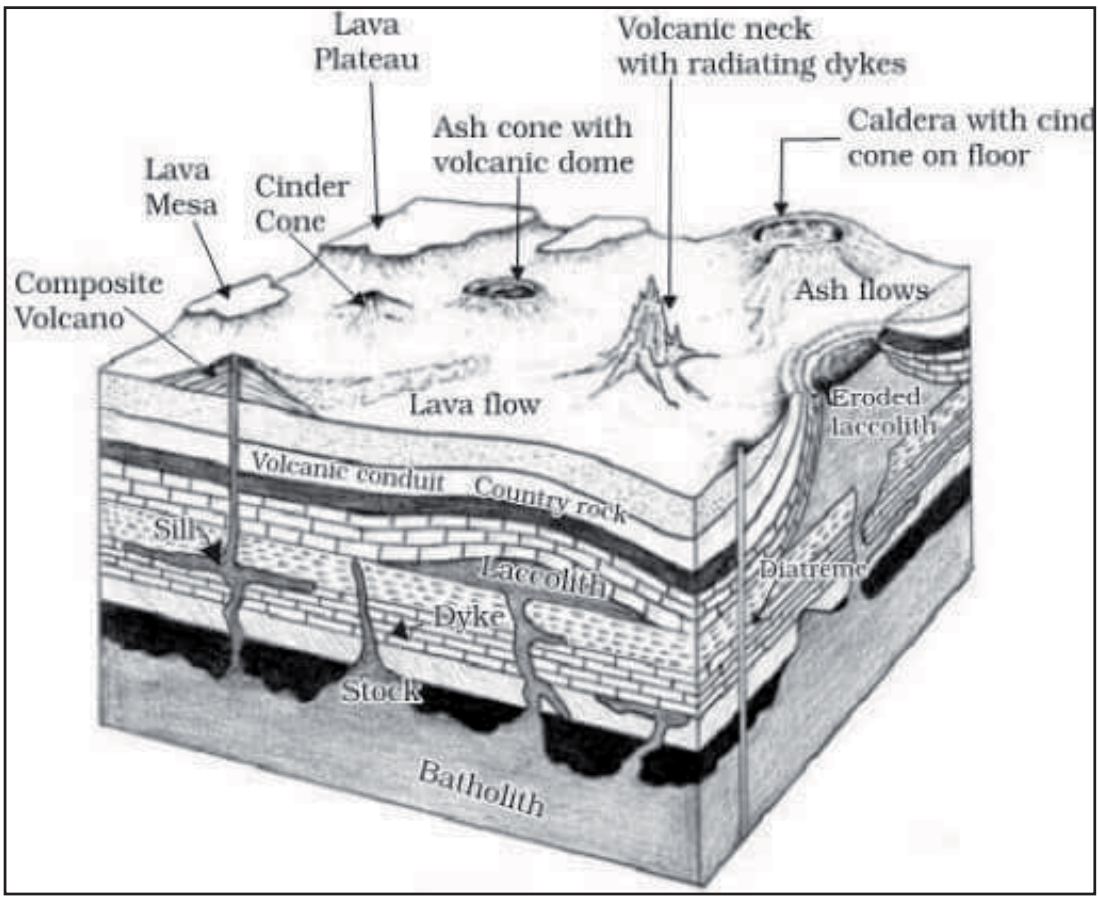
- Magma from the mantle or lower crust rises through its crust towards the surface. If magma reaches the surface, its behavior depends on the viscosity of the molten constituent rock.
- Viscous magma produces volcanoes characterised by explosive eruptions, while non-viscous magma produce volcanoes characterised by effusive eruptions pouring large amounts of lava onto the surface.

- First and most important thing is type of volcanic eruptions has direct bearing on the various landforms in the region. For example formation shield or volcanic mountain depends directly upon the type of eruption. Shield is formed in the region where magma flows in liquid form rather than solid and magma has low viscosity.

Various associated extrusive and intrusive landforms

Intrusive Landforms:

- The lava that is released during volcanic eruptions on cooling develops into igneous rocks. The cooling may take place either on reaching the surface or also while the lava is still in the crustal portion.
- Depending on the location of the cooling of the lava, igneous rocks are classified as volcanic rocks (cooling at the surface) and plutonic rocks (cooling in the crust). The lava that cools within the crustal portions assumes different forms. These forms are called intrusive form.
  Intrusive Landforms:
- The commonest intrusive landforms are-
  - **Sills**: When an intrusion of molten magma is made horizontally along the bedding plains of sedimentary rocks, the resultant intrusions is called a sill.
  - **Dykes:** Intrusions when injected vertically as narrow walls igneous rocks within the sedimentary layers are termed as dykes.
  - **Laccolith**: It is large blister of igneous mound with a dome-shaped upper surface and a level base fed by a pip-like conduit from below.



- **Lopolith:** A lopolith is another variety of igneous intrusions with a saucer shape.
- **Phacolith**: It is a lenses-shaped mass of igneous rocks occupying the crest of an anticline or the bottom of a syncline and being fed by a conduit from beneath.
- **Batholith**: It is a huge mass of igneous rocks, usually granite, which after removal of the overlying rocks forms a massive and resistant upland region.

Extrusive Landforms:

These are those landforms that are formed as a result of magma that reaches the earth surface as lava. These include:

- **Cinder Cone**: Lava is blown at a great height when it is ejected. Several ash layers of cinder and ash form on each subsequent eruption. The result is a cone consisting of basaltic cinders
- **Lava Cone**: Slope of these cones depend on whether lava is fluid or viscous. Basic, shield or fluid lava is very fluid and mobile.
- **Composite Cone**: It is formed on alternate layers of lava and ash. Volcano begins each eruption cycle with a pyroclastic eruption which forms a layer of ash .it ranges in height from moderate to high.

Conclusion:

From this we can say that type volcanic eruption has direct impact on the type of landforms in the region. In return these landforms have direct bearing on the economy of the region.

4. Explain the distribution pattern of temperate cyclones. Why is the distributional pattern of these cyclones very distinct particularly in the northern hemisphere?

(250 words)

Approach

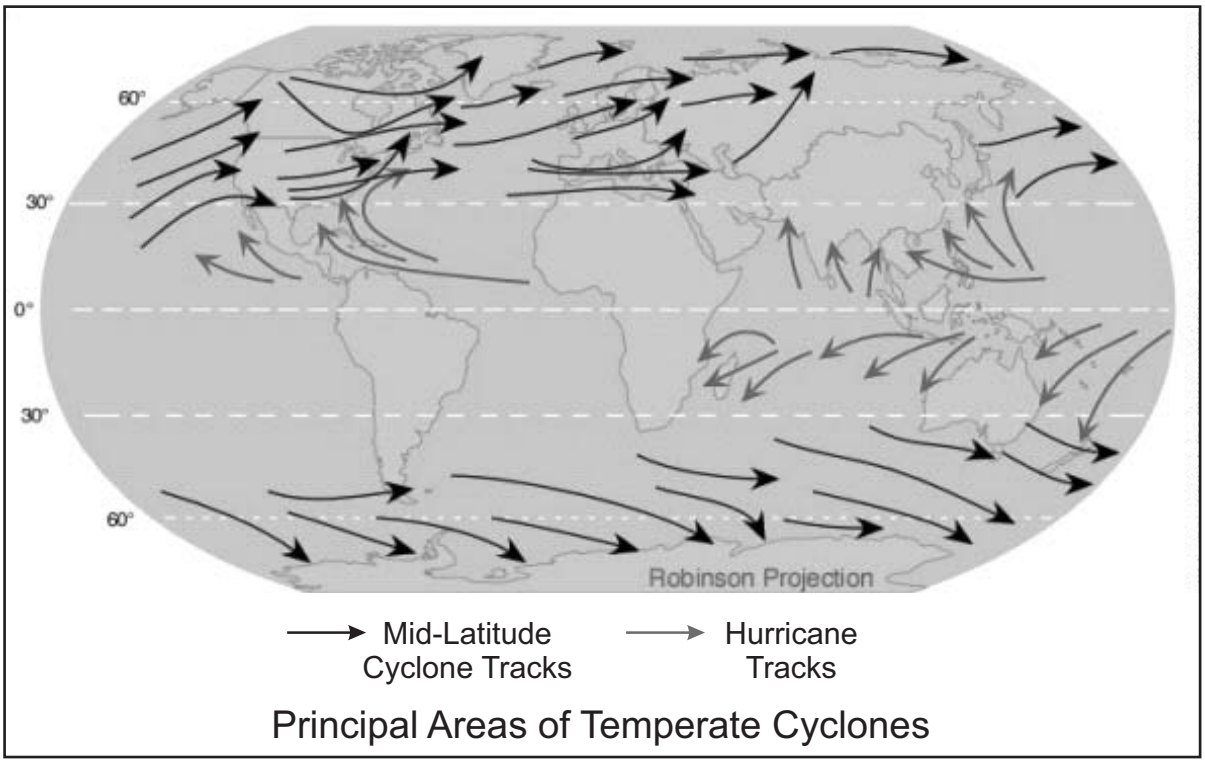
1. **Briefly introduce with temperate cyclone** ***(50 words)***
2. **Discuss how these cyclones are developed** ***(130 words)***
3. **Explain distribution pattern of these cyclones with emphasis on its distribution in north hemisphere** ***(70 words)***

Hints

Temperate cyclones are formed along a front in mid-latitudes between 35 degree and 6 degree N and S. They blow from west to east and are more pronounced in winter. Atlantic Ocean and North West Europe are major regions of temperate cyclones. They are generally extensive having a thickness of 9 to11 kilometers and with 1040-1920 km short and long diameters respectively. The weather associated with the cyclone is drizzling rain and of cloudy nature for a number of days.

Distribution pattern of temperate cyclone

- **Atlantic-Arctic Front**: The north Atlantic is much warmer while the Arctic air mass is very cold. When both of them are coming into contact with each other, the strong temperature contrast is created and strong low pressure formation is resulted. It causes the cyclone to move towards the northeast direction and reach Western Europe.
- **North America-Polar Front**: The air mass of North America and the north polar air mass convergence cause the cyclone to develop, particularly in the Great Lakes region and move towards northeast direction.
- **Mediterranean Front**: The third important area of the development of temperate cyclones in the northern hemisphere is the Mediterranean-Caspian front region. Huge expanse of the continental areas to the north of Mediterranean-Caspian parts and relatively warmer air mass over these seas create front. Along this front, the extra-tropical cyclone is generated and moves in the general wind patterns of the region. The light shower in the winter over north-western parts of India is caused by the western disturbances coming from this zone.
- **In the Southern Hemisphere**: The southern hemisphere does not have big landmass for creating temperature contrast, hence there are no specific regions of the development of extratropical cyclones. They are developed with lesser intensity between 350 to 650 south latitudes and travel in south-easterly direction.



Principal Areas of Temperate Cyclones

Reasons behind distinct pattern of temperate cyclone in northern and southern hemisphere

- The distributional pattern of temperate cyclones is very distinct particularly in the northern hemisphere. It happens because of the land water contrast and greater temperature variations. Its frequency is more during the winter season than the summer.
- Southern hemisphere has more water bodies and the temperature contrast is relatively less and hence the extra-tropical cyclone is not confined to a certain region or pocket.

- But in northern hemisphere, its major areas of concentration are with Atlantic-Arctic belt, North America Great Lakes belt and Mediterranean Caspian belt

5. Discuss the Orogenesis of Himalayan Mountain ranges on the basis of plate tectonics. Elaborate with geographical evidences supporting collision of different types and nature of tectonic plates during process of orogeny.

(150 words)

Approach

1. **Briefly introduce with plate tectonics theory** ***(20 words)***
2. **Formation of Himalayas by the process of plate tectonics** ***(60 words)***
3. **Evidences that support the formation of Himalayas as explained by plate tectonics** ***(50 words)***
4. **Conclusion** ***(20 words)***

Hints

Plate tectonics has emerged as the most acceptable theory in modern time regarding formation of continents and oceans, Orogenesis, epeirogenesis and different other landforms. Himalayan mountains are young fold mountains and said to be still in the process of formation has been well defined by the theory of plate tectonics.

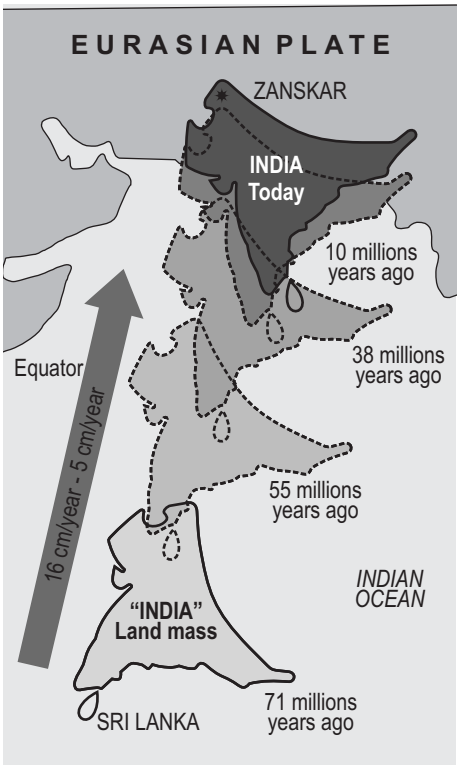
Formation of Himalayas by the process of plate tectonics

- 100 million years ago, Indian plate collided with the Eurasian plate. Before collision there was a swampy sea between the two plates called the Tethys Sea.

First stage: Collision Oceanic-Oceanic crusts and formation of festoons or Island arcs

- The oceanic crust of the Indian plate collided with the oceanic crust of the Eurassian plate and later being heavier subducted. This resulted in formation of island arc of explosive volcanic which developed in the Tethys Sea. Later they formed part of Ladakh and Tibet.

Second stage: Collision Oceanic-Continent crusts and formation of young fold mountains on margin of contienents



- Indian plate continued its march towards Eurasian plate which led to subduction of its oceanic crust into the Eurasian continental crust. This led to formation of young fold mountain on the margin of the Eurasian land mass in the form of Karakoram Range.

Third Stage: Collision of continent-continent crusts and formation of Himalayas

- Continent-Continent crusts of the Eurasians and Indian plate collided which resulted in folding of sediments of Tethy's sea. Due to folding activity, young fold mountain, the Himalayas started to rise up. There are various evidences which support this theory.

Evidences that support the formation of Himalayas as explained by plate tectonics

- Evidences of Island arcs in Drass sector of Himalayas.
- Evidences support that Karakorum ranges are of volcanic origin.
- Karewas in Kashmir valley prove that the valley was essentially a lake in the Pleistocene Epoch.
- Discovery of a hippopotamus' skull at 14,000 ft at Ladakh indicating that till recently the Himalayan region was a warm, low-lying swampy region.
- Evidence of stone-age man in the higher reaches, showing that the mountains' rapid rise was more recent than earlier believed and was even witnessed by primitive man.
- Proof that swarms of earthquakes and periods of quietude occur just before a giant earthquake strikes the region making prediction fairly accurate that Himalayas is still rising.

Conclusion:

Various evidences which support the theory of Orogenesis of Himalayan mountain ranges are in line with the process which was illustrated by the theory of plate tectonics. Predictions by the geologists about the Great Himalayan Earthquake and unconsolidated materials which leads to landslides in the Shiwalik region of Himalayas prove that the region is still tectonically active due to movement of the Indian plate towards the Eurasians plates and authenticate the plate tectonics as the most suitable theory to explain it.

6. Why is the Bay of Bengal more prone to cyclones as compared to Arabian Sea? Explain the reasons for changing pattern of cyclonic activities in Arabian Sea.

(250 words)

Approach

1. **Introduction with current linking of cyclonic activities.** ***(50 words)***
2. **Explain the reason for Bay of Bengal experiencing a greater number of cyclones than Arabian sea.** ***(80 words)***
3. **Bring out recent climatic changes responsible for increasing cyclonic activities in Arabian sea.** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

Both the Bay of Bengal and Arabian Sea experience cyclonic events. However, when the two are compared, the Bay of Bengal sees approximately five times as many cyclones as its Western counterpart.

Reason for Bay of Bengal experiencing a greater number of cyclones than Arabian sea:

Sea surface temperature (SST):

- It is generally higher in the Bay of Bengal than the Arabian sea due to the high stratification and less Mixing in the Bay of Bengal than the Arabian sea.
- Warm air currents enhance this surface temperature and aid the formation of cyclones.

Rainfall:

- The Bay of Bengal receives higher rainfall and constant inflow of fresh water from the Ganga and Brahmaputra rivers. This means that the Bay's surface water keeps getting refreshed, making it impossible for the warm water to mix with the cooler water below, making it ideal for a depression.

Winds:

- Bay of Bengal comes in the North East trade wind belt which makes the region conducive for the cyclonic activities with the formation of depressions and onshore winds to Indian subcontinent.
- On the other hand, the Arabian Sea receives stronger winds that help dissipate the heat, and the lack of constant fresh water supply helps the warm water mix with the cool water, reducing the temperature.

But according to the India Meteorological Department (IMD) data, in recent decades, there has been increased occurrences of extreme weather events in Arabian sea region.

Reasons for Changing pattern of cyclonic activities in Arabian sea:

- The Arabian Sea has been warming faster, partly due to global warming. Warming is seen not only in the top layers, but also in the deeper ocean layers.
- There is a strong link between the accelerated warming of the Arabian Sea and the frequency and intensity of cyclones in the sea.
- Of all oceans, Indian ocean is warming up fastest in Arabian sea region.
- Usual processes of upwelling and winter convection are failing to offset buildup of carbon dioxide.
- The availability of moisture is much higher in Arabian Sea whereas Bay of Bengal appears to be turning moisture-deficit.

Conclusion:

The recent unusual phenomenon like the simultaneous occurrence of cyclones in the Arabian Sea and the Bay of Bengal — like Luban (Arabian Sea) and Titli (Bay of Bengal) in 2018 and in 2020, Nisarga (Arabian Sea) was followed by Amphan (Bay of Bengal) shows the fast-changing pattern of cyclonic events in Indian Ocean. As this change could be attributed to anthropological and natural climate change, controlling anthropological climate change to is the only hope to maintain the naturally occurring phenomenon.

NOTES

SET-6: QUESTIONS

CRITICAL GEOGRAPHICAL FEATURES AND EFFECT OF CLIMATE CHANGE

Q1. While Arctic scientists warn that the increasing rapid melting of Arctic ice could lead to disastrous consequences, most nations will be touched by developments in the Arctic. Discuss the impact of Arctic ice melt.

Q2. Bring out the causes and consequences of shrinking Himalayan glaciers on human settlements and river drainage system.

Q3. Rising sea level will have an adverse impact on flora and fauna particularly the small island countries. In this context, discuss what are the remedial measures required to address this issue.

Q4. Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted and trees are flowering sooner. In light of this, discuss how climate change affects oceans?

Q5. Coral reefs are among the most threatened ecosystem on earth due to unprecedented global warming and climate change. In light of above statement examine the phenomena of coral bleaching across the world. Also, explain the methods of coral restoration.

Q6. As the world glaciers are depleting rapidly, what consequences will it likely to have on the humans and environment? Suggest various measures to tackle its causes and consequences.

Q7. Prolonged periods of marine heatwaves (MHWs) are a major threat to marine ecosystems and their functioning that have resulted in devastating and long-lasting impacts . Discuss.

Q8. Glaciers are sensitive indicators of modern climate change. Justify the statement in the context of retreat of glaciers in Zaskar valley in India.

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SET-6: ANSWERS

1. While Arctic scientists warn that the increasing rapid melting of Arctic ice could lead to disastrous consequences, most nations will be touched by developments in the Arctic. Discuss the impact of Arctic ice melt.

(250 words)

Approach

1. **Briefly introduce the changes in the arctic region** ***(50 words)***
2. **Discuss the disastrous consequences of these changes** ***(150 words)***
3. **Discuss the impact of Arctic ice melt** ***(50 words)***

Hints

Changes in the arctic region could cause uncontrollable climate change at a global level with temperature in the Arctic about 20 degrees Celsius above what would be expected, Arctic ice melt has both positive and negative impacts on human:

Consequences due to these changes

- The Arctic has few species and short food chains and thus simple food webs. This actually makes the Arctic particularly vulnerable to environmental change. When an Arctic species is lost, it is unlikely that a new one will take its place and replace its function in the ecosystem.

Negative impacts:

- Arctic scientists have warned that the increasingly rapid melting of the ice cap risks triggering 19 "tipping points" in the region that could have catastrophic consequences around the globe.
- Climate tipping points occur when a natural system undergoes sudden or overwhelming change that has a profound effect on surrounding ecosystems, often irreversible.
- Increase in temperature has made it conducive for growth in vegetation on tundra, which replaces reflective snow and ice with darker vegetation, thus absorbing more heat.
- Higher releases of methane, a potent greenhouse gas, from the tundra as it warms. Methane a highly potent green-house gas further aggravates rise in temperatures.

- Shifts in snow distribution that warm the ocean, resulting in altered climate patterns as far away as Asia, where the monsoon could be affected.
- The collapse of some key Arctic fisheries, with knock-on effects on ocean ecosystems around the globe.
- Sea ice melting does slightly contribute to sea level rise since the fresh melt water is less dense than the salty ocean water it displaces.
- Continued loss of Arctic sea ice may dramatically alter global weather and precipitation patterns. The jet stream will probably move further north in response to warmer temperatures over the pole, which will bring more precipitation to the Arctic.
- Changes to the course of the jet stream affect weather patterns for the entire planet, and we can expect impacts on the strength of the monsoons and likelihood of hurricanes.
- Sea ice is important in marine ecosystems – for habitat, food and temperature regulation of water below it.
- The retreating ice has reduced the available platforms that Seals, Bears, walruses use to live and hunt on. Retreating ice will reduce polar bear population by two-thirds.

Positive impacts:

- Most nations will be touched by developments in the Arctic, because the region's shipping, fishing, energy and mineral production, scientific research, and other activities affect national economic welfare and security.
- Shorter trade routes decrease the cost of travel, fuel savings and thus goods at a cheaper rate. Ex Arctic ice melt could be a boon to export-driven nations like China.
- Melting of arctic sea will extend the continental shelf of the boundary country, thus providing good fishing grounds.
- Nearly one-quarter of the earth's undiscovered, recoverable petroleum resources lie in the region. According to a report in 2008, 13 percent of the oil; 30 percent of the natural gas; and 20 percent of the liquefied natural gas are unexploited in this region. More than 80 percent of these are thought to be offshore. The extensive Arctic continental shelves may constitute the geographically largest unexplored prospective area for petroleum remaining on Earth.

2. Bring out the causes and consequences of shrinking Himalayan glaciers on human settlements and river drainage system.

(250 words)

Approach

1. **Briefly introduce the Himalayan glaciers** ***(60 words)***
2. **Discuss the causes and consequences of shrinking Himalayan glaciers** ***(150 words)***
3. **Conclusion** ***(40 words)***

Hints

The Tibetan Plateau and surrounding regions contain most of the world's glaciers outside the polar region. The Himalayan glaciers are shrinking at an alarming rate of 0.50% annually, and are expected to shrink by 45% by 2100, according to the Intergovernmental Panel on Climate Change's Fifth Assessment Report.

The Himalayas gets its precipitation from the Indian monsoon and studies show that the Indian monsoon is weakening influencing the precipitation patterns, reducing the annual snow accumulation.

Temperature rise also affects glacier shrinkage and an increasing warming trend at higher elevations has been observed leading to shrinking of glaciers.

In the eastern and central Himalayas, it snows mainly during monsoon season, and a slight increase in summer temperatures can affect glaciers drastically. Nine out of 10 world's loftiest peaks including Mount Everest have been experiencing a rapid meltdown of glaciers.

These melting of glaciers have disastrous consequences:

- Melting of the glaciers could impact the levels of water flowing through the major rivers of the Indian subcontinent. The preliminary reports of a study funded by the USAID have showed that glaciers supply 5% and 30% of the water in the Ganges and Indus respectively.
- Could impact the lives and livelihoods of the millions of people living on the Gangetic plains etc. People of this region are agrarian community. Affecting agriculture production can eventually lead to lessening food security and put millions of people in the sub-continent at risk of food shortages.
- Most of the farmers of the northern plains are small and marginal, water shortage and lack of agriculture push people into poverty as their capacity to cope is very low
- Tourism based on high altitude adventures is one of the major sources of income for hilly and mountainous states shrinking glaciers would have impact on tourism and associated livelihoods. Ex In Nepal, Khumbu glacier in the Himalayas have expanded and merged to form enormous lakes, preventing mountaineers from ascending.
- Shrinking Himalayan glaciers have initiated a pattern of potentially disastrous lake formations that could imperil settlements downstream in the event of an unanticipated overspill
- **Energy generation**
  - **Hydropower:-** Shrinking glaciers reducing the water flow of the Himalayan rivers affecting the hydropower potential of the large dams built across these rivers
  - Reduced water capacity of the rivers affect energy production. The reduced flow of water in Ganga during summers forced the shutdown of Farakha thermal power plant.
- Reduced flows affect the river cleaning capacity and also biodiversity of the living organisms living in it.
- The absence of glaciers will have a significant effect on late summer stream flow and stream temperature in mountainous watersheds (drainage basins). Both of these properties are important in maintaining fish populations
  - Temperatures too warm, often above only 13°C (55°F), may have an impact on the survival of young fish.
  - Moreover, many sources of drinking water for large cities in mountainous regions would be negatively affected by the loss of glaciers because the streams that supply their water will flow at a considerably lower volume.

3. Rising sea level will have an adverse impact on flora and fauna particularly the small island countries. In this context, discuss what are the remedial measures required to address this issue.

(200 words)

Approach

1. **Brief introduction on causes of sea level rise** ***(30 words)***
2. **Adverse impact of sea level rise** ***(70 words)***
3. **Remedial measures required to address the issue related to sea level rise** ***(70 words)***
4. **Conclusion** ***(30 words)***

Hints

Over the past century, the burning of fossil fuels and other human and natural activities has released enormous amounts of heat-trapping gases into the atmosphere. These emissions have caused the Earth's surface temperature to rise, and the oceans absorb about 80 percent of this additional heat. This ongoing global climate change has raised the sea level and severely affected flora, fauna and small island nations.

Adverse impact of sea level rise:

- Hundreds of millions of people live in areas that will become increasingly vulnerable to flooding. Higher sea levels would force them **to abandon their homes and relocate.** Low-lying islands could be submerged completely.
- **IPCC assessments** suggest that deltas and small island states are particularly vulnerable to sea-level rise caused by both thermal expansion and increased ocean water.
- Maldives, Tuvalu, and other low-lying countries are among the areas that are at the highest level of risk. The **UN's environmental panel** has warned that, at current rates, sea level would be high enough to make the Maldives uninhabitable by 2100.
- **The remedial measures required to address the issue related to sea level rise:**
- The rapid implementation of the **Paris Agreement on Climate Change** is crucial to avoid temperatures and sea levels from rising even faster.
- Global greenhouse gas emissions, mainly caused by fossil fuel combustion and deforestation, need to decline rapidly to avoid the worst impacts of climate change, which include rising sea levels, more droughts, floods and forest fires
- **Shifting major infrastructure investments** like power plants, public works, schools, etc. away from the coasts and to higher ground.
- Preparing highly populated coastal areas, particularly those in developing countries, for the **massive migration of people from low-lying areas**.
- **Coastal Armoring:** Linear protection, such as levees and seawalls, that fixes the shoreline in its current place.
- When sea levels rise rapidly, as they have been doing, even a small increase can have devastating effects on coastal habitats and will increase **"climate refugees"**. Hence, holistic steps need to be taken on local, national and international level to prevent global warming which is causing sea level rise.

4. Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted and trees are flowering sooner. In light of this, discuss how climate change affects oceans?

(250 words)

Approach

1. **Introduce climate change, global warming and their domino effect on our ecosystem.** ***(100 words)***
2. **In detail explain the how climate change is affecting oceans.** ***(150 words)***

Hints

The Earth's climate has changed throughout history, Most of these climate changes are attributed to very small variations in Earth's orbit that change the amount of solar energy our planet receives. But humans' impact on the Earth is now so profound that a new geological epoch - the Anthropogenic has been declared. Many of these impacts are irrevocable affecting air, water, and land.

This climate change triggered by humans has far reaching impact on oceans.

- **Surface sea level -** Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers and the expansion of seawater as it warms. Global sea level has been rising over the past century but the rate has increased in recent decades. Sea level continues to rise at a rate of about one-eighth of an inch per year.
- **Sea surface temperature-** It increased during the 20th century and continues to rise. From 1901 through 2015, temperature rose at an average rate of 0.13°F per decade.
- **Ocean currents -** Climate change is weakening massive ocean circulatory system. Sunlight is most intense at Earth's equator; ocean circulation pushes this tropical heat toward the poles. When the currents transporting the heat, change, it can have major impacts. Melting ice from Greenland has spilled huge quantities of freshwater into the North Atlantic, diluting the dense salinity of North Atlantic currents. Also currents play an important role in movement of ships, which would get affected due to weakening of ocean currents
- **Corals -** Increasing Sea surface temperature has led to bleaching of corals. 2015 saw the third mass coral bleaching event. Corals are supposed to be the Tropical Rain Forest of the ocean and support ocean biodiversity in a large way. Bleaching of corals thus has an effect on ocean biodiversity as well
- **Effect on Biodiversity-**
  - **Fish Migration -** Increased ocean temperature has led to migration of fishes towards the poles which has affected the fishing zones of the world, thereby having an impact on livelihood of people in coastal areas
  - Increasing ocean acidification due to greater absorption of CO2 as blue carbon leading to deoxygenating of oceans. This impacts biodiversity including coral formation. It leads to increasing levels of Lysoclineie (the line above which corals cannot exist), thereby impacting coral ecosystem. Increasing acidification has impacted the Sulfur cycle i.e. the flow of Sulfur from the oceans back into the atmosphere. This reduces reflection of solar radiation back into space, resulting in even more warming.

- **Drowning Wetlands** - Wetlands are critical ecosystems having immense benefits and rising sea level has led to inundation of wetlands. Normally wetlands have the capability of vertical expansion to match up with rising sea levels; however the pace of increase of sea surface level has led to inundation of wetlands.

5. Coral reefs are among the most threatened ecosystem on earth due to unprecedented global warming and climate change. In light of above statement examine the phenomena of coral bleaching across the world. Also, explain the methods of coral restoration.

(250 words)

Approach

1. **Introduction about coral reef** ***(30 words)***
2. **Explain phenomena of coral bleaching.** ***(50 words)***
3. **Discuss impact of climate change on coral reefs. You can mention the IPCC report.** ***(60 words)***
4. **Discuss methods of coral restoration such as biological restoration and structural restoration.** ***(70 word)***
5. **Conclusion** ***(40 words)***

Hints

Coral reefs are shallow-water ecosystems that consist of reefs made of calcium carbonate which is mostly secreted by reef-building corals and encrusting macroalgae. They occupy less than 0.1% of the ocean floor yet play multiple important roles throughout the tropics, housing high levels of biological diversity as well as providing key ecosystem goods and services such as habitat for fisheries, coastal protection, and appealing environments for tourism.

Phenomena of coral bleaching

- Corals can become stressed by changes in ocean temperature, and their reaction is to expel the algae that live within them. The algae give a reef its colour, and when it's gone, just the white skeletons of the coral remains, so a reef looks 'bleached'.
- Corals rely on algae for nutrition, so once the algae have gone, this weakens the coral polyp and if the algae don't return to the polyp, the coral will eventually die.
- As per reports of IUCN reefs around the world have suffered from mass bleaching events for three consecutive years. Iconic reefs such as the Great Barrier Reef in Australia and the Northwestern Hawaiian Islands in the United States have all experienced their worst bleaching on record with devastating effects.
- The bleaching of the Great Barrier Reef in 2016 and 2017, for instance, killed around 50% of its corals. Corals cannot survive the frequency of current bleaching events from global temperature rise.

- If temperatures continue to rise, bleaching events will increase in intensity and frequency. Scientists estimate that even those events that occur twice per decade can threaten corals' survival.
- The first global scientific assesment of climate change impacts on World Heritage coral reefs, published in 2017 by UNESCO, predicts that the coral reefs in all 29 reef-containing World Heritage sites would cease to exist as functioning coral reef ecosystems by the end of this century if humans continue to emit greenhouse gases under a business-as-usual scenario.

Impact of climate change on coral reefs:

- The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007)3 presented strong evidence that global warming over the last century was largely a result of human activity, such as the burning of fossil fuel, deforestation and the conversion of lands for agricultural use.
- Global concentrations of carbon dioxide (CO2) have also shown increased levels from an average of 280 parts per million (ppm) in the mid-nineteenth century, at the beginning of the industrial revolution, to approximately 388 ppm at the beginning of the twenty-first century.
- Increasing levels of CO2 in oceans that cause ocean acidification. This process impacts the ability of corals to make calcium carbonate. Corals need water that has a specific salinity and low turbidity, and these changes in weather create an environment that does not support healthy coral.

Methods of coral restoration:

- Coral restoration may include growing asexually or sexually derived corals in land-based or ocean nurseries for later restoration, to directly transplant coral colonies or fragments from intact areas (often to-be construction sites) to degraded reefs, and to transplant corals to substrate stabilization structures after ship groundings or dynamite fishing, respectively.
- The conditions for coral restoration must be conducive for growth. Generally, this means that you maintain the same light levels (depth), and transplant the corals to an area where threats such as sedimentation, pollution, anchor damage, etc are low or absent. Depending on the size of the project, achieving high levels of success and minimizing mortality or unexpected consequences or disasters (risk mitigation), can be quite difficult.
- In restoring coral reef through asexual propagation and the securement of coral fragments as discussed above, there are three primary or foundational objectives that are either addressed individually or in unison; **(1) Increase solid structures available for coral growth, (2) increase coral coverage (3) alter growing conditions**. These objectives can also be referred to structural, biological, and physical conditions.
- **Structural Restoration: Structural** restoration generally involves construction of **artificial reefs, sinking of wrecks, or relocation of rocks/dead coral** heads.
- **Biological Restoration:** Biological restoration usually involves increasing the amount of living corals on the reef in areas were structure is already available. This is generally achieved through methods such as **collecting and rehabilitating naturally broken coral fragments, propagating coral colonies, culturing coral larvae or transplanting living coral colonies.**

Conclusion:

Monitoring, research, and restoration are the most important things to helping us save coral reefs. However, the only way to ultimately protect the reefs are through legal mechanisms. One legal mechanism involves the establishment of marine protected areas. This is because marine protected areas have a law behind them that can be enforced. This may allow for a better chance of survival. With the right tools, education, and research we can take the right steps into saving the coral reefs.

6. As the world glaciers are depleting rapidly, what consequences will it likely to have on the humans and environment? Suggest various measures to tackle its causes and consequences.

(250 words)

Approach

1. **Introduction on glacier** ***(30 words)***
2. **Discuss the consequences it will have on the humans and environment** ***(110 words)***
3. **Suggest various measures to tackle the issue** ***(80 words)***
4. **Conclusion** ***(30 words)***

Hints

Glaciers are made up of fallen snow that, over many years, compresses into large, thickened ice masses. Glaciers form when snow remains in one location long enough to transform into ice. What makes glaciers unique is their ability to flow. Due to sheer mass, glaciers flow like very slow rivers. Some glaciers are as small as football fields, while others grow to be dozens or even hundreds of kilometers long.

Consequences it will have on the humans and environment

On Ecology:

- Disturbance of food web in polar realm.
- Flora and fauna affected due to increased temperatures.
- Invasive species may take control of local ecosystem.
- On global scale, the changes in albedo of the Earth and in the system of ocean currents.
- Threat to ice dependent animals like walruses and polar bears.
- Arctic is heating up twice the rate of rest of earth which exposes permafrost that may release huge amount of methane and may cause further increase in global warming.

On Humans:

- Transhumance will be affected.
- Habitats of people living just below the glaciers may have to rehabilitate due to increased flood like situations. For example, in Himalayas.

- Tribes may have to look for another source of livelihood, if local ecosystem is disturbed.
- Its retreating creates floods and landslides causing many deaths as in Uttrakhand.
- Retreating glaciers pose a danger to availability of drinking water and irrigation problems in many parts of world.

Other Issues:

- It will have a major impact on water systems like rivers, as many of them depend on glaciers for supply of water.
- In initial stages it will increase the chances of 'Mountain Tsunamis' in hilly areas due to sudden increase in water flow.
- The polar ice caps contain the largest glaciers in the world and their melting will cause the sea level to rise.
- Threat to polar wildlife is also heightened.
- Increase in the volume of the rivers can cause floods in plains, which could prove disastrous for animal as well as human lives.

Various methods to tackle the issue as suggested by an international environmental

- Reduce, Reuse, and Recycle: It better to reduce garbage by choosing reusable products. If it is something that can't be reused, one can try to purchase products with minimum packaging. Recycle paper, plastic, glass, newspaper, and aluminum..
- **Save gas and walk more:** When you save a gallon of gas you can help keep 20 pounds of CO2 out of the atmosphere. You also get lots of benefits by walking to the office, school, or grocery store.
- **Planting a tree:** Plants absorb CO2 and produce oxygen. Planting a tree can help balance the increases of CO2.
- **Eating green:** Transportation is a major contributor of greenhouse gasses. Better to eat locally grown food to reduce transportation emissions.
- **Use of less heat and air conditioning:** Using less air conditioning and heat, or just keeping house 2 degrees lower in winter or 2 degrees higher in summer can make a big difference.
- **Save electricity:** One should turn off the lights, television, PC, or any other electrical devices when not in use.
- **Awareness:** Informing family, friends, and colleagues about how they can reduce their carbon footprint by following the tips above.

Conclusion:

Melting Arctic ice can accelerate global warming by reinforcing the vicious feedback loops on climate change. A large quantity of organic carbon derived from terrestrial vegetation is now trapped in the permafrost (frozen soil) that underlies the Arctic region. As the permafrost thaws, the microbial activity in the soil increases, decomposing the organic matter and releasing carbon dioxide and methane – a more potent greenhouse gas – into the atmosphere. The release of these heat-trapping gasses absorbs radiation from the Earth's surface, which in turn causes more permafrost to thaw and so on.

7. Prolonged periods of marine heatwaves (MHWs) are a major threat to marine ecosystems and their functioning that have resulted in devastating and long-lasting impacts . Discuss.

(250 words)

Approach

1. **Define Marine heat waves.** ***(50 words)***
2. **Causes of Marine heat waves.** ***(80 words)***
3. **Describe impacts and implications of marine heatwaves** ***(80 words)***
4. **Conclude with suggestions.** ***(40 words)***

Hints

Marine heatwaves (MHWs) are periods of extreme warm sea surface temperature that persist for days to months and can extend up to thousands of kilometers. Heatwaves can happen in summer and also in winter, where they are known as "winter warm-spells". Marine heatwaves (MHWs), or prolonged periods of anomalously warm sea water temperature, have been increasing in duration and intensity globally for decades. However, there are many coastal, oceanic, polar, and sub-surface regions where our ability to detect MHWs is uncertain due to limited high quality data.

Causes of Marine Heatwaves:

- The most common drivers of marine heatwaves include ocean currents which can build up areas of warm water and air-sea heat flux, or warming through the ocean surface from the atmosphere.
- Winds can enhance or suppress the warming in a marine heatwave, and climatic events like El Niño can change the likelihood of events occurring in certain regions.

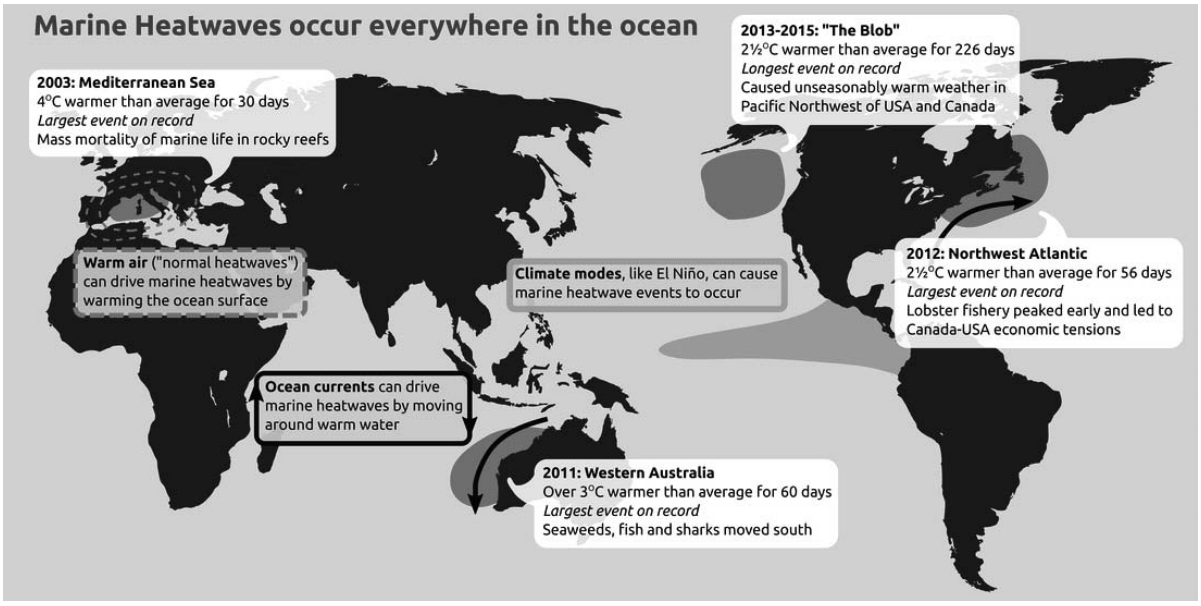


Fig: Occurrence of Marine heatwaves

These marine heatwaves, when ocean temperatures are extremely warm for an extended period of time can have significant impacts on marine ecosystems and industries.

Impacts and implications of marine heatwaves:

Impact on Ecology:

- Marine heat waves affect ecosystem structure, by supporting certain species and suppressing others.
- Eg: after the 2011 marine heat wave in Western Australia the fish communities had a much more "tropical" nature than previously and switched from kelp forests to seaweed turfs.
- Some animals can also find their way well outside their normal range.
- Eg: following the warm waters of a marine heat wave, tropical fish (the spiny sea urchin) found off Tasmania during the 2015/16 marine heat wave.
- **Change in habitat ranges:** Marine heat waves can change the habitat ranges of certain species, such as the **spiny sea urchin** off southeastern Australia which has been expanding southward into Tasmania at the expense of kelp forests which it feeds upon.
- **Adverse impact on biodiversity:** Biodiversity can be drastically affected by marine heatwaves. In 2016, marine heat waves across northern Australia led to severe bleaching of the Great Barrier Reef and have been speculated to be linked to mangrove die-offs in the Gulf of Carpentaria.

Impact on Environment:

- **Ocean warming:** Climate change has already contributed to substantial warming of the ocean over most of the globe. The ocean has absorbed ~93 percent of additional heat, leading to significant warming of the upper ocean. marine heat waves will further intensify the ocean warming.
- **Seasonal variability:** marine heat waves have already exceeded the range in natural seasonal variability in subtropical areas and the polar region.
- **Extreme climatic events:**The rise in sea surface temperatures due to marine heat waves is causing more severe hurricanes and the intensification of El Niño events bringing droughts and floods.

Impact on Economy:

- **Fisheries and aquaculture**: Marine heat waves can cause economic losses through impacts on fisheries and aquaculture.
- Eg: In 2011 in Western Australia, the marine heatwave impacted the abalone fishery in the north of the state and in 2015/16 the marine heatwave off southeastern Australia led to high levels of abalone mortality in Tasmania.
- **Forests and corals:** Marine heat waves can last for weeks or months, killing off kelp forests and corals, and producing other significant impacts on marine ecosystems.
- **Food security :** Rising Marine heat waves induced ocean temperatures also affect the benefits humans derive from the ocean – threatening food security, increasing the prevalence of diseases and causing more extreme weather events and the loss of coastal protection.
- **High cost of health**: Warming ocean temperatures are linked to the increase and spread of diseases in marine species. Humans risk direct transmission of these diseases when consuming marine species, or from infections of wounds exposed in marine environments.

Conclusion:

Marine heatwaves clearly have the potential to devastate marine ecosystems and cause economic losses in fisheries, aquaculture, and ecotourism industries. However, their effects are often hidden from view under the waves until it is too late. By raising general awareness of these phenomena, and by improving our scientific understanding of their physical properties and ecological impacts, we can better predict future conditions and protect vulnerable marine habitats and resources.

8. Glaciers are sensitive indicators of modern climate change. Justify the statement in the context of retreat of glaciers in Zaskar valley in India.

(250 words)

Approach

1. **Introductory paragraph related to glacier retreat.** ***(30 words)***
2. **Causes of retreat of glacier** ***(40 words)***
3. **Brief the reasons for glacier retreat in Zaskar valley.** ***(60 words)***
4. **Impact of glacier retreat** ***(60 words)***
5. **Suggest some Mitigation measures.** ***(40 words)***
6. **Conclusion.** ***(20 words)***

Hints

Glaciers are sensitive indicators of modern climate change because they respond to both temperature and precipitation. Glaciers have been retreating for more than 100 years worldwide. Recent example of the Pensilungpa Glacier located in Zanskar; Ladakh in India is the evidence of the same.

Causes of Glacier retreat:

The melting of glaciers depends on a variety of factors such as

- **Solar Radiation:** Glaciers deflect up to 80% of solar radiation (sunlight), while absorbing the rest. When a glacier melts completely, it exposes the earth's surface, and this has the opposite effect, meaning that 80% of heat is absorbed and 20% is deflected. Increased radiation increases melting rates, causing glaciers to shrink.
- **Calving:** Recent high-temperature levels reduce the ability of snow to form on glaciers, leading to the weakening of the outer layers, and causes them to break off.
- **Global Warming:** Global warming creates temperature increases, causing glaciers to melt faster. Human-caused global warming is the leading cause of glacier retreat.

Reasons for retreat of glaciers in Zaskar valley:

- The retreat is attributed to an increase in the temperature and decrease in precipitation during winters.

- Influences of debris cover on the mass balance and retreat of the glacier's endpoint, especially in summer.
- The rise in the air temperature in line with the global trend, the melting would increase, and it is possible that the precipitation of summer periods at higher altitudes will change from snow to rain, and that may influence the summer and winter pattern.
- Hence, various climatological and anthropological factors contribute to the retreat of glaciers throughout the world.

Impact of glacier retreat

Glacier retreat results in a variety of negative consequences, including increased sea levels, floods, and fresh water shortages. When ice glaciers melt faster, temperatures rise further, and more glaciers shrink, which creates a vicious cycle that is significantly changing the climate across the globe.

Glacier retreat cannot be stopped but its impact can be reduced and the retreating rate could be slowed down.

Adaptation and mitigation strategies:

- Land-use planning
- Structural protection measures.
- Improving Warning systems
- Vulnerability and risk assessment.
- Preparedness for emergency situations.
- Relocation strategies.

Conclusion:

Glaciers play a significant role as reservoirs of water, habitats for species, enhancing electric power generation, as well as serving as tourist destinations. Glacial shrinking is higher today than it has been in the last 100 years. Therefore, reducing impact of human actions is the key to reduce the adversities.

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NOTES

ECONOMIC GEOGRAPHY: DISTRIBUTION OF KEY NATURAL RESOURCES

SET-1: QUESTIONS

NATURAL RESOURCES

Q1. Fear of resource scarcity is not new, however, the globalization has added new dimension to it. Analyze the statement with respect to the global trends in the production and consumption of key resources.

Q2. Unscientific exploitation of resources is more hazardous than over-exploitation of resources. Critically analyse.

Q3. Soil degradation impact is increasing in India and is having a negative effect on food production. Discuss the various problems associated with it and suggest some concrete measures to tackle the problem of soil degradation in India.

Q4. How poverty leads to the desertification of any landmass? Illustrate with example. What are the responses of the International community to mitigate desertification?

Q5. Analyze the causes of desertification in India and suggest remedial measures to control it.

Q6. Desertification represents the 'greatest environmental challenge of our times'. In the context of given statement discuss the major reasons for desertification and suggest some concrete measures to fight desertification.

Q7. India has registered a decline in barren and wasteland, Cultural wasteland, area under pastures and net area sown in recent years. Explain the causes and also enlist the environmental impacts of this decline.

Q8. Discuss the concept of Social Forestry. What are the challenges of community forestry in India?

Q9. Sustainability of India's forest cover lies in adoption of social forestry, examine. Also discuss what factors are hampering the growth of social forestry in India?

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SET-1: ANSWERS

1. Fear of resource scarcity is not new, however, the globalization has added new dimension to it. Analyze the statement with respect to the global trends in the production and consumption of key resources.

(250 Words)

Approach

1. **Give a brief description of the resource scarcity** ***(60 words)***
2. **Discuss the major reasons behind the Unsustainable production and consumption of key resources** ***(150 words)***
3. **Conclusion** ***(40 words)***

Hints

Fear of resource scarcity is not new. On many occasions, higher rates of investment and improved technology have resolved the problem of the day, though often with additional environmental and social costs. With the maturation of technologies to access non-conventional gas and oil, as well as the global economic downturn, some analysts suggest that the resource boom of the past decade is coming to an end – especially in the extractive industries – and that resource related tensions will take another turn. The world is undergoing a period of intensified resource stress, driven in part by the scale and speed of demand growth from emerging economies and decade of tight commodity markets.

Reasons behind the Unsustainable production and consumption of key resources

- The emerging economies lie at the epicentre of the new and evolving political economy of critical resources. The growth of China and India – as both consumers and producers – has affected multiple resource markets. In the past decade, global use of coal, palm oil, and iron ore has been growing at 5–10% a year, while that of oil, copper, wheat, and rice has been growing at 2% a year.
- Resource trade has grown nearly 50% from a decade ago in weight terms owing to expanding trade in oil, iron and steel, coal, oilseeds, and cereals – all feed stocks for China, the factory of the world. Beyond the traditional powers and emerging economies, a number of developing countries will become important resource consumers in the next decade. They are likely to include Iran, Vietnam, Turkey and Thailand.

- Large-scale resource extraction remains concentrated in a handful of countries. Across 19 resources (crops, timber, fish and meat, metals, fossil fuels and fertilizers) the three largest producers on average account for 56% of global production. The eight dominant players are China, the United States, Australia, the European Union, Brazil, Russia, India, and Indonesia. Others with significant production capacities for one or two major resources include Argentina (soybeans), Saudi Arabia (oil), Iran (oil and gas), Canada (potash and nickel), and Chile (copper). For resources with smaller production volumes, such as palm oil or many specialty metals, concentration among producer countries is even higher.
- A new wave of increasingly important producers has emerged in the wake of the resource boom, often fuelled by large-scale foreign investment. Peru has become an important producer of copper and zinc, as has Angola for oil. Mongolia (for copper and coal) and Mozambique (for coal and gas) are poised to follow suit. **Paraguay has become the fourth largest soybean exporter.** Their fast-expanding resource sectors are becoming a flashpoint for social and political tensions.
- African countries are conspicuous by their absence from lists of major resource producers. Despite the hype surrounding the so-called 'new scramble for Africa', many agricultural or resource-seeking investments remain speculative or have yet to commence production.
- The dynamics of resource production and consumption are interlinked through markets, trade and the global environment. Constraints on the future production of any particular resource lie not only in their availability and price, but also in the accessibility and cost of the other resources used to produce them.

Conclusion:

Thus, future availability of food, energy, timber, and metal resources at affordable costs will be determined by a combination of factors – including accessible reserves, transportation routes, environmental considerations, technology and input costs (such as water and energy). Reserve figures are often imperfect guides. Also significant will be investment conditions, shaped by the socio-political context in producer and consumer countries.

2. Unscientific exploitation of resources is more hazardous than over-exploitation of resources. Critically analyse.

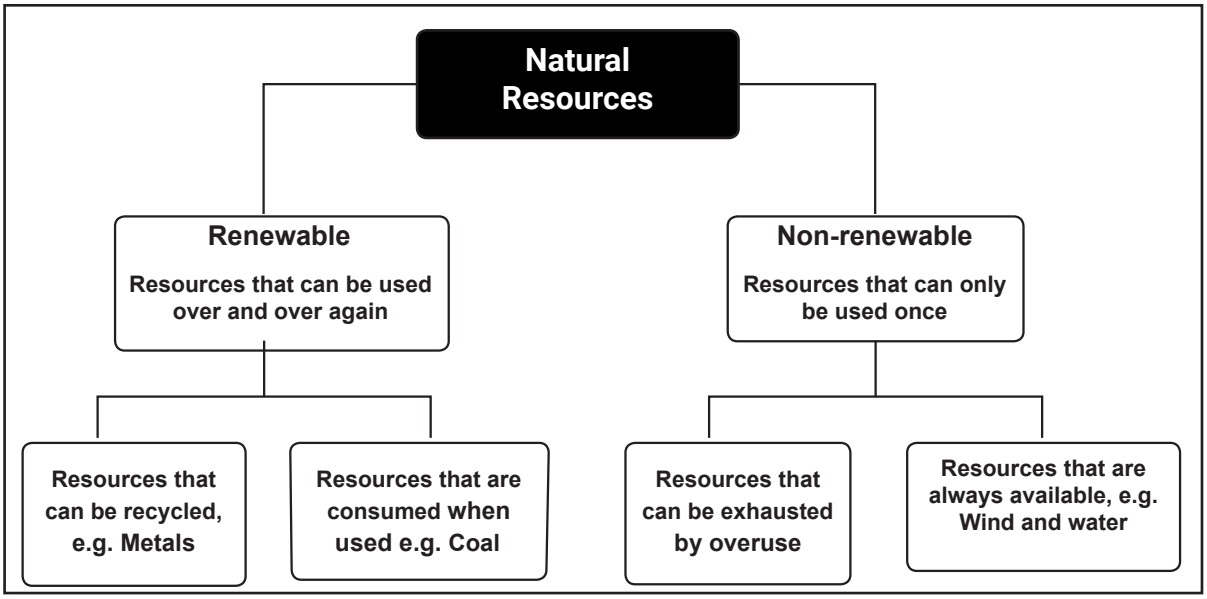
(200 Words)

Approach

1. **Give a brief description of the natural resources** ***(50 words)***
2. **Elaborate, Unscientific exploitation of resources is more hazardous than over-exploitation of resources** ***(120 words)***
3. **Conclusion** ***(30 words)***

Hints

Natural resources may be divided into renewable resources such as land (arable and grazing land), air, ground water, forests, plants and animals, etc. and non-renewable resources such as oil, coal, natural gas, metals, minerals, etc. The exploitation of both renewable resources and non-renewable resources is increasing, as more countries embark on industrialization and consume more resources.



How Unscientific Exploitation of Resources is more hazardous than over exploitation?

- It is necessary to fully rely on scientific and technological progress to raise the efficiency of resources utilization through study on, development and use of advanced new technology as well as special efforts have to be made in these aspects toward the direction of building a resources-saving society which is next to impossible in case of unscientific way utilizing resources.
- Unscientific aspects of mining are hazardous in which Bombs are being used as explosives and the impact of explosion is so severe that the stability of houses and buildings often get affected.
- Tremors caused by explosions are creating an earth quake like situation in the hill areas, posing a threat to wildlife and survival of human beings
- Unscientific means of exploitation may cause loss of biodiversity which lead to a break down in the functioning of ecosystem.
- Unscientific exploitation also leads to depletion of medicinal plant which will ultimately have a negative impact in formation and discovery of drugs that are used to address hazardous outbreak of diseases.
- In regard to improve the efficiency of the utilization of coal; future emphasis should be on developing the gasification and liquefaction of coal and other clean coal technologies. Because coal accounts for over 70 percent of India's energy sources, if the extensive use of clean coal can be realized, it will improve efficiency by more than 30 percent.
- At present, the successfully developed technology of liquefaction of coal has been widely used in chemical and metallurgical industries, power generation and in urban gas supply, this has greatly raised the utilization efficiency of coal.
- Non-Scientific use of water especially for agricultural-use may leads to scarcity of water as well as it causes pollution of ground water therefore it is necessary to raise the utilization efficiency of agricultural-use water through such techniques or means as drip irrigation, spray irrigation and running water-saving wagons. The application of such technology has gained desirable results, if the utilization efficiency of agricultural-use water is raised by 10 percent, it would mean an increase in the volume of effective use of water equivalent to irrigating million hectare of land.

Conclusion:

In short, in building a resources-saving society, scientific and technological work not only plays its role in a certain link, but rather in the whole chain of the utilization of resources, efforts should be made to strive for the achievement of technical break through so as to provide support and guarantee for the building a resources-saving society for sustainable energy management.

3. Soil degradation impact is increasing in India and is having a negative effect on food production. Discuss the various problems associated with it and suggest some concrete measures to tackle the problem of soil degradation in India.

(250 words)

Approach

1. **Give a brief description of Soil degradation** ***(50 words)***
2. **Discuss the problems associated with soil degradation and how it effect food security in India** ***(80 words)***
3. **Suggest some measures to tackle the problem of soil degradation in India** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

Soil degradation is the decline in soil quality caused by its improper use, usually for agricultural, pastoral, industrial or urban purposes. It is a serious global environmental problem and may be exacerbated by climate change. It encompasses physical, chemical and biological deterioration.

Examples of soil degradation are loss of organic matter, decline in soil fertility, decline in structural condition, erosion, adverse changes in salinity, acidity or alkalinity, and the effects of toxic chemicals, pollutants or excessive flooding.

- **Problems associated with soil degradation:** The loss of fertile soil makes land less productive for agriculture, creates new deserts, pollutes waterways and can alter how water flows through the landscape, potentially making flooding more common.
- **Loss of Arable Land:** Arable land is any land that can be used to grow crops. Many of the practices used in growing those crops can lead to the loss of topsoil and destruction of soil characteristics that make agriculture possible.
- **Clogged and Polluted Waterways:** Soil eroded from the land, along with pesticides and fertilizers used in the fields get washed away into streams and waterways. This sedimentation and pollution can damage freshwater and marine habitats and the local communities that depend on them.
- **Increased Flooding:** Land is often transformed from a forest or other natural landscape, such as floodplains and wetlands, into a crop field or pasture. The converted land has less ability to soak up water, making flooding more common.

- **Loss of microbial activity:** Soil degradation may impair the function of soil organisms and thus result in further problems. The soil microbial community is essential for cycling of nutrients and decomposition of wastes; thus hindrance of microbial activities may have serious ecological results. Degradative forces such as erosion that result in loss of organic matter may also result in long-term losses of microbial activity.
- **Depletion of plant nutrients:** Soil degradation often affects productivity by depleting plant nutrients. Excessive leaching of cations involved in buffering soil pH may result in soil acidification, changing the solubility, and thus availability, of certain nutrients to plants. Misuse can also result in concentration of chemicals that are toxic to plants.
- **Loss of biodiversity:** Soil degradation may involve the disappearance of the climax vegetation and decrease in animal habitat, thus leading to a biodiversity loss and animal extinction.

Soil degradation and food insecurity

- Agriculture productivity had greatly increased during the "green revolution" of the last 40 years, as farmers have had more sophisticated technology available. Modern equipment and inorganic chemicals for herbicide, pesticide and fertilizers (inputs) help maximize agriculture production. These and other technological developments assured that globally more cereal grains were produced from 1975 to 2000 than in any other period in history. But the present declining crop yield is exponentially related to loss of soil quality. Continuous cultivation is linked to irreversible soil degradation and top soil loss.

Other problems include:

- Salinization, Water erosion, Acidification, Natural disasters, Contamination, Reduced food web functioning and consequently crop yield losses, Reduced nutrient cycling and nitrogen fixation, Reduced carbon sequestration, Reduced resilience of the soil to endure pressures, and Reduced water infiltration rate and water holding capacity

How to tackle the problem:

- Abatement strategies, such as afforestation, for combating accelerated soil erosion are lacking in many areas. To reduce the risk of soil erosion, farmers are encouraged towards more extensive management practices such as organic farming, afforestation, pasture extension and benign crop production.
- Nevertheless, there is a need for policy makers and the public to intensify efforts to combat the pressures and risks to the soil resource. Methods to reduce or prevent erosion can be mechanical, e.g., physical barriers such as embankments and wind breaks, or they may focus on vegetation cover and soil husbandry.
- Overland flow can be reduced by increasing infiltration. Mechanical methods include bunding, terracing and contour ploughing, and shelter belts such as trees or hedgerows. The key is to prevent or slow the movement of rain water down slope. Contour ploughing takes advantage of the ridges formed at right angles to the slope to act to prevent or slow the downward accretion of soil and water.
- On steep slopes and in areas with heavy rainfall, such as the monsoon in South-East Asia, contour ploughing is insufficient and terracing is undertaken. The slope is broken up into a series of flat steps, with bunds (raised levees) at the edge. The use of terracing allows areas to be cultivated that would not otherwise be suitable. In areas where wind erosion is a problem shelterbelts of trees or hedgerows are used.
- The trees act as a barrier to the wind and disturb its flow. Wind speeds are reduced which therefore reduce its ability to disturb the topsoil and erode particles.

Preventing erosion by different cropping techniques largely focuses on:

- Maintaining a crop cover for as long as possible.
- Keeping in place the stubble and root structure of the crop after harvesting.
- Planting a grass crop. Grass roots bind the soil, minimising the action of the wind and rain on a bare soil surface. Increased organic content allows the soil to hold more water, this preventing aerial erosion and stabilising the soil structure. In addition, care is taken of the use of heavy machinery on wet soils and ploughing on soil sensitive to erosion, to prevent damage to the soil structure.

4. How poverty leads to the desertification of any landmass? Illustrate with example. What are the responses of the International community to mitigate desertification?

(250 words)

Approach

1. **Briefly introduce the Desertification** ***(50 words)***
2. **Explain how poverty leads to the desertification of any landmass. ? Illustrate with example** ***(80 words)***
3. **What are the responses of the International community to mitigate desertification** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

The United Nations Convention to Combat Desertification defines the term desertification as 'land degradation in arid, semi-arid and sub-humid areas resulting from various factors including climatic variations and human activities'. Desertification, along with climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit.

Poverty has an inextricable link with the desertification in following way:

- Poor people are largely engaged in primary activities like agriculture, animal rearing, fishing & forestry, etc. This leads to over-cultivation, overgrazing, deforestation and overexploitation of marine biotic resources turning the once fertile soil into unproductive and barren patches of land leading to desertification.
- The dependence of poor on nature for food, fodder & fuel is very high. The predictable effect of these practices is declining food production and an increase in the level of poverty. Poverty then drives populations to over-exploit the remaining natural resources triggering a vicious cycle, accelerating land degradation still further.
- A classic case of poverty driving the process of desertification can be seen in India. In 2009, the ISRO in a first-of-its-kind 'Desertification Status Map' study estimated that one fourth of India's geographical area, or 81 million hectares, is undergoing a process of desertification

due to cutting of forests beyond permissible limits, unsustainable fuel wood and fodder extraction, shifting cultivation, encroachment into forest lands, forest fires, overgrazing, inadequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals, improper management of irrigation systems and excessive extraction of ground water.

- Effective prevention of desertification requires both local management and macro policy approaches at the international level that promote sustainability of ecosystem services.

The international community has responded to this threat in various ways as follows:

- The United Nations Convention to Combat Desertification (UNCCD) was adopted in 1994 that demonstrated a growing awareness of the problems of desertification & resolve of the international community to address it. The UNCCD has specific objectives of promoting sustainable development, imparting education & training, measuring human development, creating an enabling environment for the involvement of local communities.
- The Global Environment Facility was established as a USD 1 billion programme in the World Bank in 1992. The GEF has evolved to become the financial mechanism for several multilateral environmental agreements, including the UNFCCC, the UNCBD, the UNCCD and the Stockholm Convention.
- The Food and Agriculture Organization has launched the FAO Dry lands Restoration Initiative in 2012 to draw together knowledge and experience on dry land restoration.
- The Addis Ababa Action Agenda 2015 has promised measures to overhaul global finance practices and generate investments for tackling a range of economic, social and environmental challenges including desertification.

5. Analyze the causes of desertification in India and suggest remedial measures to control it.

(200 words)

Approach

1. **Give a brief description of Desertification** ***(40 words)***
2. **Discuss the causes of desertification in India** ***(60 words)***
3. **Suggest some remedial measures to control it** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Desertification is the process that turns productive land into non-productive desert as a result of poor land-management. Desertification occurs mainly in semi-arid areas (average annual rainfall less than 600 mm) bordering on deserts.

Desertification is the persistent degradation of dry land ecosystems by variations in climate and human activities. It manifests itself in the loss of vegetation cover, loss of topsoil as a result of salinization or excessive sedimentation associated with sand dunes.

Causes

- Destruction of natural vegetation in arid regions, often for fuel wood.
- Incorrect irrigation practices in arid areas can cause salinization (the build-up of salts in the soil) which can prevent plant growth. The mismanagement of canal water has created the problems of salinization and water-logging in rice cultivating regions of Punjab and Haryana which has ultimately led to desertification.
- Wind and water erosion aggravate the damage, carrying away topsoil and leaving behind a highly infertile mix of dust and sand.
- In western Rajasthan, about twenty major minerals and nine minor minerals are being mined. More than 90 percent of the mine owners have open cast mining. The rest are underground mines. The surface mining activity causes immediate degradation of land.
- The mining sites are abandoned after the excavation work is over, without adopting any reclamation measure. Mining on agricultural land, either surface or underground, reduces the productivity of land by way of excavation, disposal of debris and tailing. Mineral processing like grinding of limestone for cement industry, calcite and soapstone for ceramic industry, have three-fold adverse effects. The fine dust, generated and released in the atmosphere, leads to surface scaling of the adjacent land after it settles down, consequently the infiltration rate is reduced and the run-off increases.
- Mining activity restricts the sub-surface movement of water. With the removal of vegetation, the rate of evapotranspiration is reduced and as a result, there is a change in the hydrological balance in the area.

Measures to fight against desertification:

- Reforestation and tree regeneration.
- Water management — saving, reuse of treated water, rainwater harvesting, desalination, or direct use of sea water for salt-loving plants.
- Farmer Managed Natural Regeneration (FMNR), enabling native sprouting tree growth through selective pruning of shrub shoots. The residue from pruned tress can be used to provide mulching for fields thus increasing soil water retention and reducing evaporation.
- Local adaptation and conservation practices can mitigate some losses of dry land services, but it will be difficult to reverse losses in terms of biodiversity and in the provision of food and water, which is linked, to biodiversity.
- The creation of a "culture of prevention" that promotes alternative livelihoods and conservation strategies can go a long way toward protecting dry lands both when desertification is just beginning and when it is ongoing. It requires a change in governments' and peoples' attitudes. Building on long-term experience and active innovation, dry land populations can prevent desertification by improving agricultural and grazing practices in a sustainable way. Even once land has been degraded, rehabilitation and restoration measures can help restore lost ecosystem services. The success of rehabilitation practices depends on the availability of human resources, funds, and infrastructures. It requires a combination of policies and technologies and the close involvement of local communities.
- However, the only realistic large-scale approach is to prevent desertification through good land management in semi-arid areas.

6. Desertification represents the 'greatest environmental challenge of our times'. In the context of given statement discuss the major reasons for desertification and suggest some concrete measures to fight desertification.

(250 words)

Approach

1. **Briefly introduce Desertification** ***(50 words)***
2. **Discuss the major reasons for desertification** ***(70 words)***
3. **Suggest some measures to fight desertification.** ***(80 words)***
4. **Conclusion** ***(50 words)***

Hints

- Desertification is the persistent degradation of dry land ecosystems by variations in climate and human activities. It manifests itself in the loss of vegetation cover, loss of top soil as a result of salinization or excessive sedimentation associated with sand dunes. Desertification is the process which turns productive land into non- productive desert as a result of poor land-management.
- Desertification occurs mainly in semi-arid areas (average annual rainfall less than 600 mm) bordering on deserts.

Causes

- Overgrazing and over-cropping have resulted in nutrient depletion, widespread soil erosion and desertification.
- Destruction of natural vegetation in arid regions, often for fuel wood
- Incorrect irrigation practices in arid areas can cause salinization (the build-up of salts in the soil) which can prevent plant growth. The mismanagement of canal water has created the problems of salinization and water-logging in rice cultivating regions of Punjab and Haryana which has ultimately led to desertification.
- The development of irrigation and intensification of agriculture in the highly fragile ecosystems of semi-desert areas have brought radical changes in the environment.
- Cultivation of marginal lands, for example, some parts of Punjab and Rajasthan.
- Wind and water erosion aggravate the damage, carrying away topsoil and leaving behind a highly infertile mix of dust and sand.

Mining and desertification

- In western Rajasthan, about twenty major minerals and nine minor minerals are being mined. More than 90 per cent of the mine owners have open cast mining. The rest are underground mines. The area occupied by the mines is increasing and by 2000 AD 0.05 per cent of Jaisalmer district and 1.15 per cent of Jhunjhunu district are reportedly under mining activities.

- The surface mining activity causes immediate degradation of land. The mining sites are abandoned after the excavation work is over, without adopting any reclamation measure. Mining on agricultural land, either surface or underground, reduces the productivity of land by way of excavation, disposal of debris and tailing. Mineral processing like grinding of limestone for cement industry, calcite and soapstone for ceramic industry, have three-fold adverse effects.
- The fine dust, generated and released in the atmosphere, leads to surface scaling of the adjacent land after it settles down, consequently the infiltration rate is reduced and the run-off increases.
- Mining activity restricts the sub-surface movement of water. With the removal of vegetation, the rate of evapotranspiration is reduced and as a result, there is a change in the hydrological balance in the area.
- Due to this change, the perched water table rises and causes salinity. When the mining debris of minerals like ball clay, china clay, Fuller's earth, bentonite and gypsum are dumped on the sandy plain, a semi-impermeable surface layer is developed. These areas get flooded during the monsoon and gradually develop salinity. Sodium salt mining activity increases the surface salt concentration, causing total loss of vegetation.

Measures to fight desertification:

- Reforestation and tree regeneration
- Water management — saving, reuse of treated water, rainwater harvesting, desalination, or direct use of seawater for salt-loving plants
- Fixating the soil through the use of sand fences, shelter belts, woodlots and windbreaks
- Enrichment and hyper-fertilizing of soil through planting
- Farmer Managed Natural Regeneration (FMNR), enabling native sprouting tree growth through selective pruning of shrub shoots. The residue from pruned tress can be used to provide mulching for fields thus increasing soil water retention and reducing evaporation.
- Soil conditions must be made favourable for plant growth by, for example, mulching. Mulch (a layer of straw or leaves covering the soil) reduces evaporation, suppresses weed growth, enriches soil as it rots, and prevents runoff and hence erosion. Reseeding may be necessary in badly degraded areas. Mulching and reseeding are expensive practices.
- Local adaptation and conservation practices can mitigate some losses of dry land services, but it will be difficult to reverse losses in terms of biodiversity and in the provision of food and water which is linked to biodiversity.
- The creation of a "culture of prevention" that promotes alternative livelihoods and conservation strategies can go a long way toward protecting drylands both when desertification is just beginning and when it is ongoing. It requires a change in governments' and peoples' attitudes. Building on long-term experience and active innovation, dryland populations can prevent desertification by improving agricultural and grazing practices in a sustainable way.
- Even once land has been degraded, rehabilitation and restoration measures can help restore lost ecosystem services. The success of rehabilitation practices depends on the availability of human resources, funds, and infrastructures. It requires a combination of policies and technologies and the close involvement of local communities.
- The implementation of the U.N. Convention to Combat Desertification (UNCCD) would be particularly difficult in a regionalized-reactive world, while prospects would improve in a more globalized world with proactive ecosystem management.
- However, the only realistic large-scale approach is to prevent desertification through good land management in semi-arid areas.

7. India has registered a decline in barren and wasteland, Cultural wasteland, area under pastures and net area sown in recent years. Explain the causes and also enlist the environmental impacts of this decline.

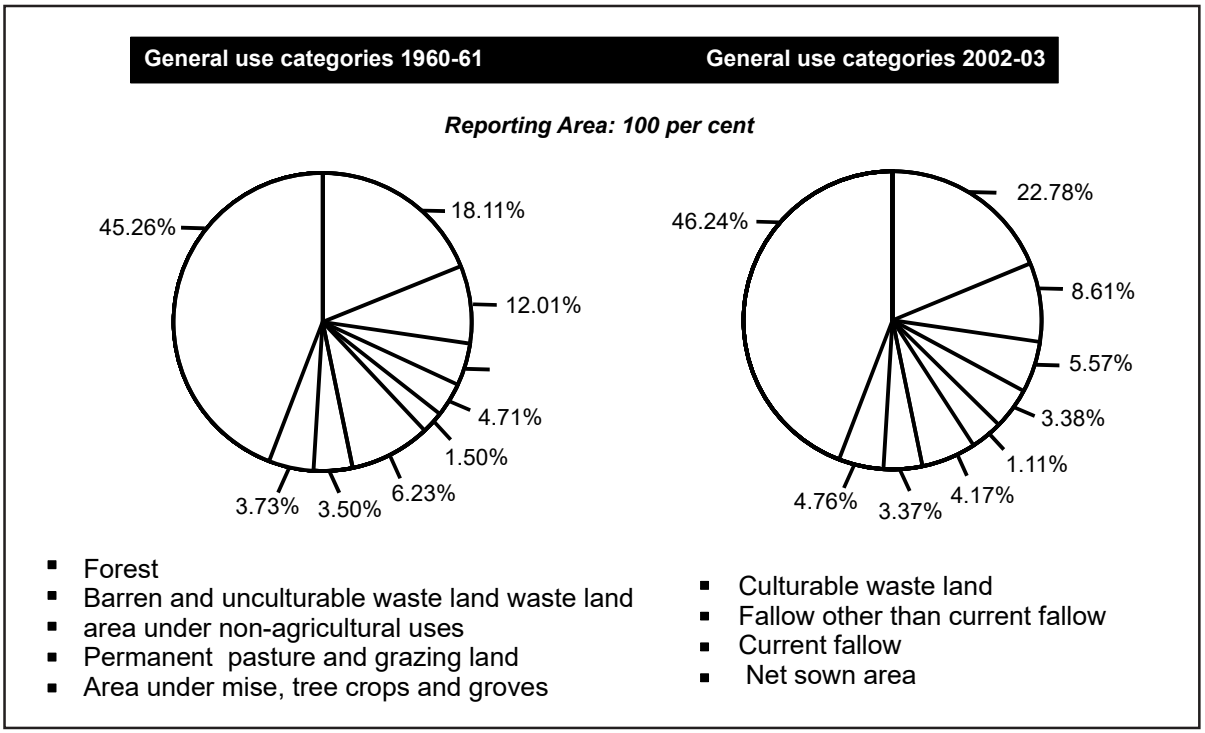
(250 words)

Approach

1. **Briefly explain, why India has registered a decline in barren and wasteland, cultural wasteland, area under pastures and net area sown** ***(100 words)***
2. **Explain the causes behind this declining trend** ***(100 words)***
3. **Way Forward** ***(50 words)***

Hints

Land is a crucial natural resource and an important determinant of a country's socioeconomic and ecological health. Given the finite supply of land resource, sustainable use and management of land resources is a necessity for the wellbeing of people of a country. Land-use change has broad lines of impact, with a potential for influencing economic growth, quality of life, management of environmental resources and national food supply. India has undergone major changes within the economy over the past four or five decades, and this has influenced the land-use changes in the country. The barren and wasteland, cultural wasteland, area under pastures and net area sown have seen a decline.



Observations from the above fig:

- Area under non-agricultural uses marks the highest rate of increase due to the changing structure of Indian economy, which is increasingly depending on the contribution from industrial and services sectors and expansion of related infrastructural facilities. Thus, the area under non-agricultural uses is increasing at the expense of wastelands and agricultural land.
- Increase in the share under forest, can be accounted for by increase in the demarcated area under forest rather than an actual increase in the forest cover in the country.

The following explanations can be given for the declining trends:

- As the pressure on land increased, both from the agricultural and non-agricultural sectors, the wastelands and cultural wastelands have witnessed decline over time. India has been experiencing rapid urbanization over the last few decades, which accelerated during the last decade. High economic growth during the two decades has also spurred growth in rail, road and port traffic, necessitating further infrastructure improvements and therefore demand for more land.
- The decline in land under pastures and grazing lands can be explained by pressure from agricultural land. Illegal encroachment due to expansion of cultivation on common pasture lands is largely responsible for this decline.
- Rapid increase of area under non-agricultural use is also responsible for most of the decline.

Way Forward

Unlike carbon dioxide, the greenhouse gas whose effects last for hundreds of years, land cover and land management generate drivers in climate systems that influence local and regional weather patterns. This is largely due to changes in aerosols, carbon, nitrogen and other gases along with the moisture in the air, heat and light. While this subject clearly requires more research to provide guidance to policy makers. But we already know that protecting water bodies, conserving groundwater, reducing our ecological footprint and living in more compact communities are good ways to address both climate change mitigation and adaptation.

What is desperately needed at this moment is a manifesto for the protection of the commons and open lands, and for the re-creation of economies that derive value out of healing wounded landscapes and covering open lands with diverse vegetation, water and life. For this, we need to defer to the Constitution and ensure that those who are challenging 'development' projects like the bullet train can speak without fear.

8. Discuss the concept of Social Forestry. What are the challenges of community forestry in India?

(250 words)

Approach

1. **Briefly introduce the concept of Social Forestry.** ***(50 words)***
2. **How social forestry helps in environmental conservation** ***(60 words)***
3. **Role of social forestry in environmental conservation** ***(60 words)***

4. Challenges of community forest ***(50 words)***

5. Conclusion ***(30 words)***

Hints

- The Social Forestry programmes in India form one of the largest and most innovative experiments in participatory forestry anywhere; and also one of the largest interventions designed to improve the productivity and use of communal land.
- Social Forestry had its formal origins in India with the report of the National Commission of Agriculture of 1976, which recommended growing trees on lands accessible to village people in order to reduce the pressures on forests set aside for production forestry brought about by mounting rural demands for fuel, grazing, and other forest products. It was then that India embarked upon a social forestry project with the aim of taking the pressure off the forests and making use of all unused and fallow land. Government forest areas that are close to human settlement and have been degraded over the years due to human activities needed to be afforested.
- This was to be achieved by encouraging the growing of trees by farmers on their land, and by block plantings on various categories of public land. Trees were to be planted in and around agricultural fields. Plantation of trees along railway lines and roadsides, and river and canal banks were carried out. They were planted in village common land, Government wasteland, and Panchayat land.
- With the introduction of this scheme the government formally recognised the local communities' rights to forest resources, and is now encouraging rural participation in the management of natural resources. Through the social forestry scheme, the government has involved community participation, as part of a drive towards afforestation, and rehabilitating the degraded forest and common lands.
- Social forestry scheme can be categorized into groups: farm forestry, community forestry, extension forestry and agro-forestry.
- **Farm forestry:** In almost all the countries where social forestry projects have been taken up, both commercial and non commercial farm forestry is being promoted in one form or the other. Individual farmers are being encouraged to plant trees on their own farmland to meet the domestic needs of the family. It is not always necessary that the farmer grows trees for fuel wood, but often they are interested in growing trees without any economic motive. They may want it to provide shade for the agricultural crops; as wind shelters; soil conservation or to use wasteland.
- **Community forestry:** Another scheme taken up under the social forestry programme is the raising of trees on community land and not on private land as in farm forestry. These programmes aim to provide for the entire community and not for any individual. The government has the responsibility of providing seedlings, fertilizer but the community has to take responsibility of protecting the trees.
- **Extension forestry:** Planting of trees on the sides of roads, canals and railways, along with planting on wastelands is known as 'extension' forestry, increasing the boundaries of forests. Under this project there has been creation of wood lots in the village common lands, government wastelands and panchayat lands. Schemes for afforesting degraded government forests that are close to villages are being carried out all over the country.
- **Agro-forestry:** Planting of trees on and around agricultural boundaries, and on marginal, private lands, in combination with agricultural crops is known as agro-forestry.

Role of social forestry in environmental conservation:

- Protection and Conservation of natural resources through active involvement of the people.
- Checking land degradation and deforestation.
- Checking loss of biodiversity.
- Ecological restoration and environmental conservation and eco-development.
- Regeneration of degraded forest and adjoining areas on a watershed basis.
- Promotion of fuel saving devices to encourage efficient use of fuel wood.
- Raising coastal shelterbelts to mitigate the adverse impacts of cyclonic winds.
- Develop water resources through plantation and water harvesting programmer.
- Rehabilitation of special problem lands like saline/alkaline soils, ravines, mining areas, desert areas, and coastal areas, the Himalayas, the Aravallis, and the Western Ghats.

Challenges of community forestry

- The primary objective of community forestry was to generate employment, protect the environment while ensuring basic needs of fodder, fuel and timber. However, the schemes could not fulfil the objectives due to lack of people's participation. Hence the community forestry during the next decade should focus on enhancing the productivity of natural resources, while empowering the local communities.
- Development of tree based farming systems in association with watershed development is expected to be a popular community forestry programme in the near future in India. There will be a preference for tree species producing fruits, timber and non-wood forest products because of sustainable income.
- As wood will continue to be the major source of fuel in rural areas, efforts will be made to produce wood fuel by introducing fast growing tree species in mixed plantations. Development of community wastelands, rehabilitation of mined areas, protection of natural forests, establishment of industrial greenbelts in urban area and environmental awareness are the other important components which will gain significance.
- Development of local organisations for input supply and processing of the produce, marketing and information sharing, based on the research studies require further emphasis for effective management of the programme.
- Research back up is needed to improve the productivity through selection of improved germplasm, enhancement in growth and yields, value addition through processing and marketing.

9. Sustainability of India's forest cover lies in adoption of social forestry, examine. Also discuss what factors are hampering the growth of social forestry in India?

(250 words)

Approach

1. **Briefly introduce the forest cover of India** ***(40 words)***
2. **Discuss the importance of social Forestry** ***(60 words)***

3. **Discuss the factors hampering Growth of Social Forestry in India** ***(60 words)***
4. **Discuss the measures to be adopted to overcome such issues** ***(60 words)***
5. **Conclusion** ***(30 words)***

Hints

Forest is one of the most important resources of any county providing various services including provisioning, regulatory and supporting services. As per forest Survey Report 2015, the Total forest covers in India: 7, 01,673 sq. km or 21.34 per cent of geographical area while Total tree cover is 92,572 sq. km or 2.82 percentage of geographical area per cent.

Although the total forest cover has seen an increase, around 2,510 square km of very dense and mid-dense forests have been wiped out since 2013. States of Jammu and Kashmir, Uttarakhand, Meghalaya, Kerala, Arunachal Pradesh, Karnataka and Telangana have suffered huge loss of forest cover. Around 2,254 square kilometre of mid-dense forest cover has turned into non-forest lands in the past two years. With Increasing population, urbanization, industrialization and need of agriculture land, there is huge pressure on forest resource. Thus, sustaining green cover of India is becoming a challenge. India has set the target to enhance forest cover to 33% of total geographical area and Under INDC submitted in Paris climate agreement, India seeks to create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030. The supply of land to enhance forest cover is major challenge. In this scenario, Social Forestry could provide a way out.

Social Forestry includes farm forestry, community forestry, and extension forestry and. Agro forestry. It aims to decreases dependency of rural population on natural forest for fuel wood, poles; timber and fodder thus protect forests, to create jobs and to protect environment and aid agriculture.

Importance of social Forestry:

- Increasing Forest Area and Restoring Ecological Balance: This is achieved through: Moisture conservation-trees take water from the lower soil strata and bring it to the upper layers through long tap root system and, also, trees check evaporation of water; Soil conservation-trees help in checking erosion by wind and water; Natural habitat conservation-trees provide habitat to many birds and animals, some of which are agro-friendly.
- Meeting Basic Rural Needs: Social forestry satisfies the basic rural needs referred to as 'five Fs'-food, fuel, fodder, fertiliser (green manure) and fibre. The large-scale depletion of easily accessible forests has resulted in acute scarcity of fuel-wood and fodder. What is disturbing is that the deficit in fuel wood is met by using cow-dung cakes, thus wasting a rich and cheap source of manure. Trees also supply the raw material for various small and village industries through small timber and minor forest produce.
- Ensuring Better Land Use: Social forestry helps achieve a balanced and viable land use by checking soil erosion, facilitating reclamation of marginal lands, checking waterlogging and by bringing about monolithic integration of forestry, agriculture and animal husbandry.
- Generation of Employment: Social forestry operations have the potential of improving the employment situation in rural areas especially during the lean agricultural season. This helps in stabilising incomes of weaker sections of Society.
- Controlling Pollution: Rees are known to absorb harmful gases and release oxygen. This way they help reduce air pollution especially in urban areas.

Factors hampering Growth of Social Forestry in India:

Social Forestry programmes were started in India in 1980s, however significant success has not achieved. Major factors inhibiting growth are:

- Fragmented responsibility and accountability. Like Agro forestry fall between the cracks of agriculture and forestry, thus no ownership by either sector.
- Adverse policies and legal bottlenecks regarding harvesting trees.
- Inadequate investment in sector.
- Weak marketing infrastructure and no price discovery mechanism.
- Lack of post harvesting processing technologies.
- Strict regulation in setting of wood based industries.
- Unawareness and Lack of community participation

Measures to be adopted to overcome such issues:

- Amending unfavourable legislations and incorporating social forestry in all policies relating to land use and natural resource management.
- Encouraging government and private investment in social forestry related infrastructure, research-education and in establishing of sustainable enterprises.
- Coordination nation between various mission and programmes like Green India mission and social forestry programme.
- Loan and insurance from financial sector.
- Location specific tree based technologies and research.
- Involvement of NGOs and farmers organisations.
- Building capacities, awareness campaigns and increase community participation.

Social forestry has great potential to enhance green cover, adding carbon sink and provide sustainable livelihoods in rural areas. For this focused effort are required. Harnessing National Agro forestry policy 2014 can provide an opportunity for institutionalised framework for its development.

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NOTES

SET-1.1: QUESTIONS

NATURAL RESOURCES

Q1. Discuss the status of mangroves in India. Why are they facing a constant threat? Critically analyze various domestic and international initiatives taken to protect the mangroves.

Q2. Illustrate the main problems related to Indian forestry.

Q3. The harsh environment support less population'. Justify this statement with suitable arguments from the tundra biome.

Q4. Forest fires pose a threat not only to the forest wealth but also to the entire regime of fauna and flora seriously disturbing the bio-diversity. Explain the man-made reasons for forest fires and ways for controlling it.

Q5. Although forest resources are widely utilized by pharmaceutical companies , Paper Industries and others but produces less revenue for state and contributes less in welfare of forest dwellers and affected communities." Discuss with reference to Uttarakhand High Court order to Patanjali to share its profit under equitable benefit-sharing as provided under the Biological Diversity Act, 2002.

Q6. "The fertile soils, perennial rivers and favorable climate, the great plains of north India are of immense economic and social significance". Elaborate. Also discuss despite huge economic potential entire Gangetic plain mainly in Uttar Pradesh and Bihar are marred by poverty.

Q7. "India can utilize vast natural resources of Himalayan region in the form of minerals, herbs, shrubs and tourism to boost it economy". Critically analyze with reference to economic opportunities and sustainable utilization of resources of the fragile Northern Mountain Complex.

Q8. Alluvial cover of the coastal plains of India makes it one of the most fertile plains of the world. Elucidate. Also, discuss why the West Coastal plain is infertile and agriculturally not prosperous unlike eastern coastal plain.

Q9. "The folds of the Greater Himalayas are asymmetrical in nature." Explain the formation of asymmetrical ranges in Himalayas. How does it play an important role in shaping the biodiversity and culture of the region?

Q10. What do you understand by 'Land Degradation Neutrality'? Discuss the causes of increasing desertification in Northeastern states of India. Suggest remedial measures.

SET-1.1: ANSWERS

1. Discuss the status of mangroves in India. Why are they facing a constant threat? Critically analyze various domestic and international initiatives taken to protect the mangroves.

(250 word)

Approach

1. **Briefly introduce the status of mangroves in India** ***(50 words)***
2. **Discuss the threats facing by the Mangroves both due to natural and anthropogenic factors** ***(80 words)***
3. **Discuss domestic and international initiatives taken to protect the mangroves** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

- Mangroves are plants that survive high salinity, tidal regimes, strong wind velocity, high temperature and muddy anaerobic soil - a combination of conditions hostile for other plants. The mangrove ecosystems constitute a symbiotic link or bridge between terrestrial and marine ecosystems.
- According to the latest report, the overall mangrove cover in the country stands at 4,740 sq. km., which is 0.14 sq. km. of India's overall geographical area.
- West Bengal has the highest mangrove cover followed by Gujarat.

Mangroves are facing threats both due to natural and anthropogenic factors such as:

Cyclones, typhoons and strong wave action especially in the geographically vulnerable Andaman and Nicobar Islands; Browsing and trampling by wildlife (e.g. deer) and livestock (goats, buffaloes and cows), which are often left to graze freely, especially in areas close to human habitation; and Damage by oysters to the young leaves and plumules of Rhizophora and Ceriops plants.

Indiscriminate tree felling and lopping, mainly for fuel wood, fodder and timber, especially in areas close to human habitation.

Indiscriminate conversion of mangroves on public lands for aquaculture (e.g. for prawn culture at Chorao, Goa), agriculture, mining (e.g. along the Mapusa estuary in Goa), human habitation and industrial purposes.

Encroachment on publicly owned mangrove forest lands, e.g. cultivation of paddy observed on government land, which involved uprooting of natural and planted seedlings.

Illegal large-scale collection of mangrove fruits for production of medicines, which hinders their natural regeneration.

Discharge of industrial pollutants into creeks, rivers and estuaries, which is a major problem in some regions of the world.

Obstruction and diversion of water for culvert construction.

- The dramatic decline in global mangrove cover and the on-going removal of mangrove habitat have led both governmental and non-governmental organizations to take actions to protect mangroves. It is done through legislation, new partnerships between governments and local communities, and the REDD+ programme (Reduced Emissions from Deforestation and forest Degradation) in developing countries.
- But due to poor implementation of legislations, it fails to give results. Urban and aquaculture wastewater discharge, oil pollution, biological invasion, insect outbreak and the influence of water remain serious threats to mangroves. Wastewater from the upstream and landfill pollution discharged directly into the mangrove wetland without proper treatments changed the ecosystem functions and the biodiversity of the mangrove ecosystem. Further the survival rates in mangrove afforestation are quite low. Few states have banned cutting of mangroves it is still prevalent in private areas.
- Mangrove conservation measures need traditional approaches including creation of designated areas protected from clearing and legislation restricting or prohibiting clearing, to conservation, education and restoration projects on local, national, regional, or international scales. These often involve local communities and organizations as stewards of mangrove ecosystems and may allow sustainable harvest within the project areas.
- Measures that can help to reverse some of these problems include vigilance in the field, jetties and harbours during the fruiting period to control the illegal collection of mangrove fruits; strict implementation of antipollution laws; a ban on dragnet fishing in areas where there are seedlings less than five years of age; and the establishment of a speed limit for barges in areas with young mangrove seedlings.

2. Illustrate the main problems related to Indian forestry.

(200 words)

Approach

1. **Give a brief description of Indian Forestry** ***(50 words)***
2. **Discuss major problems related to Indian forestry** ***(100 words)***
3. **Steps needed for its conservation** ***(50 words)***

Hints

Forest covers, as defined by Forest Survey of India; include all areas, more than one hectare in extent, with tree canopy density of more than 10 percent. India has about 7,08,273 square kilometres of forest, which is 21.53% of the geographic area of the country (32,87,569 sq. km Between 2015 and 2017, India has added 6,778 square km of forest cover and extended 1, 243 square km of tree cover. These forest cover are important not only for meeting the demands of timber, fuel wood; but are also the major repository of biodiversity; supply a wide range of goods and ecosystem services and provide livelihoods to millions of forest dependent dwellers.

Major problems related to Indian forestry:

- **High population:** The pressure on India's forests is very high because of high population. The rapid growth in the economy of the country in the last one decade has put additional demands on forest for infrastructure development. The societal demands on forests are becoming more diversified and rising faster than the capacity of forests to supply them on a sustainable basis. The widening gap is one of the main causes of forest degradation and loss of forest biodiversity that is taking place on an unprecedented scale, fast eroding the very basis of the livelihood of forest-dependent communities.
- The existing administrative structure and functions, planning and control system, and research and training methods are all geared toward securing a sustained supply of timber, mainly from state forest reserves. A mismatch between the changing societal demands on forests and non-changing forestry institutions could slow down the growth or even allow the sector to stagnate, thereby accelerating forest degradation.

Factors affecting forest degradation in India are:

- Demand and supply gap in fuel wood, timber and fodder.
- Encroachments due to development of wildlife reserves and national parks as a tourist spot (development of resorts and hotels).
- Shifting cultivation mainly in tribal regions.
- Incidences of forest fire damages small trees and regeneration are often hampered due to this.
- Diversion of forest land for development work such as construction of roads, dams, bridges, etc.
- Growth of population and poverty which leads towards to unsustainable exploitation of forest region.
- Mining.
- Reckless felling of trees for domestic and commercial purposes.
- Forest degradation had manifold impacts on the socio-economic life of the communities. The ecological fallout of such degraded surrounding forests negatively affects the local agriculture, animal husbandry practices and completely shatters the forest based livelihood of many. People start travelling to far off forest areas for need fulfilment resulting in conflicts with other communities and harassment by the forest department.

Steps needed for its conservation:

- Regulated and Planned Cutting of Trees

- Control over Forest Fire:
- Reforestation and Afforestation:
- Check over Forest Clearance for Agricultural and Habitation Purposes
- Protection of Forests:
- Proper Utilisation of Forest and Forests Products

Role of Government in Forest Conservation: Pass acts for the conservation of forests, Survey of the forest resources, Categorization of forest areas and proper delimitation of reserved forest areas, Find out the areas where reforestation can be done, Regulate the commercial use of forest products, Protect forest from fire, mining and other natural calamities, Develop national parks, Encourage forests developmental activities like social forestry, agro-forestry, etc., and Prepare master plans, both for long-term and short-term period, etc

Forest Management: Survey of forest, Categorisation of forest. Economic use of forest, Administrative setting for forest management, Training programmes for persons engaged in forest conservation activities, Use of forest land as tourist centres, Social and agro-forestry, Development of new techniques for the conservation of forests, Research for efficient use and conservation of forest, and Policy decisions and their proper implementation.

Thus a paradigm shift is happening in the field of forest and wildlife management and the new strategy tries to reconcile the multiple demands on forests and to conserve the biodiversity on one hand and to meet the demands of the society on the other. As a participatory forest management strategy for Protected Areas, eco-development aims at conserving the biodiversity by addressing both the impact of local people on the Protected Areas and the impact of the Protected Areas on local people.

3. The harsh environment support less population'. Justify this statement with suitable arguments from the tundra biome.

(200 words)

Approach

1. **Briefly introduce the tundra biome** ***(40 words)***
2. **Describe the harsh environment support less population in the context of tundra biome** ***(60 words)***
3. **Discuss its pros and cons if any** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Tundra is the coldest of all the biomes. Tundra comes from the Finnish word tunturia, meaning treeless plain. The tundra is a biome characterized by an extremely cold climate, little precipitation, poor nutrients, and a short growing season. Other characteristics include low biodiversity, simple plants, limited drainage, and large variations in populations.

Tundra biome is located in the Arctic Circle, which is a circle that surrounds the North Pole, but this is not the only place which can find freezing cold temperatures and a few animals.

In Antarctica, and other cold environments, there are areas that can be described as part of a tundra biome as well. This biome is very unique because of its harsh climate and limited vegetation and animal life.

The tundra is the coldest and the driest of all the biomes on Earth. There is very little rainfall in the tundra; it rains less than ten inches a year. Winters here are long, and summers short, sometimes they last for only 6 - 10 weeks. In the winter the temperature can reach -50°F (-45.5°C). The tundra is a very windy environment. The high winds dry the surface of the land and create a colder environment. The winds move dust and snow around the land, which can make life more challenging in the tundra. These characteristics make this biome unique:

- Extremely cold climate
- Low biotic diversity
- Simple vegetation structure
- Limitation of drainage
- Short season of growth and reproduction
- Energy and nutrients in the form of dead organic material
- Large population oscillations

In such an adverse environment as the tundra, there is less population. Cool summers and very cold winters characterize the tundra zone, at the northernmost limit of plant growth. Areas of low rainfall that should be desert-like are moist because evapotranspiration is low (because of low temperatures) and permafrost holds water.

The ground stays permanently frozen, the permafrost depth varying with the air temperatures of different areas. The soils are often gleys, poorly drained and alternately wet and dry, thus with mixtures of gray ferrous oxide and reddish ferric oxide compounds because they are alternately reduced and oxidized. Thus there are large areas with very low nutrient content.

Overall plant and animal diversity is low, as the environment is harsh and structurally simple; diversity decreases toward the north to an essentially lifeless polar zone. Many major taxonomic groups of both plants and animals are poorly represented or absent. Dominant plant groups include Cyperaceae, Poaceae, Salicaceae, and Brassicaceae. Mammals are restricted to species that are winter-active, either above or below the snow cover. Thus, there is low diversity in organisms that live here, but many still flourish. Many lichens, mosses, and small shrubs flourish in the arctic tundra. The few people who live in the tundra live a semi-nomadic life and have adapted themselves to harsh environment.

This biome supported historically very low human population densities, so there has been little effect on terrestrial plant communities until recent times, when advanced technology has allowed more intense use of the land for purposes such as oil extraction. This has scarcely changed the overall environment in the zone, but the potential for oil spills and other chemical pollution has increased. Even low levels of disturbance of tundra can have an intense local effect, as the vegetation regenerates very slowly. More recently, the higher temperatures of global climate change, generally acknowledged to be human-caused, have melted permafrost, dried lakes, and reduced arctic ice cover, all with potentially severe consequences. Thus, this biome is very unique because harsh environment supports less population.

4. Forest fires pose a threat not only to the forest wealth but also to the entire regime of fauna and flora seriously disturbing the bio-diversity. Explain the man-made reasons for forest fires and ways for controlling it.

(250 words)

Approach

1. **Briefly introduce the major reasons behind forest fires** ***(50 words)***
2. **Discuss the threats pose by the forest fires and its effects on fauna and flora** ***(80 words)***
3. **Suggest measures** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

- The forests of the country are under tremendous pressure. Forest fires are a major cause of degradation of India's forests.
- Most of the forest fires in India are deliberately set by small-scale farmers or landless rural people. In the north-eastern parts of India, the practice of slash-and-burn shifting cultivation is the leading cause of forest destruction.
- The most heavily affected areas are Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Nationally, an estimated 4.35 million ha are affected by fire as part of shifting cultivation. This is especially significant in that with the growth of population and consequent decrease in the land/person ratio, not only are more areas subjected to shifting cultivation, but also the fallow period for regeneration has been reduced from the initial 30 years to two years.
- Another of the most important causes of forest fires is related to the need for fodder for grazing animals. Although some 12.5 million ha of land is officially classified as permanent pasture or grazing land, most of this area is virtually devoid of grass. Therefore, most of the grazing requirement is met from forest area by setting fires to produce new flushes of grass in the dry season.
- In central India, the production of tendu leaves (Diospyrosmelanoxylon) is another major cause of forest fire. Tendu leaves are rolled and filled with tobacco to make a cigarette known as beedi. Their collection and sale is an important secondary source of income. Collectors of tendu leaves set fires in the summer months to promote a better flush of leaves. The problem is compounded by the fact that tendu areas are leased for the collection of leaves on an annual basis; the purchasers are therefore reluctant to make long-term investments in crop improvement. The most economical and quick alternative is to set tendu areas on fire; these fires all too often then extend to other forest areas owing to negligence and carelessness.
- Another non-wood forest product that contributes to forest fire is the mahua flower (Madhucaindica), collected by local people in north-central India to produce a popular beverage, or boiled with sal seeds (Shorearobusta) as a seasonal grain substitute. Mahua pickers burn the dry leaves under the trees to get a clean patch of floor to facilitate flower collection. While the intention is only to clear a small patch beneath a single tree, these fires often spread out of control. Since the collection of mahua flowers is done during the summer months, the hot dry weather aggravates the situation.
- **Steps for controlling forest fires**:
  - Construction and maintenance of fuel breaks in the mountainous terrain
  - Use of mechanized equipment (tractors with plough) to construct fire breaks in the plains to protect eucalyptus plantations.

- Educational measures to increase awareness of the danger and damage due to forest fire.
- A network of fire detection towers need to be positioned and during the fire seasons trained personnel should be placed equipped with binoculars and a radio for rapid reporting of observed smoke or fire.
- Removal of forest litter.

5. Although forest resources are widely utilized by pharmaceutical companies , Paper Industries and others but produces less revenue for state and contributes less in welfare of forest dwellers and affected communities." Discuss with reference to Uttarakhand High Court order to Patanjali to share its profit under equitable benefit-sharing as provided under the Biological Diversity Act, 2002.

(250 words)

Approach

1. **Discuss the case of Divya Pharmacy and provisions under the convention on biodiversity.** ***(50 words)***
2. **Discuss the provisions of Fair and equitable sharing of the benefits under Convention on Biodiversity.** ***(150 words)***
3. **Conclude with the need of better implementation of act to ensure welfare of related communities.** ***(50 words)***

Hints

Recently, the Uttarakhand High Court directed Divya Pharmacy which is run by Yoga guru Ramdev's Patanjali, to share a percentage of its profits with local farmers and communities. The court gave the order and rejected a petition of Divya Pharmacy against the Uttarakhand Biodiversity Board (UBB) and upheld the provisions of fair and equitable benefit-sharing as provided under the Biological Diversity Act, 2002.The Convention on Biological Diversity (CBD) is an international legally-binding treaty with three main goals such as conservation of biodiversity; sustainable use of biodiversity and fair and equitable sharing of the benefits arising from the use of genetic resources.

Case of Divya pharmacy

- In truth, there are several aromatic, medicinal or rare biological resources used in industry, not all of which support sustainable pickings, or share profits with local communities, who are the true guardians of these resources. Now, a landmark judgment from the Uttarakhand High Court last month sets out to change that.
- The judgment dismissed a case filed by yoga guru Baba Ramdev's Divya Pharmacy, which pleaded against sharing revenues from indigenous biological resources with local communities.

- The court said Divya must pay the Uttarakhand Biodiversity Board as it uses biological resources for commercial purposes. This is crucial as several biological resources are rare, or grow only in the wild and cannot be cultivated.
- Take, for instance, yarsagoomba, a fungus that grows on a caterpillar, found only in the Himalayas and used widely in Chinese medicine for its supposed aphrodisiac properties.

Fair and equitable sharing of the benefits under Convention on Biodiversity

- India being a signatory to CBD, enacted the Biodiversity (BD) Act in 2002.In pursuance of the Nagoya Protocol, NBA published Guidelines on Access to Biological Resources and Associated Knowledge and Benefits Sharing Regulations, 2014, popularly known as ABS guidelines, 2014.
- These guidelines provide a detailed procedure for determination and sharing of benefits arising out of the use of biological resources obtained from India.
- Thousands of notices were issued by State Biodiversity Boards under Section 7 of the Act to various Indian companies including those of pharmaceuticals, Ayurvedic, coal extracting, liquor, sugar, oil as well as food and industrial processors using bio-resources, for deposition of a "benefit sharing" amount as per ABS guidelines, 2014.
- But 'Fair and equitable sharing of the benefits under Convention on Biodiversity' has not been followed by different industries which adheres to share a part of profit made by them with local community. This has caused intervention of judiciary in different cases.
- Divya Pharmacyhad filed a petition in Uttarakhand High Court against state biodiversity board which had directed it to share Rs 2 crore out of its Rs 421-crore profit with the farmers of the raw product from which Ayurvedic medicines were made.

Conclusion:

Convention of biological biodiversity has clearly stated benefit sharing mechanism which has been highlighted in Biodiversity Act, 2002. It is similar to corporate social responsibility under which corporates spend significant part of their profit for welfare of society. Central government must make non- adherence to the provisions of the act as punishable offence with heavy penalties. So that, companies can shell out their profits for welfares of related communities.

6. "The fertile soils, perennial rivers and favorable climate, the great plains of north India are of immense economic and social significance". Elaborate. Also discuss despite huge economic potential entire Gangetic plain mainly in Uttar Pradesh and Bihar are marred by poverty.

(150 words)

Approach

1. **Briefly explain location and formation of the northern Indian Plain and major rivers associated with it.** ***(30 words)***
2. **Explain the socio-economic significance of the northern Indian Plain and Causes of poverty and under development of Northern Plains area despite huge economic potential.** ***(90 words)***

3. Conclude with way forward to develop the area to achieve sustainable development goals. ***(30 words)***

Hints

The northern plains were formed during the Pleistocene period when the Himalayas were rising and the sediments of it were brought down by the rivers to fill up a great depression which was formed between the Himalayas and the peninsular plateau. Thus this arcuade shaped plain is also called Indo-Gangetic-Brahamputra plain, which is fertile due to sediments brought by these rivers. The vast stretch of this plain is one of the world's densely populated area due to multiple economic activities which are supported by it.

Socio-economic significance of the Northern Plains

- Northern plains are made up of Bhangar (old alluvium) and Khadar (new alluvium) which were brought by the Himalayan Rivers from the Pleistocene period to the recent period (quaternary).
- The fertile and well drained soil coupled with adequate rainfall has resulted in favorable conditions for the growth of the food crops which is supports the large population of the plain.
- Rice is grown in middle and lower Gangetic plain while wheat and millet is grown in upper Gangetic plain.
- Apart from it several cash crops such as jute (lower Ganga plain) and sugarcane (Upper and middle Ganga plain) is also cultivated in northern plain.
- Availability of cheap labour, adequate water, ores from neighboring Chhotanagpur plateau region in the eastern part and Vindhyan region in the west, electricity from hydro-power and thermal power plants in neighboring areas makes it suitable for industrialization.
- Cheap labor of this region has provided opportunities for cottage, craft and metal -craft industries. Cottage metal craft industry is more developed in western region such as Rajasthan plains and upper Gangetic plain (Western Uttar Pradesh) while cotton based industries is more developed in middle Ganga plain in Western Uttar Pradesh and Bihar.

Despite huge economic potential significant part of the northern plain areas are affected by poverty due to various factors.

Causes of poverty and under development of Northern Plains area despite hugeeconomic potential

- Due to huge population, average size of land holdings in northern plains is very small and intensive subsistence agriculture is practiced. This checks the economic development of the region as the farmer is left with very little to spend on health and education.
- Most of the part of Northern Plains except Punjab and Western Uttar Pradesh, rain fed agriculture is practiced. Erratic monsoon often decreases the productivity of these crop lands.
- Punjab Plain which is most productive is also affected by soil salinity which has reduced its productivity. This has also affected the employment of migrant farm labourers from eastern UP and northern Bihar.
- Huge population of the northern plain has created the problem of lower wages.

- Potential of industrialization has not been tapped optimally in northern plain as it lacks large scale industries like other parts such as Peninsular and coastal regions. However few industries have been developed in patches such as Chhotanagpur plateau.

Conclusion:

Northern plain is one of the most productive plain of the world but due to certain underlined limitations, it is yet to achieve its full potential. Institutional and policy framework must be strengthened to tap the potential of the plain areas, which will further help India to achieve multiple sustainable development goals pertaining to food security (Zero Hunger (Goal 2)) and No poverty (Goal 1).

7. "India can utilize vast natural resources of Himalayan region in the form of minerals, herbs, shrubs and tourism to boost it economy". Critically analyze with reference to economic opportunities and sustainable utilization of resources of the fragile Northern Mountain Complex.

(250 words)

Approach

1. **Briefly discuss the volatility of Himalayas and underline the fact that it is still in the process of elevation and needs to be treated sustainably for economic activities.** ***(50 words)***
2. **Discuss the economic opportunities provided by Himalayan regions and challenges posed by its fragile ecosystem in economic development of the region.** ***(150 words)***
3. **Conclude with the need of sustainable development of the Himalayan regions owing to its geographical importance.** ***(50 words)***

Hints

Himalayan started to rise during the tertiary period and continues to rise at present earmarked by discoveries of fossils, unconsolidated rock system found over it and the fact that it is rising with an average of 5cm/year. The Himalayan region on the Indian side is one of the rich regions in terms of biodiversity, mineral deposits and scenic beauty. These factors provide India an opportunity to cater economic benefits from it by using these resources sustainably keeping in mind the fragile ranges which are still in process of formation. Hence, Himalayas needs to be treated sustainably to cater economic opportunities from it.

Economic opportunities provided by Himalayan regions

- Himalayan slopes provide adequate opportunities for the cultivation of horticulture crops and herbal medicines to cater demands of organic products and Ayurvedic medicines across the world.

- Himalayan Hot Springs and Young rivers originating from it must be utilized to generate electricity in a sustainable manner.
- India must promote research and development in the Himalayan region to help sustainable mining of rich mineral wealth. Himalayas have rich deposit of coal, mica, gypsum, and graphite and ores of iron, copper, lead, and zinc.
- Hot water Springs, Duns, Duars and Valleys such as Kashmir, Kullue.t.c are one of the best tourist's destination of the world. They must be promoted in a better way to attract visitors. Promotion of skiing and trekking can help India to boost tourism.
- Himalayas referred as the abode of the Gods must be promoted as spiritual centers of wellness and Yoga. This will help India to increase footfalls. Similarly, areas such as Ladakh which is home to unique culture and tradition must be promoted.

Challenges to sustainable economic development of Himalayan region

- Himalayan regions are more prone to landslide, mudslides, earth flows e.t.c. This leads to hurdle in smooth traffic movements across it apart from damage to infrastructure projects.
- This region is also prone to earthquakes which often destabilizes the economy of the region.
- Infrastructure development of this region is a challenging task due to high altitudes and difficult terrain.

Conclusion:

Himalayas are one of the most important physiographic features of Indian sub-continent which prevents the cold Siberian winds to enter in India on the one hand and caused Orographic rainfall by acting as barrier for Indian monsoon. Further, it also has rich reserves of minerals and potential of agriculture and tourism. Hence, any economic development in this region must be done in a sustainable manner.

8. Alluvial cover of the coastal plains of India makes it one of the most fertile plains of the world. Elucidate. Also, discuss why the West Coastal plain is infertile and agriculturally not prosperous unlike eastern coastal plain.

(250 words)

Approach

1. **Briefly discuss the formation of coastal plains in India and its landforms.** ***(50 words)***
2. **Discuss how does rich alluvium soil aided by climate of the region makes coastal plains one of the most fertile plains of the world. Discuss the infertility of the western cast of India.** ***(150 words)***
3. **Conclude with aligning the physiography of the coastal region with economic activities.** ***(50 words)***

Hints

Indian coastline is one of the most straight and regular coastline of the world except few creeks, inlets and backwaters. This makes more than 6100 km coastline unsuitable for too many large ports and harbors except few places. Straight and regular coastline of India is due to disruption and faulting of the Gondwana land during Cretaceous period. The east coast is marked by delta and lagoons while the west coast is marked by estuaries except Malabar coast which as few lagoons. The physical features of the coastal regions of India is the footprints of its geological and geophysical history.

Impact of rich alluvium soil aided by climate of the region which makes coastal plains one of the most fertile plains of the world.

- There are geological evidences which show that large part of the coastal plains of the peninsular plateau has submerged and emerged. This happened during the cretaceous period when the peninsular plateau tilted from north-west to south-east . And western part of itis submerged after breaking from it after a severe tectonic jolt.
- Submergence of the western coast made it narrower and Western Ghats steeper, while eastern coast remained wider than it.
- Further, deltas made by the rivers due to flow towards Eastern Ghats due to flow of the rivers made it more fertile and suitable for agriculture while huge Orographic rainfall received by the Western Ghats due to steepness made it hotspot of biodiversity, but it lacks agricultural prosperity due to lack of alluvium content in soil.
- Eastern Ghats also receives Orographic rainfall from Bay of Bengal Branch of Monsoon. Rich alluvium deposited by the rivers such as Cauvery makes it most fertile alluvial plain in India. Aided by the north-east monsoon, Cauvery Delta grows paddy crops thrice in a year.
- Further in Ganga- Brahmaputra Delta region, cultivation of jute is done on large scale due to presence of heat and moisture together.
- Biodiversity of different coastal plains is the result of soil and rainfall pattern.
- Mangrove is common species of tree found across the coastal plain. Further, rich alluvium aides in growth of different species of tree and forest away from coastline.
- Lagoons are most prominent on eastern coastline are hotspots of migratory words and aquatic species such Olive ridely turtle which migrates for reproduction in certain part of year. Further being the ecotone, coastal plains are hotbed of a number of species.

Infertility of Western Coastal plains

- Except the Malabar coast, the western coastal plains are infertile and agriculturally not prosperous because it is rocky and lack alluvium content.
- As very few rivers drains into Arabian sea due to south-east tilt of the peninsular plateau and rivers flowing through it makes estuaries due to steep slopes of the western ghats making less alluvial deposition on west coastal plains. Also rivers of western ghats are short and swift.
- This makes the western coastal plains less prosperous from agriculture point of view but important centers for industries due to presence of quality raw materials in adjoining areas and presence of natural ports.
- Significant area of the western coastal plain is occupied by saline desert of Rann of Kachchh which is unsuitable for agriculture.

Conclusion:

There are various other land forms such as creeks, bars and barriers, cliff, reef etc makes the coastal landform tourist hotspots. A large number of ports aided by availability of raw materials make it suitable for industries. Long coastline of India aides fisheries as a main economic activity of the coastal regions. Coastal Economic Zones are setup by government to boost economy of the region. Overall, landforms of the coastal regions contribute significantly to the prosperity of Indian economy in different ways.

9. "The folds of the Greater Himalayas are asymmetrical in nature." Explain the formation of asymmetrical ranges in Himalayas. How does it play an important role in shaping the biodiversity and culture of the region?

(150 words)

Approach

1. **Briefly discuss the formation and nature of the greater Himalayan ranges.** ***(20 words)***
2. **Discuss the asymmetrical nature of the Himalayan mountain range and along with the process of formation of asymmetrical folds.** ***(50 words)***
3. **Discuss and how has asymmetrical nature has impacted the biodiversity of the region along with its impact on culture and drainage system.** ***(60 words)***
4. **Conclude with the note with Himalaya as a physical and cultural divide.** ***(20 words)***

Hints

Himalayas are the most recently formed young fold mountains which has risen during the tertiary period and witnessed Pleistocene glaciations and sediment deposition during quaternary period. Himalayan upheaval is due to folding and faulting of the sediments of the former Tethys's Sea around 14-25 million years ago. Greater Himalayas are formed by metamorphic rocks is the result of constant heat and pressure during continuous faulting and folding events in its ridge and valley topography. Greater compressional force is the major reason behind the asymmetrical nature of the greater Himalayan ranges apart from folding and faulting events. Himalayan mountains are having steep south slope while gentle North Slope giving it a 'hog back' topography.

Formation of asymmetrical ranges in Himalayas

- A fold whose limbs are unequal in length, and axial plane is inclined, dipping in the same direction as that of the gently dipping limb.
- This is formed when compressional force on the dipping limbs or one of the limbs is greater than the other.

- During the formation of the greater Himalayas during tertiary period, the Indian plate was moving towards rapid pace towards the Eurasian continental plate. The excessive pressure unleashed by it when collided, resulted in formation of asymmetrical folds in the Himalayan range apart from metamorphosis of sedimentary rocks.

Impact of asymmetrical Himalayan range on biodiversity and cultural division

- Due to steep southern slope of the Himalayan ranges, it receives maximum precipitation in form of rainfall and snowfall. Further, it has more diversity than the northern side.
- Apart from few passes, Himalayas are inaccessible and hence acts as a barrier between India and Nepal on the southern side and China on the northern side.
- Southern side of Himalayas is most habitable due to presence of biodiversity owing to better precipitation than the northern side. This has resulted in better economic activities in form of horticulture and tourism.
- Drainage pattern of both sides of the Himalayan ranges are different due to differential slopes. It acts as the watershed between the drainage systems of both the sides.
- The culture, language and traditions of both sides of Himalayas are quite different. While Culture and tradition of Nepal and India are somehow identical but different from China and Central Asia.
- Nomadic herding is extensive in central Asia which is absent in India barring few patches. In China Buddhism, Taoism, Islam, Catholicism, and Protestantism are major religion while in India Hinduism, Islam, Buddhism e.t.care followed extensively.
- Mandarin is spoken in China while Hindi, Urdu, Tamil, Telgu, Odia, Assamese e.t.c are India's major languages.
- This physical barrier hence acts as a cultural divide due to less people to people connectivity on the both side of the mountain.

Conclusion:

The asymmetrical nature of Greater Himalayan ranges provides different topography of it northern and southern slope of the Himalayan ranges. Differential precipitation, soil and vegetation has impacted the biodiversity and way of living of the inhabitants of the both sides of the mountain range. Differential slope on both side has also impacted drainage pattern and rate of denudation of the physiographical divisions of the Himalayan ranges. Thus it has acted as a physical and cultural divide of the Asian mainland.

10. What do you understand by 'Land Degradation Neutrality'? Discuss the causes of increasing desertification in Northeastern states of India. Suggest remedial measures.

Approach

1. **Briefly introduce with desertification and reports related to increasing desertification in India**
2. **Define 'Land Degradation Neutrality'. Bring out the relationship between land degradation and desertification.**

3. **Explain reasons for increasing desertification in northeastern states of India.**
4. **Suggest remedial measures to mitigate desertification.**
5. **Conclusion**

Hints

Desertification is the process by which a relatively dry region becomes increasingly arid. The Indian Space Research Organization (ISRO) recently reported that six states in northeastern India were among the top 10 places in the country with the highest desertification rates between 2003 and 2018. These states are Mizoram, Arunachal Pradesh, Assam, Tripura, Nagaland and Meghalaya. In northern India, Punjab, Delhi, Jammu and Kashmir, and Uttarakhand have seen some of the highest rates of desertification.

Land Degradation Neutrality

According to United Nations Convention to Combat Desertification 'Land Degradation Neutrality (LDN) 'has been defined as a state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.

Land degradation and Desertification:

- Land degradation is defined as decline in productivity of land in terms of biodiversity and economy, resulting from various causes, including climate and human dominance, leading to loss of ecosystem.
- Desertification is a type of land degradation in which a relatively dry region becomes increasingly arid, typically losing its water bodies as well as vegetation and wildlife.

With time desertification throughout the world is increasing which is major cause of concern. Increasing desertification in North East India is the example of the same. Six states in northeastern India were among the top 10 places in the country with the highest rates of desertification between 2003 and 2018.

Causes of increasing desertification in northeastern states of India:

- **Deforestation and loss of green cove**r are the main reasons for land degradation and desertification in the region. In Mizoram, the role of vegetation loss in the degradation of land was responsible for 12.04 per cent in 2018-19.
- **Human settlements and water erosion** are another main reason behind increasing vegetation loss and the resulting desertification in these states.
- **Water logging:** Agricultural land in Assam and Meghalaya has been extensively suffered from water logging.

Measures to control desertification in North east India:

- **Awareness among communities:** North East is home to myriad tribes and ethnicities where the "elders" have a predominant say in how a particular social unit function. Such community elders must take initiative towards combating this problem. Nagaland already has started preliminary groundwork in this matter which can be used as a template by the other states of the North East.

- **Land and water management:** It can be achieved by harnessing traditional knowledge systems which were largely sustainable.
  - The first step towards this can be documentation of local traditional knowledge/ practices related to farming, water conservation, weather forecasting etc.
  - Other steps include:
    - Establishment of green belt of traditional plants
    - Practicing water harvesting techniques
    - Development of soak pits
    - Conservation of local water bodies
    - Preparation and promotion of bio-pesticides, biofertilzers, vermi-compost,
    - Establishments of trenches, bunds, soak pits etc.
- **Fixating the soil through the use of shelter belts, woodlots and windbreak**s. Windbreaks can be constructed with trees and bushes that ensure that wind will not wipe the soft top soil off the surface land.
- **Traditional tillage systems** like zaï are often effective as sustainable practice.
- **Contour trenching:** In this method trenches are made which are dug parallel to the height lines of the landscape, preventing the water from flowing beyond the trenches and causing erosion. Stone walls are placed around the trenches to prevent the trenches from closing up again.

Conclusion:

Large parts of the total population of North East reside in rural areas and are dependent on agriculture for their livelihood. Increasing degradation and desertification of land is a threat to all of them. A proper well thought and well laid out plan with community participation is the need of the hour.

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NOTES

SET-2: QUESTIONS

WATER RESOURCES

Q1. Sustainable Development Goal 14 recognizes that Oceans, along with coastal and marine resources, play an essential role in human well-being and social and economic development worldwide. Discuss their significance in the light of blue economy.

Q2. With increasing population pressure on pastoral and agricultural economy, the importance of marine resources is certain to increase. In this context explain, how India has utilized its marine resources?

Q3. India has 7500 km long coastline, but the Indian fishery sector is not so well developed. Highlight the major impediments to the growth of this sector? Discuss.

Q4. What is coral bleaching? What are its causes and consequences?

Q5. A mass bleaching event on the Great Barrier Reef this year killed more corals than ever before sounding the alarm over the delicate ecosystems. What is coral bleaching? Discuss the conditions favourable for coral formation. What are the recent environmental conditions that are leading to mass bleaching events?

Q6. Corals are called as rain-forest of oceans. Highlight the significance of corals. Enlist the major threat of coral bleaching. Suggest measures to contain this problem.

Q7. Discuss the strengths and weaknesses of the drainage system in India? How is the river interlinking going to affect the Drainage System in India?

Q8. Ganga river system has been the lifeline of northern plains, however, this lifeline is threatened by anthropogenic activities, discuss. Also suggest what should be done to make Namami Ganga a success to develop a sustainable river ecosystem?

Q9. Bring out the geographical reasons behind increasing pollution in the river Ganga. Suggest innovative solutions for cleaning it.

Q10. Briefly discuss the drainage of India's west flowing rivers. Also discuss their importance in their drainage basin region.

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SET-2: ANSWERS

1. Sustainable Development Goal 14 recognizes that Oceans, along with coastal and marine resources, play an essential role in human well-being and social and economic development worldwide. Discuss their significance in the light of blue economy.

(200 words)

Approach

1. **Briefly introduce the importance of the oceans & coastal and marine resources** ***(50 words)***
2. **Discuss, How blue economy is helpful in human well-being and social and economic development worldwide** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Significance of oceans:

- Coastal population represent 37% of the world total population in 2010.
- Coastal and marine resources contribute an estimated $28 trillion to the global economy each year through ecosystem services.
- Oceans provide livelihoods and tourism benefits, as well as subsistence and income.
- They also help regulate the global ecosystem by absorbing heat and carbon dioxide from the atmosphere and protecting coastal areas from flooding and erosion.
- However, over fishing, pollution through effluents, micro-plastics, shipping, eutrophication, climate change has led to severe degradation of ocean environment.
- The First Global Integrated Marine Assessment carried out under the United Nations warns that climate change, over exploitation of marine living resources, increased uses of ocean space, rising pollution and other factors have placed excessive pressure on oceans.
- Also there has been severe use and degradation of terrestrial resources. 50% of the forests have been degraded, mass homogenisation of agrarian ecosystems, destruction of wetlands etc
- In this regard, urgent action on a global scale is needed to protect the world's oceans from the many pressures they face.

Blue economy is a marine-based economic development that leads to improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities. The concept stresses on the conservation and sustainable management of oceans.

- The Blue Economy is envisaged as the integration of Ocean Economy development with the principles of social inclusion, environmental sustainability and innovative, dynamic business models.
- It is founded upon a systems approach, where in renewable and organic inputs are fed into sustainably designed systems to fuel "blue growth". Such "blue growth" addresses the problems of resource scarcity and waste disposal, while delivering sustainable development that enhances human welfare in a holistic manner.
- **The central principle of the blue economy is the idea of cascading nutrients and energy** the way ecosystems do. Cascading energy and nutrients leads to sustainability by reducing or eliminating inputs, such as energy, and eliminating waste and its cost, not just as pollution, but also as an efficient use of materials.
  - Fisheries and their vital role in providing food security and sustainable livelihoods,
  - Tourism as a source of decent employment and a contributor to poverty alleviation,
  - Ocean as a source of renewable energy from wind, wave, tidal, thermal and biomass sources.
- **The Blue Economy will promote innovations and open a new world of production and lifestyle**. They also have the potential to increase rather than shed jobs, as emulating natural systems will mean the deployment of humans rather than machines.
- The primary goal of the Blue Economy is to identify examples in nature where organic recycling or up cycling occurs and mimic these processes to find out where and how the waste that we generate can be innovatively used again.
- In the coming years, the blue-water economy will become central to the development of the entire Asia-pacific region.
- Ex The Indian Ocean region is rich with diversified marine ecosystems, fisheries and aquaculture resources. It is also a source of renewable ocean energy, ports, shipping, manufacturing and other services and seabed exploration and minerals.
- India's neighbourhood policy too assumes primary importance in light of the blue economy. India can profitably integrate its on-going programmes like Make in India, smart cities, skill development and self-reliance in defence.
- It is a tool that offers specific mechanisms for Small Island Developing States (SIDS) and coastal countries to address their sustainable development challenges

2. With increasing population pressure on pastoral and agricultural economy, the importance of marine resources is certain to increase. In this context explain, how India has utilized its marine resources?

(250 words)

Approach

1. Briefly introduce marine ecosystem &Discuss the importance of marine resources ***(50 words)***

2. **Benefits of marine resources** ***(80 words)***
3. **Explain, how India has utilized its marine resources** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

Marine ecosystem is one of the most diverse ecosystems which provide numerous marine wealth by integrating diverse coastal features.

- Marine resources have gained importance because of twin aspects, one positive and other negative. Positive constitutes wealthy resources in the form of foods and minerals. On the other hand, unsustainable growth activities and other causes have disastrous effect on marine ecosystem in 21st century. So, importance has increased, because of threat to lose it.
- Marine resources are those wealth that are found in coastal areas and deep sea that are important for social and economic development. They form part of food, rare earth minerals and natural gas and oil.
- With the increase in population, economic and scientific developments the demands for marine resources are ever increasing considering the food security of the nation but ironically the importance has also enhanced because of the depleting marine ecosystem having impacted due to unsustainable human activities, natural causes and anthropogenic activities.
- Traditionally marine resources have supported the livelihood and economy of coastal regions but integrated development and its importance has raised its importance to national and international levels.
- Recent geopolitical, virtual and real hot stances between nations are testimony for the economic and strategic importance of marine resources. Recent examples include South China Sea and East China Sea dispute, Whaling dispute, Sri Lanka-India fishermen issue and Strategic minerals (Rare Earth Minerals) dispute etc.
- However the threats from their loss have enhanced their importance for every nation beholding marine resources.

Benefits of marine resources:

- Livelihood of local people.
- Ecotourism
- Important resources like pelagic and demersal fishes, oysters and pearls.
- Food security for the people of coastal areas
- Regulation of marine ecosystem
- Regulates climate of coastal areas.
- Act as Carbon sink to reduce global warming.
- Generates employment where there is no other scope of employment.

India

- India has vast population to support and long coastal line act as an important resource.

- Cheap source of protein and food security for its people in the form of various marine fishes and crustaceans.
- Exclusive economic zone (EEZ) has come up for rational resource exploitation.
- Historically Marine export has been increasing and India is exporting many valuable products and food.
- Brackish water ecological system and aquaculture has caused the breeding, rearing and harvesting of marine species.
- With the Mechanization of fishing industry, deep sea trawlers are being used to catch big fishes into the seas in large volume.
- Because of mechanization, over fishing and waste of processed fishes are polluting the water and also excessive uses of fishing vessels are disturbing the marine ecosystem. One report suggests that India has been exploiting more than 80% of its marine resources without scientifically sound technologies.
- Resources are getting scare and impacting ecosystems and livelihood of local people.
- In India, Centre for Marine Living Resources & Ecology (CMLRE), Kochi, an institute under Ministry of Earth sciences looks after research and project implementation.
- Palk Strait has become a bone of contention. India has dispute with Sri Lanka over marine resource sharing and territorial rights.
- Recent announcement to launch a 'Blue Revolution' is a progressive step in this regard. It would provide a framework for people associated with it. Socio-economic as well as ecological development is the aim of this program.
- Over all marine resources are asset of a country and of ecosystem. It must be judiciously used so that sustainability of the ecosystem remains intact.
- There is need to collaborate and invest into it. Government organizations, international institutions and private corporations need to put their hands together to maintain, restore and utilize the marine resources sustainably.

3. India has 7500 km long coastline, but the Indian fishery sector is not so well developed. Highlight the major impediments to the growth of this sector? Discuss.

(200 words)

Approach

1. **Briefly introduce the Indian fishery sector** ***(50 words)***
2. **Highlight the major impediments to the growth of this sector** ***(100 words)***
3. **Steps need to be taken** ***(50 words)***

Hints

Fishing in India has been a traditional occupation and India has many communities of fishermen. Fisheries constitute about 1 percent of the GDP of the country and 5.08 per cent of agriculture GDP.

Major impediments to the growth of this sector

- Heterogeneous variety of fish is available in India and it is commercially unviable
- Fishes in India have high oil content and thus are not good for human consumption.
- Fish is caught in shallow waters whose depth is moderately less. The fishing boats remain near the coast and they rarely go beyond a distance of around 11 km from the coast. Coastal fisheries are not significant in the country as Indian coastline is not indented and lack fishing grounds.
- Loss of fish cash: Fishermen use fine sized net and 30% to 40% of the juvenile catch is discarded by fishermen in high seas because juvenile fish that don't fetch good prices in market leading to resource lost.
- Fishing is seasonal in India and during breeding time fishing is not allowed.
- The EEZ around Andaman-Nicobar and Lakshadweep confluences with international waters. This makes these Island territories vulnerable to illegal Fishing by foreign vessels.
- Also the maritime boundary issues with Sri Lanka and Pakistan and the security of the fishermen also remains a concern.
- Pond culture is not feasible in those regions on the Indian Plateau and northern Western India where ponds go dry and have little water during the hot dry season.
- Lack of surveillance of territorial waters leading even outsiders (Pakistani fishermen) do illegal fishing in our area
- Lack of scientific fishing: Most fishing vessels don't have facility to freeze the fish on board immediately after catching leading to quality deterioration before they reach the coast.
- Modernization requires replacing fishing craft by power driven boats, providing facilities of quick refrigeration of fish to avoid its putrefaction. It also includes arranging canneries for surplus fish, utilizing discarded portions of fish for making fertilizers, etc.
- There is a need to provide refrigerated road transport facilities to inland markets and the marketing of fish on cooperative lines
- Most vessels don't have special equipment to do deep water fishing beyond depth of 400m. Example yellow fin tuna found around Lakshadweep islands. They're almost unexploited since the technology for deep long lining is not prevalent in the Islands.
- India's current production of quality fish seed is far lower than the demand. Traditional fish feed made from rice bran oil and cakes is not high-yielding.
- Lack of funds: All the funds regarding the fisheries are channelized through the National Fisheries Development Board (NFDB). The cooperative sector, which engages around three million fishermen and is in direct contact with traditional fishermen, is neglected.
- The fishing industry suffers from low-scale, stagnating yields of inland and freshwater aquaculture, and poor infrastructure for marine fishery, leading to an estimated 15-20 per cent post-harvest loss.
- Inland fish production has declined due to proliferation of water control structure, loss of habitat and indiscriminate fishing.
- The sector is also experiencing loss of biodiversity on account of adverse climate change and ocean acidification.

Some of the measures government has taken:

- Blue Revolution, on lines of white revolution announced. It envisages transforming the fisheries sector with increased investment, better training and development of infrastructure.

- Government seeks to undertake initiatives to tap the potential of neglected water bodies like wetlands, brackish waters, floodplain lakes, ponds and tanks for breeding purposes though the use of modern technologies.
- Making available quality fish feed - to improve quality of fish produce
- Encouraging fishermen to use technology include - cage culture and GPS.
- Allowing FDI up to 49% in deep sea fishing, which could encourage technology transfer and improve India's capabilities in this regard.

Potential of the sector:

- The sector currently employees about 15 million people. It has the potential to improve the livelihoods options of coastal communities provided it is organised on scientific and commercial lines.
- India is one of world's largest producers of fish. Increased production can contribute significantly to our export and it has the potential of encouraging food processing industries catering to the global demand
- Besides being a major source of revenue, this sector also holds key to achieving food as well as nutritional security, given that fishes are one of the richest sources of protein.
- Finally, given that thousands of villages settled along India's 7500 km long coastline are entirely dependent on fishing, any improvements can lead to economic and social development of these people.

4. What is coral bleaching? What are its causes and consequences?

(200 words)

Approach

1. **Give a brief description of coral bleaching** ***(100 words)***
2. **What are its causes and consequences** ***(100 words)***

Hints

The corals that form the structure of the great reef ecosystems of tropical seas depend upon a symbiotic relationship with algae-like unicellular flagellate protozoa that are photosynthetic and live within their tissues. Zooxanthellae give coral its coloration. Under stress, corals may expel their zooxanthellae, which lead to a lighter or completely white appearance, hence the term "bleached".

When a coral bleaches, it is not dead. Corals can survive a bleaching event, but they are under more stress and are subject to mortality. If the stress-causing bleaching is not too severe and if it decreases in time, the affected corals usually regain their symbiotic algae within several weeks or a few months. If zooxanthellae loss is prolonged, i.e. if the stress continues and depleted zooxanthellae populations do not recover, the coral host eventually dies.

Causes and consequences

- Coral species live within a relatively narrow temperature margin and anomalously low and high sea temperatures can induce coral bleaching. Bleaching events occur during sudden temperature drops accompanying intense upwelling episodes, (-3 degrees C to –5 degrees C for 5-10 days), seasonal cold-air outbreaks. Bleaching is much more frequently reported from elevated sea water temperature. A small positive anomaly of 1-2 degrees C for 5-10 weeks during the summer season will usually induce bleaching.
- Bleaching during the summer months, during seasonal temperature and irradiance maxima often occurs in shallow-living corals. Solar radiation has been suspected to play a role in coral bleaching. Both photosynthetic active radiation and ultraviolet radiation have been implicated in bleaching.
- Sudden exposure of reef flat corals to the atmosphere during events such as extreme low tides, ENSO-related sea level drops or tectonic uplift can potentially induce bleaching. The consequent exposure to high or low temperatures, increased solar radiation, desiccation, and sea water dilution by heavy rains could all play a role in zooxanthellae loss, but could also very well lead to coral death.
- Rapid dilution of reef waters from storm-generated precipitation and runoff has been demonstrated to cause coral reef bleaching. Generally, such bleaching events are rare and confined to relatively small, near shore areas.
- Pollution from urban or agricultural run-off
- Sedimentation, which relates to a decrease in light levels, as well as suffocation of sessile marine life.
- Changes in water chemistry (in particular acidification). Excess nutrients such as ammonia and nitrate from fertilizers and household products entering the reef ecosystem. (The nutrients might increase the number of zooxanthellae in the coral, but it is possible that the nutrient overload increases the susceptibility of coral to diseases.)
- Increased or high water turbulence.
- Many scientists have acknowledged that global warming is one of the most significant reasons of coral bleaching.

5. A mass bleaching event on the Great Barrier Reef this year killed more corals than ever before sounding the alarm over the delicate ecosystems. What is coral bleaching? Discuss the conditions favourable for coral formation. What are the recent environmental conditions that are leading to mass bleaching events?

(250 words)

Approach

1. **What is coral bleaching** ***(50 words)***
2. **Discuss the conditions favourable for coral formation** ***(80 words)***
3. **What are the recent environmental conditions that are leading to mass bleaching events** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

Often called as 'rainforests of the sea' Coral reefs are one of the most important and diverse ecosystems of the world.

Coral bleaching:

- The 'whitening' of the coral is called coral bleaching and is due to a loss of the symbiotic din flagellates (algae) living within the tissue of the coral.
- In a healthy reef, the algae supply the coral with energy (sugars and amino acids) and in turn receive products essential to their survival (ammonia and phosphate).
- During a bleaching event, the brownish algae disappear from the tissue of the corals, leading to the observed colour change. This loss of the 'nutrient factory' in corals may lead to death of the coral. However the coral may slowly recover once the normal conditions set in.

Conditions that favour coral growth:

- Temperature: An optimum temperature of around 18C is required, that is why most of the corals are found in tropical and sub-tropical climates. An increased temperature causes the death of corals.
- Sunlight: Corals are found in areas that receive good amount of sunlight as sunlight is required for the algae to food through photosynthesis. They grow only in shallow waters.
- Sediment: large amount of sediments choke the pores of corals thus causing its death, hence the water must be sediment free
- Salinity: Corals need saltwater to survive and require a certain balance in the ratio of salt to water. This is why corals don't live in areas where rivers drain fresh water into the ocean ("estuaries").
- Clear water: Corals need clear water that lets sunlight through; they don't thrive well when the water is opaque. Sediment and plankton can cloud water, which decreases the amount of sunlight that reaches the zooxanthellae.

Recent environmental conditions that is leading to mass bleaching events:

- Coral reefs are very fragile and are under threat from climate change, ocean acidification, improper fishing practices, agricultural run-off, oil spilling etc. Thus, they are getting degraded at a fast rate.
- According to NASA report 33 to 50 percent of our planet's coral reefs have been significantly degraded or lost, and the concern among reef scientists is that most functioning reef ecosystems will disappear by mid-century.
- Major threats to corals reefs are ocean acidification, over fishing, coral disease, invasive species, and both natural and human disturbances.
- Increased frequency of el-Niño increases the ocean water temperatures. Coral bleaching takes place due to increased temperature as corals require optimum temperature for their growth.
- Increased human activities ex: according to the world resource institute, more than 85% of the reefs in Asia's coral triangle are directly threatened by human activities such as coastal development, pollution, fishing etc.

- The single greatest determining factor as to whether a coral survives a bleaching event is the amount of time that it is exposed to elevated temperatures under high light conditions. The longer the coral is exposed, the greater the chances of mortality, with many succumbing to disease and being overgrown by algae.

6. Corals are called as rain-forest of oceans. Highlight the significance of corals. Enlist the major threat of coral bleaching. Suggest measures to contain this problem.

(200 words)

Approach

1. **Give a brief description of corals** ***(30 words)***
2. **Highlight the significance of corals** ***(50 words)***
3. **Discuss the major threat of coral bleaching** ***(50 words)***
4. **Suggest measures** ***(50 words)***
5. **Conclusion** ***(20 words)***

Hints

Corals are submarine calcareous colonial organisms, also known as coral polyps. These organisms thrive in typical habitat having warm, shallow, saline and transparent tropical water. They live in mutualistic relation with algae known as zooxanthalle which provide beautiful colours and most of nutrient requirement to corals.

Significance of Corals:

- Coral reef provides diverse variety of plants and animals. They are home to nearly 25% of oceanic species. They act as a store house of living resources like fish, reef fish account for about 15% of total worldwide fish catch.
- They are one of the most attractive tourism spot thus earn revenue. Example Great Barrier Reef, Australia, Lakshadweep islands, India etc.
- Coral reefs protect coastline from wave erosion.
- They act as carbon sink thus reduces impact of greenhouse gases thus climate change.

However due to certain unsustainable anthropogenic practices, there is vast destruction and bleaching of coral reefs.

Major threats include:

- Increase in oceanic temperature due to climate change, increase concentration of GHGs, El-Nino and seasonal fluctuations.
- Eutrophication and acidification of coastal waters.
- Marine pollution like oil spill, urban discharge, plastic and nuclear waste dumping.
- Unsustainable fishing practices like use of dynamite and cyanide in fishing.

There is an urgent need to protect this diversified resource base and natural wonder. Artificial coral implantation can be done to re-establish coral colonies; IUCN has taken this route to reinvigorate the coral reefs especially in waters of Australia and India. Major coral site can be declared as protected areas or national parks; only treated urban discharge to be allowed in coastal areas; stricter and internationally agreed norms to control marine pollution and use of sustainable fishing and resource exploration technologies can be supportive in protecting corals.

7. Discuss the strengths and weaknesses of the drainage system in India? How is the river interlinking going to affect the Drainage System in India?

(200 words)

Approach

1. **Briefly introduce the drainage system in India** ***(50 words)***
2. **Discuss the strengths and weaknesses of the drainage system in India** ***(60 words)***
3. **How is the river interlinking going to affect the Drainage System in India** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

By the term 'drainage', we mean the river system of an area. Small streams from different directions join to form a river. The river ultimately merges into a larger water body –a lake, a sea or an ocean. The area that a single river drains is the drainage basin of that river. Sometimes two drainage basins are separated by upland or a mountain/hill. Such upland or mountain is called water divide.

Advantages:

- It forms geopolitical boundaries
- In hydrology, the drainage basin is a logical unit of focus for studying the movement of water within the hydrological cycle
- It is the principal hydrologic unit considered in fluvial geomorphology
- Drainage basins are important in ecology
- It is the resources rich area
- Can increase a stream's carrying capacity through overflow channels, channel straightening, restrictive crossing replacements, or rainfall or runoff storage.

Disadvantages:

- It may create the water wars in two or many parties who share the drainage basin
- May help one area but create new problems upstream or downstream of the proposed improvements.

- Channel straightening increases the capacity to accumulate and carry sediment, thereby potentially adversely affecting the surrounding areas and the stream system's equilibrium.
- There can be difficulty in setting culverts of a sufficient size in a stream to convey the 100-year flood discharge, unless weir flow over the road surface is considered.
- India's Rivers Interlink (IRL) is a project that aims to link India's rivers by a network of reservoirs and canals. River inter linking is based on the simple theory that the excess water in some rivers in spate during the monsoon can be diverted to other rivers. This way, everyone will have enough water.

Effects of inter-linking of river drainage system:

- The entire ILR project is designed on the concept of transferring waters from water surplus to water deficit areas. A seasonal average water surplus area could face water deficit because temporally and spatially, water requirements maintain some unique patterns depending on demands from agriculture, industry, domestic and economic other economic sectors. For example, Areas downstream will experience severe water shortage. This will also have an impact beyond the borders of India, like in Nepal & Bangladesh.
- Although Himalayan & Peninsular components are treated independent but they are interconnected. Water will be transferred either by gravity (tunnelling through mountains) or by lifting across natural barriers. The ILR should be treated from a systematic point of view otherwise it would become a failure. Besides, it requires enormous security arrangements and resources.
- Mitigating floods and droughts is one of the major objectives of the ILR. This will be done by storing water in the reservoirs during monsoon and releasing in dry season. However, in the context of the hydrology of Indian rivers it is a complex issue due to high seasonal variations. Storing water enormously in flood years is going to impact river morphology and agriculture adversely in the downstream areas.
- Although hydropower is currently an attractive option mainly due to high energy demand, its social and potential costs are very high. Lifting water across basin boundaries will require significant energy inputs. This could decrease the net hydropower component of ILR. Instead of expending resources into ILR, India can expand its existing cooperation with Bhutan to further develop its hydropower and purchase supplies from there.
- Dams & reservoirs impound water that creates favourable conditions for vectors to develop. Therefore, an outbreak is likely to occur as long irrigation canals will serve as a route for them to travel. An environment polluted by fertilizers, pesticides, hazardous chemicals, water and soil salinization endanger the availability of freshwater. It will alter micro-climatic and environmental settings of large areas of India.
- Interlinking of polluted rivers with the non-polluted ones will adversely impact the ecosystems of the latter and the people dependent on it.
- Climate change will have substantial implication the ILR scheme. To factor in the climate change on the engineering designs of the ILR will be a highly complex undertaking and may prove intractable.
- Ecosystem integrity, productivity & sustainability are highly dependent on adequate water flows required in flood plains, riparian zones, wetlands, estuaries. Freshwater flows also push back the intrusion of saline water. Damage to ecosystem is also a possible hazard.
- The ILR will host a cause of serious population & wildlife displacement. Moreover, aquatic ecosystems will migrate from one river to another, which in turn may affect the livelihoods of people who rely on fishery as their income.

- Nepal & Bangladesh is respectively located upstream and downstream of the Ganges. The planning, commission and construction of the project must comply with rules, principle, norms of international laws governing the international rivers.

Conclusion:

- Prior experience teaches that we must study basic aspects of each river basin, including catchment area treatment, command area development, benchmark survey of the affected population, and impacts of the reservoir and canal system on farmers, and fisheries, and public health.
- Environmental Impact Assessment will be inevitable.
- Compensatory and migratory plans must be rationally conceived.
- The River Valley Guidelines (1983) discuss environmental and social impacts due to transfer of water and people beyond suitability.
- All these issues must be taken into consideration otherwise this appealing project will prove to be a mere distraction of money and time.

8. Ganga river system has been the lifeline of northern plains, however, this lifeline is threatened by anthropogenic activities, discuss. Also suggest what should be done to make Namami Ganga a success to develop a sustainable river ecosystem?

(250 words)

Approach

1. **Briefly introduce the Ganga river** ***(50 words)***
2. **Discuss, How Anthropogenic activities polluting The Ganga River** ***(80 words)***
3. **What is NamamiGange ,And also suggest what should be done to make Namami Ganga a success to develop a sustainable river ecosystem** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

The Ganga is the most revered river of India originates in Himalayas in Uttarakhand and flow nearly 2525Km before discharging into Bay of Bengal. It is also a lifeline to 400 million of Indians who live along its course and depend on it for their daily needs. The Ganga has religious, economic, **social, geographic and even political significance thus has been the centre of focus among all rivers.**

Anthropogenic activities polluting The Ganga:

In spite of such a high significance, the health of the Ganges River is not ensured. There has been indiscriminate pollution of river water owing to human activities. Major reason of pollution which threatened the life of river is:

- **Urbanisation and direct sewerage discharge**: The River flows through 29 cities with population over 100,000; 23 cities with population between 50,000 and 100,000, and about 48 towns. A large proportion of the sewage water with higher organic load in the Ganges is from this population through domestic water usage. The Ganga river basin contributes about one-third of the total wastewater of India.
- **Industrial Waste**: Because of the establishment of a large number of industrial cities on the bank of river Ganga like Kanpur, Allahabad, Varanasi and Patna, countless tanneries, chemical plants, textile mills, distilleries, slaughterhouses, and hospitals prosper and grow along this and contribute to the pollution of the Ganga by dumping untreated waste into it. Industrial effluents are about 12% of the total volume of effluent reaching the Ganga. Although a relatively low proportion, they are a cause for major concern because they are often toxic and non-biodegradable. Several examples can be cited, such as oil wastes present in the storm-water channel along Haldia Refinery and ammonia pollution in ground water around a urea factory of Kanpur.
- **Agricultural runoff and improper agricultural practices**: Traces of fertilizers and pesticides are wasted into the nearest water-bodies at the onset of the monsoons or whenever there are heavy showers. As the point of entry of such agricultural inputs is diffused throughout the river basin, they are termed as non-point sources of pollution.
- **Withdrawal of Water**: Indian rivers, particularly the Himalayan Rivers, have plenty of water in their upper course. They are, however, starved of water when they enter the plain area. Irrigation canals whisk away clean water soon after the rivers reach the plains, denying water to flow in the river downstream. As the quantity of fresh water in the river is negligibly small, pollution-either from urban and rural areas, industries or even natural forms of pollution-cannot get diluted and its ill effects are not reduced.
- **Religious and Social Practices:** Religious faith and social practices also add to pollution of our river waters. Carcasses of cattle and other animals are disposed in the rivers. Dead bodies are cremated on the river banks. Partially burnt bodies are also flung into the river. All this is done as a matter of religious faith and in keeping with ancient rituals.

Cleaning the Ganga:

There have been several projects and schemes to clean The Ganga since 1986. Which include

- Ganga Action Plan (1985) in two phases. Not much success.
- Setting up of National Ganga River Basin Authority as coordinating authority.
- Clean Ganga Fund.
- Most recent Namami Ganga Program as a comprehensive approach.

Namami Ganga: An Integrated Ganga Conservation Mission called “NamamiGange” has been launched with a sum of Rs. 2,037 crore. It envisages the following activities.

- NirmalDhara- ensuring sustainable municipal sewage management
- NirmalDhara- managing sewage from Rural Areas
- NirmalDhara- managing Industrial discharge
- AviralDhara
- Ensuring ecological rejuvenation by conservation of aquatic life and biodiversity
- Promotion of Tourism and Shipping in a rational and sustainable manner
- Knowledge Management on Ganga through Ganga Knowledge Centre.
- Further Clean Ganga Fund has been formed to finance the activities related to Rejuvenation of Ganga

Making Namami Ganga a success:

Though it is a holistic and integrated scheme to conserve and making the ganga pollution free yet Implementation of envisaged projects on ground level is the key for success of NamamiGange Project. Following should be ensured for its success:

- Holistic and multi-dimensional approach towards improving river basin and abating industrial and human waste discharge in Ganges.
- Decentralised approached with multi-stakeholder-ship between Central, State Govt., NGOs, industrial representatives and local people.
- Environment audit as well as relocating the existing but important industries away from banks.
- Illegal construction due to rapid urbanization also needs a check, the role of Development authorities and state governments are important in this regard.
- In order to check proper and transparent release of fund, responsibility and accountability of the officials involved needs to be put in place. Also timely release of fund is necessary
- Effective mobilisation of resources through pollution cesses and water development taxes etc.
- One of major approach should be towards creating awareness and changing attitudes of communities in river basins towards collective ownership.
- **External guidance:** Germany, Australia and Belgium has shown great interest in helping India in cleaning Ganga. Germany's experience in cleaning river Rhine can be pivotal in direction. Also, guidance from Israel- a leader in drip irrigation technology can help.
- The Ganga has the largest river basin in India in terms of catchment area, which constitutes 26% of the country's land mass and supports about 43% of its population. The basin is spread over 11 states. We cannot afford to lose it at any cost. The government must ensure that this new 100% centrally funded project does not meet the same fate as the Ganga Action Plan and for that, implementation and strict monitoring will be critical.

9. Bring out the geographical reasons behind increasing pollution in the river Ganga. Suggest innovative solutions for cleaning it.

(200 words)

Approach

1. **Briefly introduce the river Ganga** ***(40 words)***
2. **Discuss the geographical reasons behind the pollution of river** ***(60 words)***
3. **Steps taken by the Government** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

2500Km long holy river Ganga passes through five states providing employment to nearly 10% and providing livelihood to nearly 40% of population faces severe pollution threat resulting from various geographical, economical and policy reasons.

Some of the geographical reasons behind the pollution of river are:

- **Over-extraction of water:** A river's ability to cleanse and recharge itself is significantly impaired by over-extraction of surface and ground water for irrigation, industrial and domestic usage. Numerous hydro-power projects are located within the Upper Ganga Basin, and many more are being built or planned. These have caused large stretches of the river to run dry, due to which pollution level increases as ability of restoration of river decreases.
- **Melting of glacier:** IPCC reports predict that the glacial stores of the Himalayas are retreating fast which is decreasing the availability of freshwater. Due to decline in water availability and flow the pollution gets accumulate.
- **Population explosion:** Ganga basin states are not only populous but have highest decadal growth rates, high density. This creates extra demand for water, reduced flows and more discharge of waste into river. Population explosion, resulting poverty and practise of open defecation are some of the main reasons behind this.
- **Urbanization** or rather unplanned urbanization which results into untreated sewage being discharged into river.
- **Reduced water flows** because of increasing demands from development and changing lifestyle pattern, agriculture, building of hydroelectric power stations etc.
- **Ecologically unsustainable agriculture practices** resulting into high use of fertilizers and its draining into river during rainy season.
- **Location factors of industries:** many polluting industries like sugar industry in Muzzafarnagar region, tanneries in Kanpur and Meerut are causing river pollution. The location factors of these industries did not include pollution as a factor.

Steps taken by the Government:

- To solve the problem of Ganga pollution government has started NamamiGange initiative which ensures participation from all stakeholders. It contains innovative steps like Ganga Vahini, which is a group of youth volunteers to keep vigil along Ganga, Swacha Ganga –GraminSahbhagita initiative to ensure participation of Panchayats.
- Other innovative steps which can be initiated are: using precision farming to limit use of fertilizers, constructing small check dams which maintains environmental flows along with providing irrigation and electricity generation, using treated waste water for watering road side trees, motivating and incentivising people to not to litter on ghats and retrofitting water supply to lay down separate pipelines for toilet water use under Smart Cities or AMRUT, use of biotechnology for bioremediation can be initiated.

10. Briefly discuss the drainage of India's west flowing rivers. Also discuss their importance in their drainage basin region.

(150 words)

Approach

1. **Provide overview of west-flowing rivers** ***(50 words)***
2. **Specifically discuss each river with its characteristics** ***(100 words)***

Hints

The west flowing rivers of the Peninsular India are fewer and smaller as compared to their east flowing counterparts. The two major west flowing rivers are the **Narmada** and the **Tapi.** This exceptional behavior is because these rivers didn't form valleys and instead they flow through faults (linear rift, rift valley, and trough) created due to the bending of the northern peninsula during the formation process of Himalayas. These faults run parallel to the **Vindhyas** and the **Satpuras**.

The **Sabarmati, Mahi** and Luni are other rivers of the Peninsular India which flow westwards. Hundreds of small streams originating in the **Western Ghats** flow swiftly westwards and join the Arabian Sea.

It is interesting to note that the Peninsular Rivers which fall into the Arabian Sea **do not form deltas, but only estuaries.** {Fluvial Depositional Landforms} This is due to the fact that the west flowing rivers, especially the Narmada and the Tapi flow through **hard rocks** and hence do not carry any good amount of silt.

Moreover, the tributaries of these rivers are very small and hence they don't contribute any silt. Hence these rivers are not able to form distributaries or a delta before they enter the sea.

Narmada River

- Narmada is the largest west flowing river of the peninsular India.
- Narmada flows westwards through a rift valley between the Vindhyan Range on the north and the Satpura Range on the south.
- It rises from Maikala range near Amarkantak in Madhya Pradesh, at an elevation of about 1057 m.
- Narmada basin extends over states of Madhya Pradesh, Gujarat, Maharashtra and Chhattisgarh having an area ~1 Lakh Sq.km.
- **Jabalpur** is the only important urban center in the basin.
- The river has brought some amount of silt thus has created some fertile lands near coastal areas.
- **Tapti River**
- The Tapti (also known as the Tapi) is the second largest west flowing river of the Peninsular India and is known as 'the twin' or 'the handmaid' of the Narmada.
- It originates near Multai reserve forest in Madhya Pradesh at an elevation of 752 m.
- Flows for about 724 km before out-falling into the Arabian Sea through the Gulf of Cambay [Gulf of Khambhat].
- The Tapti River along with its tributaries flows over the plains of Vidarbha, Khandesh and Gujarat and over large areas in the state of Maharashtra and a small area in Madhya Pradesh and Gujarat.
- Situated in the Deccan plateau, the basin is bounded by the **Satpura range** on the north, **Mahadev hills** on the east, **Ajanta Range** and the **Satmala hills** on the south and by the Arabian Sea on the west.
- The hilly region of the basin is well forested while the plains are broad and fertile areas suitable for cultivation.

Sabarmati River

- The Sabarmati is the name given to the combined streams the **Sabar** and **Hathmati.**

- The Sabarmati basin extends over states of Rajasthan and Gujarat having an area of 21,674 Sq. km.
- The basin is bounded by **Aravalli hills** on the north and north-east, by **Rann of Kutch** on the west and by **Gulf of Khambhat** on the south.
- The major part of basin is covered with agriculture accounting to 74.68% of the total area.
- **Gandhinagar and Ahmadabad** are the important urban centers in the basin.

Mahi River

- The Mahi basin extends over states of Madhya Pradesh, Rajasthan and Gujarat having total area of 34,842 Sq. km.
- It is bounded by **Aravalli hills** on the north and the north-west, by **Malwa Plateau** on the east, by the **Vindhyas** on the south and by the Gulf of Khambhat on the west.
- Mahi is one of the major inter-state west flowing rivers of India.
- Hydro Power stations are located in **Mahi Bajaj Sagar dam** and at **Kadana Dam.**
- **Vadodara** is the only important urban center in the basin. There are not many industries in the basin.

Luni River

- The Luni or the **Salt River** (Lonari or Lavanavari in Sanskrit) is named so because its water is brackish below Balotra.
- Luni is the only river basin of any significance in Western Rajasthan, which form the bulk of arid zone.
- Luni originates from western slopes of the **Aravalli ranges** at an elevation of 772 m near Ajmer flowing in South West direction and traversing a course of 511 km in Rajasthan, it finally flows into the Rann of Kachchh (it gets lost in the marsh).
- Most of its tributaries drain the steep north west of Aravalli hills and join it on left side. Its total catchment area falls in Rajasthan.
- The peculiarity of this river is that it **tends to increase its width** rather than deepening the bed because the banks are of soils, which are easily erodible whereas beds are of sand. The floods develop and disappear so rapidly that they have no time to scour the bed.

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NOTES

SET-2.1: QUESTIONS

WATER RESOURCES

Q1. **Inter-linking of rivers will address economic, political and social issues, but pose threat to the ecological and environmental diversity. Comment and mention some alternative strategies in this regard.**

Q2. **Discuss the disadvantages for those countries that lack access to international waters. Examine in context to Central Asia.**

Q3. **Examine the availability and extent of ground water resources in India. What are the reasons for the declining ground water and suggest measures for its effective management.**

Q4. **"The water resource scenario in India is markedly worse than it used to be decades earlier and may get further worse in future". Critically analyse.**

Q5. **Establish the relation between water resources of India with social issues related to it that needs to be addressed**

Q6. **Water resource augmentation, conservation, and efficient utilization will be very important determiner of India's future development. What is the status of water resource in India and discuss needs for its conservation and efficient utilization.**

Q7. **Discuss the nature and magnitude of drinking water problem in India and explain the impact of EI Nino on India's water security?**

Q8. **What are the prospects of Blue Revolution? Illustrate its impact on rural economy of India.**

Q9. **In addition to affecting the huge rural and urban population, the water scarcity in India also extensively affects the ecosystem and agriculture. In this context, enumerate the major issues concerning the variabilities in water resources in India.**

Q10. **What is meant by water resource management? Enumerate the challenges involved in water management. Discuss the measures in managing the water resources in India.**

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SET-2.1: ANSWERS

1. Inter-linking of rivers will address economic, political and social issues, but pose threat to the ecological and environmental diversity. Comment and mention some alternative strategies in this regard.

(250 words)

Approach

1. **Introduce interlinking of rivers.** ***(50 words)***
2. **Elaborate on its benefits and problems it can cause in the future.** ***(100 words)***
3. **Mention alternative strategy** ***(80 words)***
4. **Conclusion** ***(20 words)***

Hints

The National Perspective Plan (NPP) was prepared by the government in August 1980 for transferring water from water surplus basins to water-deficit basins. It has both Himalayan and Peninsular river component. Currently, the **central government aims to interlink 60 rivers at a cost of USD 87 billion.**

Examples: Kosi-Ghaghra link, Manas-Sankosh-Teesta-Ganga, Par-Tapi-Narmada Link Project, Damanganga- Pinjal Link Project, Ken-Betwa project.

Factors that deem it necessary:

- **Himalayan rivers Vs. Peninsular rivers:** Flow of water in Himalayan rivers is perennial, while that in peninsular rivers is seasonal. Thus, creating water surplus and water deficit divide.
- **Ecological:** It is expected to end the annual havoc created by droughts and floods in many parts of the country.
- **Economical:** It will help improve irrigation, increase water for drinking and industrial use.
- P**opulation pressure:** 17 per cent of the world population is in India, but the country has only four per cent of water.
- **Limitations of the project:**
- **Finance:** it is an expensive proposal; Cost estimation of $87 billion is excluding the costs of relief, rehabilitation and other expenses such as measures to deal with submergence in some areas.

- **Environmental impacts:**
  - It has huge adverse impact on land, forests, biodiversity, rivers and the livelihood of millions of people.
  - The ecology of every river being unique, experts have stressed that letting the waters of two rivers mix may affect biodiversity.
  - It adds to climate change impact. Destruction of forests means destruction of carbon sinks, and reservoirs in tropical climate are known sources of methane and carbon dioxide. It can further impact our adaptability to climate change.
- **Socially disruptive proposition:** As it proposes the construction of a massive network of canals and dams, it would lead to large-scale displacement of people and changes in agricultural patterns, and affect livelihoods
- **Political tussle:** It is marred by continuous political logjams. Currently, land acquisition and water sharing issues are impeding Ken Betwa project, country's first river interlinking project.
- **Sustainability**: Rainfall patterns are changing due to climate change, so the basins now supposed to be surplus, might cease to be so in a few years.

Alternatives:

- **Developing National Waterways Project (NWP)**
  - It eliminates friction between states over the sharing of river waters since it uses only the excess flood water that goes into the sea unutilized.
  - It needs one-third the land required for interlinking of rivers. It is open to navigation throughout the year and involves zero pumping.
  - It can irrigate 60 million hectares of land, almost double than that by interlinking of rivers. Its power generation capacity is also around 76 per cent more than that of interlinking rivers.
  - China has followed similar development project and created around 1.2 lakh km of waterways and is currently reaping the benefit.

Thus, inter linking of rivers is a project of national importance but has been a controversial one since its genesis. As it stirs development vs. right debate, government of the day should continuously check for cost benefit ratio to be favorable throughout the implementation of approved projects and planning of new ones, under it.

2. Discuss the disadvantages for those countries that lack access to international waters. Examine in context to Central Asia.

(250 words)

Approach

1. **Brief introduction on landlocked countries** ***(40 words)***
2. **How central Asian countries are at disadvantage** ***(100 words)***
3. **How disadvantages can be minimized** ***(70 words)***
4. **Conclusion** ***(40 words)***

Hints

Landlocked countries are those sovereign states that are surrounded completely by land (by other countries), have no territorial access to the seas, limited border crossings and transit dependence. Other form of dependence are- dependence on neighbours' infrastructure; dependence on sound cross-border political relations; dependence on neighbours' peace and stability; and dependence on neighbours' administrative practices. These dependences limit political and economical lives of the citizens.

There are over 40 landlocked countries in the world. Most of them are developing nations.

Biggest limitation of transit dependence causes following:

- **Isolation:**
  - Lack of territorial access to the sea causes remoteness and isolation
- **Limited social development:**
  - The relatively poor performance of many landlocked countries is attributed to distance from coast
  - Landlocked countries often also lag behind their maritime neighbors in overall development and external trade
- **Limited market share:**
  - In spite of technological improvements in transport, landlocked developing countries continue to face structural challenges to accessing world markets.
  - Higher transportation costs and delay causes lesser trade.
  - It is estimated that the **basic trade costs of landlocked nations are nearly twice** those of neighboring countries with coastlines.
  - As per World Bank, share of landlocked developing countries in **global trade is approximately 1%.**
- **Vulnerable during disasters:**
  - With dependence on their regional neighbors for trade and transport, landlocked countries remain **vulnerable in times of natural disasters or regional conflict.**
  - **Life expectancy, in most cases, continues to lag behind** neighboring coastal countries.

Central Asian Region:

Geographically, Central Asian region has been amply endowed with natural resources but is handicapped by its landlocked situation. It is home to many developing nations. By area, Kazakhstan, in Central Asia, is the largest landlocked country in the world.

Challenges

Landlocked countries in Central Asia face similar economic, political and social challenges as above- high transportation cost, waste due to lack of 'cold' supply chains in the agro-business sector, and slower pace in development of sub-national regions due to high cost of infrastructure.

The two major rivers are the Amu Darya and the Syr Darya. The Aral Sea is another major water reservoir for the region. However, **the distribution of water resources is very difficult in Central Asia.** Population growth, climate change and dwindling precipitation create huge challenges to the Central Asian governments.

Central Asia has abundant resources- existence of oil deposits in Kazakhstan, Turkmenistan, and Uzbekistan; significant hydroelectric potential in Tajikistan. These countries have achieved significant growth in the last decade owing to international interest in their natural resources. But need for better transport connectivity and diversification still exists, and therefore they continually seek more sustained support from international donors and development partners.

Minimizing limitations of being landlocked

- The economic disadvantages of being landlocked can be alleviated or aggravated **depending on degree of development, language barriers, and other considerations.** Some landlocked countries are quite affluent, such as Switzerland, Liechtenstein, Luxembourg, and Austria, all of which frequently employ neutrality to their political advantage.
- **Engagement with the private sector** is also essential, including through foreign direct investment and public-private partnerships
- **The Vienna conference** is set to approve an action plan that would stress the need to provide adequate aid to the land locked countries in pursuing their goals for greater economic development.
- **The BRI and Chabahar port** stand to change Central Asia from a landlocked to a transit region and thus towards a new direction in its development.

3. Examine the availability and extent of ground water resources in India. What are the reasons for the declining ground water and suggest measures for its effective management.

(250 words)

Approach

1. **Briefly introduce the status of ground water resources in India** ***(50 words)***
2. **What are the reasons for the declining ground water** ***(80 words)***
3. **Suggest measures for its effective management** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

India has a ground-water availability of 435.66BCM of total replenish able groundwater resources out of which 399 BCM is considered to be available for development for various uses after keeping 34 BCM for natural discharge during non-monsoon period for maintaining flows in springs, rivers and streams. The underground water resources are a result of climatic conditions, relief, geological structure and hydrological conditions of the area. 70% of India's groundwater resources can be exploited economically.

Reasons for the decline of ground water

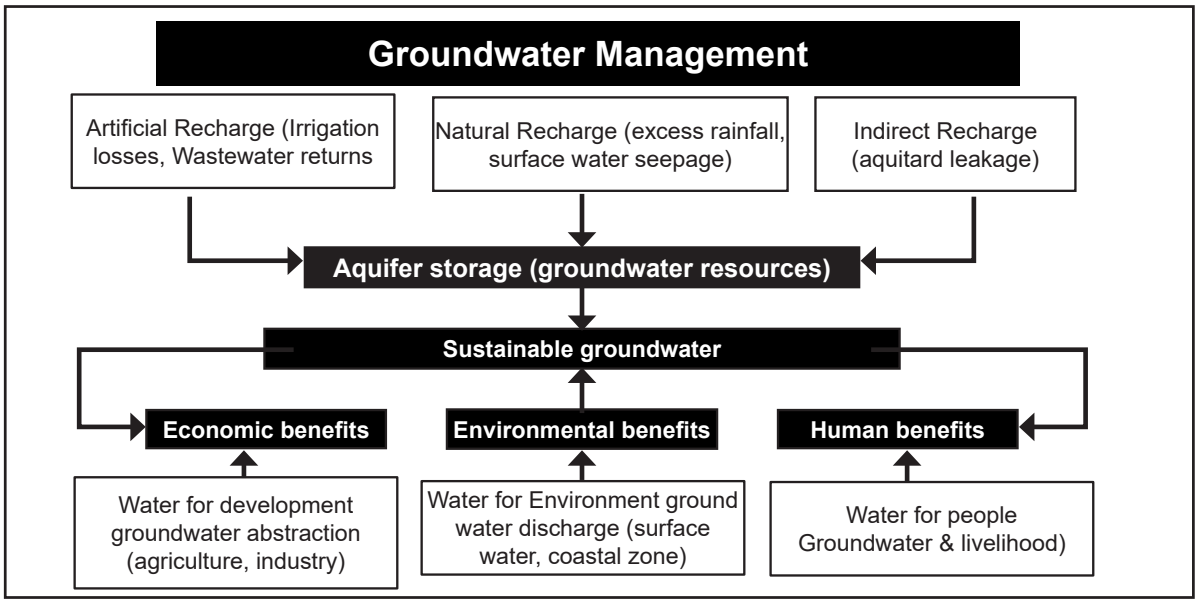
Groundwater has emerged as the primary democratic water source and poverty reduction tool in India's rural areas. On account of its near universal availability, dependability and low capital cost, it is the most preferred source of water to meet the requirements of various user sectors in India. This has led to some of the problems in groundwater like:

- 61% of the irrigation in the country is sourced from groundwater. With this tube wells have become the largest single source of irrigation water in India.
- Three states (Punjab, Uttar Pradesh and Haryana) accounted for 57% of the tube wells in India.
- Groundwater overuse has led to long-term decline of ground water levels in the country.
- De-saturation of aquifer zones.
- Quality deterioration due to saline water intrusion in coastal areas in different parts of the country.
- The canal command areas suffer from problems of water logging and soil salinity due to the gradual rise in ground water levels.
- Natural and anthropogenic pollution of groundwater with fluoride, arsenic, nitrate and heavy metal contamination has rendered domestic use vulnerable.
- Groundwater depletion in urban areas largely due to poor piped drinking water supply.

There is a need to prepare a comprehensive road map with identified strategies for scientific and sustainable management of the available ground water resources in the country.

Suggestive Measures

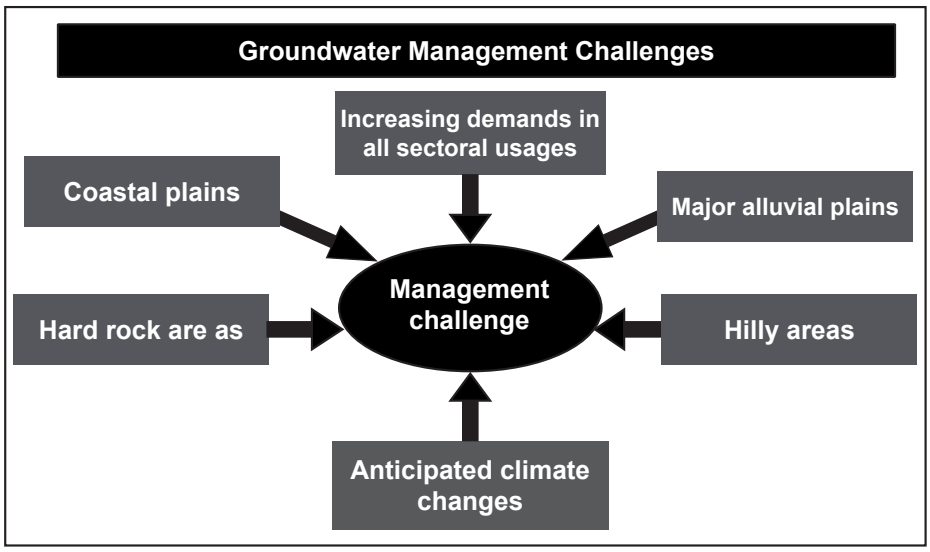
Scientific management of ground water resources involves a combination of A) Supply side measures are aimed at extraction of ground water resources depending on its availability and B) Demand side measures aimed at controlling, protecting and conserving available resources.



See Image Next Page

Supply Side Measures

- These measures are aimed at increasing the ground water availability, taking the environmental, social and economic factors into consideration. National Hydrology Project needs to be extended and made more comprehensive, including through mapping of deep aquifers in the country and determining rates of recharge.
- These are also known as 'structural measures', which involves scientific development and augmentation of ground water resource.



- Development of additional ground water resources through suitable means and augmentation of the ground water resources like artificial recharge and rainwater harvesting.
- An effective supply-side management requires us to have knowledge of the hydrologic and hydro-geologic controls that govern the yields of aquifers and behaviour of ground water levels under abstraction stress.
- Withdrawal of ground water from the flood plains during non-monsoon season to create additional space in the unsaturated zone for subsequent recharge/infiltration during rainy season.
- Budget allocation of Rs 6,000 crore for undertaking a major programme for sustainable management of groundwater resources in 2016 has been made.
- Judicious development through integrated use of surface and ground water resources can greatly reduce the menace of water-logging and salinity in canal irrigated areas.

Demand Side Measures:

- Ground water resources management requires us to focus attention on the judicious utilization of the resources for ensuring their long-term sustainability.
- Ownership of ground water, need-based allocation pricing of resources, involvement of stake holders in various aspects of planning, execution and monitoring of projects needs to be done.
- Effective implementations of regulatory measures wherever necessary are the important considerations with regard to demand side ground water management.
- Crop diversification to grow crops that require less groundwater in Punjab and Haryana regions.
- Use of micro-irrigation techniques like drip and sprinkler irrigation for efficient use of water.

Conclusion:

National Water Policy which states that surface and ground water should be viewed as an integrated resource and should be developed conjunctively in coordinated manner and their use should be envisaged right from the project planning stage to ensure sustainability of groundwater resources.

4. "The water resource scenario in India is markedly worse than it used to be decades earlier and may get further worse in future". Critically analyse.

(250 words)

Approach

1. **Briefly introduce the problems related to the water resources of India** ***(50 words)***
2. **Give reasons for its depletion and deterioration** ***(80 words)***
3. **Discuss the need for sustainable water management** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

India has more than 18 % of the world's population, but has only 4% of world's renewable water resources and 2.4% of world's land area. There are further limits on utilizable quantities of water owing to uneven distribution over time and space. In addition, there are challenges of frequent floods and droughts in one or the other part of the country. With a growing population and rising needs as well as the given indications of the impact of climate change, availability of utilizable water will be under further strain in future with the possibility of deepening water conflicts among different user groups.

Present scenario of water resource in India:

- Large parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security. There is wide temporal and spatial variation in availability of water, which may increase substantially due to a combination of climate change, causing deepening of water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc.
- Access to safe water for drinking and other domestic needs still continues to be a problem in many areas. Skewed availability of water between different regions and different people in the same region and also the intermittent and unreliable water supply system has the potential of causing social unrest. Groundwater, though part of hydrological cycle and a community resource, is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas.
- Grossly inadequate maintenance of existing irrigation infrastructure has resulted in wastage and under-utilization of available resources. There is a widening gap between irrigation potential created and utilized. Natural water bodies and drainage channels are being encroached upon, and diverted for other purposes. Groundwater recharge zones are often blocked. Growing pollution of water sources, especially through industrial effluents, is affecting the availability of safe water besides causing environmental and health hazards. In many parts of the country, large stretches of rivers are both heavily polluted and devoid of flows to support aquatic ecology, cultural needs and aesthetics.

The situation is becoming worse and will become worse in the future due to low consciousness about the overall scarcity and economic value of water results in its wastage and inefficient use. The lack of adequate trained personnel for scientific planning, utilizing modern techniques and analytical capabilities incorporating information technology constrains good water management.

Steps Needed:

In view of the existing status of water resources and increasing demands of water for meeting the requirements of the rapidly growing population of the country as well as the problems that are likely to arise in future, a holistic, well planned long-term strategy is needed for sustainable water resources management in India.

- The water resources management practices may be based on increasing the water supply and managing the water demand under the stressed water availability conditions. Data monitoring, processing, storage, retrieval and dissemination constitute the very important aspects of the water resources management.
- Proper planning and designing of the water resources structure is required. In addition to these, now a day's decision support systems are being developed for providing the necessary inputs to the decision makers for water resources management. Also, knowledge sharing, people's participation, mass communication and capacity building are essential for effective water resources management.
- A shift from social good to economic good and use of market mechanisms with the participation of the business sector will achieve a more efficient and effective allocation, use and management of water, and their roles of both public and private sectors in managing water resources must be defined.

Conclusion:

Thus water resource management is must but sustainable use and management of water in India will require a shift from the traditional top down centralised approach towards a more decentralised approach. While government has an important role to play, it is only one among many stakeholders involved. These stakeholders include Government of India, State Government, every household in India as a consumer of water, business sector, industries, larger community aggregates such as water uses association, villages.

5. Establish the relation between water resources of India with social issues related to it that needs to be addressed

(200 words)

Approach

1. **Give a brief description of water resources of India** ***(50 words)***
2. **Social issues related to water resources of India** ***(70 words)***
3. **Suggested measures** ***(50 words)***
4. **Conclusion** ***(30 words)***

Hints

Water is one of the most basic, one of the most used, one of the most exploited and perhaps equal in importance to the other natural resources essential for the survival of life. Rivers, estuaries, groundwater and other water bodies constitute the water resource of India. But due to spatial and temporal variability in precipitation and over exploitation of groundwater is leading to reduction of flows in the rivers, declining of the groundwater resources, and salt water intrusion in aquifers of the coastal areas.

Social Issues related to water resources

The relationship between water and society is a complex historical, sociological and regional problem.

The hydrology has been manipulated politically for centuries, for example, through the layout of drainage networks, the diversion of rivers, the interlinking of tanks, or the repositioning of channels.

Locally, village elites have controlled and changed the physical flows of water through diversion structures or the positioning of sluices and heights of weirs. Nations assert their ownership of water resources and build 'empires of water'.

Water supply and its quality are pathetic in both rural and urban regions. People stand in queues for five hours to get water, waking up at 4 a.m. to do so. In Pune people pays Rs.1100 every alternate day, which works out to Rs.16, 500 a month, for water supply by tankers.

Riots have broken out over bore well use, leading to death, imprisonment, deprivation and despair to families.

Due to lack of water supply, the other sanitation facilities get affected.

Drinking contaminated groundwater can have serious health effects. Diseases such as hepatitis and dysentery may be caused by contamination from septic tank waste. It usually impacts the downtrodden more and pushes them to the brink of poverty and unemployment due to huge economic loss related to it.

Suggestive Measures

- To improve the situation the government should implement effective groundwater legislation and regulations through self-regulation by communities and local institutions.
- External support agencies should support freshwater resource management. Environmental restoration should be promoted along with household water security.
- Concerning the governance of water, the decentralizing movement that exists promoting management at the watershed level is essential.
- Both the central government and the state governments need to have considerations on setting the Minimum Support Price (MSP) of water consuming crops.

Conclusion:

Ensuring active community participation in water resource management is among the major goal of the government and active participation of the communities in various activities such as formation of Water User Associations, monitoring and disseminating ground water data, water budgeting, preparation and implementation of Gram-Panchayat wise water security plans and IEC activities holds vital role for addressing the issues.

6. Water resource augmentation, conservation, and efficient utilization will be very important determiner of India's future development. What is the status of water resource in India and discuss needs for its conservation and efficient utilization.

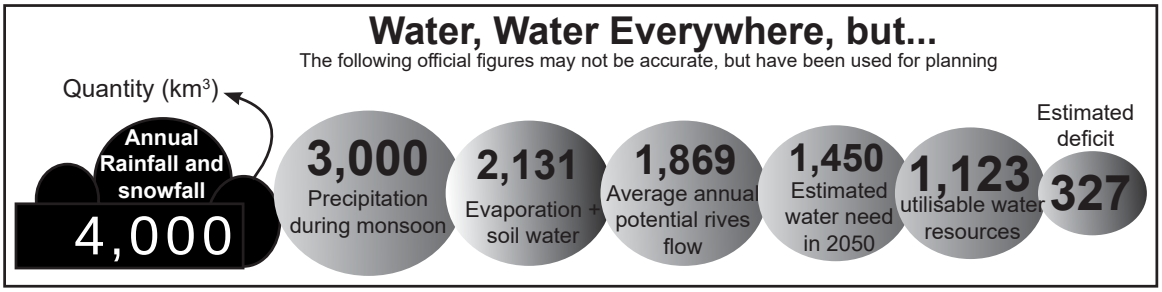
(250 words)

Approach

1. **Briefly introduce the status of water resources in India** ***(50 words)***
2. **Discuss the issues related with the water resources in India** ***(80 words)***
3. **Discuss needs for its conservation and efficient utilization** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

India accounts for 2.45% of land area and 4% of the water resources of the world population. With the present population growth rate (1.9 per cent per year), the population is expected to cross the 1.5 billion mark by 2050. The ever expanding water demand of India's growing population and economy, combined with the impacts of climate change, are already making water scarcity a major threat in many parts of the country.



Issues with water resource

Availability:

- India is water-stressed and moving towards what's technically termed "water scarcity condition" with a majority of the country accessing water that is contaminated with one or the other pollutant, or not having access to it at all. Per capita water availability less than 1,700 cubic meters is considered water stressed and the present number in India is 1,545 cubic meters.
- Water resources ministry predicts water availability could plunge to 1,341 cubic meters in 2025 and as low as 1,140 by 2050. This scenario mirrors water-scarcity condition where per-person availability is less than 1,000 cubic meters.
- In underground reservoirs water exploitation has been above safe levels in 31% of districts. The exploitation level has crossed 100% (meaning water exploitation is greater than recharge) in states like Haryana, Punjab, Western UP.

Quality:

- River water and underground water both are contaminated.
- Water in 320 of the country's 640 districts is contaminated by chemicals like fluoride, arsenic, and heavy metals like chromium and lead.
- CPCS found that many places surface water was contaminated from coli form (a bacterial which can trigger health hazard) and faecal coli form.
- According to the latest assessment by the Central Pollution Control Board (CPCB), the number of polluted rivers has gone up from 121 in 2009 to 275 and number of polluted stretches from 150 to 302.
- River pollution is not confined to river Ganga only but effects many of the rivers especially those which passes through more industrialized, urbanized states and those states which make extensive use of river water for various purposes like Maharashtra, Gujarat, West Bengal, Karnataka etc.

Water use:

- If we look at the water use there is competitive demand from different sectors like agriculture, industries, household consumption. 90% of ground water resource is being used for agriculture purpose, where the water use efficiency is minimum. In industries and household also there is lot of wastage and no focus is being given in recycling and reuse.

Need for conservation and improving the efficiency:

As the population of India increases and economy grows there will be huge demand for water from different sectors like agriculture, industries, urban areas. This will accentuate the water related conflict as happened during recent Cauvery water dispute. Therefore, there is a need to focus on both demand side and supply side issues related to water management and conservation:

Supply side management:

Adopting watershed management approach creating proper water storing facilities, rainwater harvesting facilities in houses etc.

- Drafting a national and state water policy to rationalize water use.
- Preparing contingency plan according to the monsoon prediction which must include advisories on which crops to be shown, water rationing etc.
- Interlinking of rivers to ensure evenly availability of water.

Demand side management:

- Growing agro-climatically suitable crops.
- Using latest irrigation technologies like drip irrigation which reduces water use in agriculture.
- Using market mechanism like tariff on different kinds of water use to make people sensitive to supply.

Conclusion:

Water being a State subject, steps for augmentation, conservation and efficient management of water resources to ensure sustainability and availability are primarily undertaken by the respective State Governments. At the individual level one needs to be conscious about his/her water use and need to understand where the water comes from. Awareness programs by government and school lessons for children should be taught at very young age so that every person becomes sensible when it comes to use of water.

7. Discuss the nature and magnitude of drinking water problem in India and explain the impact of EI Nino on India's water security?

(250 words)

Approach

1. **Briefly introduce the present's drinking water problem in India** ***(50 words)***
2. **Discuss the problems and its affects related with drinking water** ***(80 words)***
3. **Measures should be taken** ***(70 words)***
4. **Explain the impact of EI Nino on India's water security** ***(50 words)***

Hints

The average availability of water is reducing steadily with the growing population and it is estimated that by 2020 India will become a water-stressed nation.

India's water crisis is rooted in three causes.

The first is insufficient water per person as a result of population growth. The total amount of usable water has been estimated to be between 700 to 1,200 billion cubic meters (bcm). With a population of 1.2 billion according to the 2011 census, India has only 1,000 cubic meters of water per person, even using the higher estimate. A country is considered water-stressed if it has less than 1,700 cubic meters per person per year. For comparison, India had between 3,000 and 4,000 cubic meters per person in 1951, whereas the United States has nearly 8,000 cubic meters per person today.

The second cause is poor water quality resulting from insufficient and delayed investment in urban water-treatment facilities. Water in most rivers in India is largely not fit for drinking, and in many stretches not even fit for bathing. Despite the Ganga Action Plan, which was launched in 1984 to clean up the Ganges River in 30 years, much of the river remains polluted with a high coli form count at many places.

- Nearly 66 million people in 20 states are at risk because of excessive fluoride in water.
- Nearly 6 million children below 14 suffer from dental, skeletal and non-skeletal fluorosis.
- Arsenic is the other big killer lurking in ground water putting at risk nearly 10 million people. The deeper aquifers in the entire Gangetic plains contain arsenic.
- However it is bacteriological contamination which leads to diarrhoea, cholera and hepatitis which is widespread in India. A bacteriological analysis of the water in Bangalore revealed 75% bore wells were contaminated.

The third problem is dwindling groundwater supplies due to over-extraction by farmers.

- An appraisal of the water supply situation in major cities of India reveals a number of other problems also. Notable among these are:
- A huge water demand and supply gap;
- Poor operation and maintenance of water supply systems;
- Huge water losses mainly caused by leakages in transmission and distribution lines;
- Inadequate supply of safe drinking water to poor communities;
- Inadequate skilled manpower and institutional capacity; and
- Sixty seven per cent of Indian households do not treat their drinking water, even though it could be chemically or bacterially contaminated.

Suggestions

There is an urgent need to look for alternative sources of portable water in places where water quality has deteriorated sharply. Community based water quality monitoring guidelines should be encouraged. People should be encouraged to look at traditional methods of protecting water sources. Also in places where groundwater has arsenic or fluoride, surface water should be considered as an alternative.

Furthermore, with the adoption of innovative practices such as energy efficiency, effective billing, and collection, subsidies and incentives for water supply to urban poor, use of ICT, public-private-partnerships (in service operation and maintenance, distribution, billing and revenue collection), institutional capacity building, and customer service improvement, some urban centers have already begun to display excellence in urban water management.

In view of the fact that the issues and prescriptions in the water sector have been largely identified, the challenge now lies in speeding up the reform process and in the replication/ implementation of good governance practices in other centres.

Impact of El-Nino on India's water security:

As Indian agriculture is still dependent on monsoon rains to a large extent, the drought conditions caused by the El Nino is bound to have some effects on India's water security.

Water availability and rainfall in India are dependent on two monsoons, the south-west (summer) and north-east (winter). Most rainfall occurs between the months of June and September, with the average annual rainfall approximately 1170mm. There is, however, considerable variation between regions.

According to the FAO's Aqua stat, 80 per cent of India has an annual rainfall of 750mm or more. A key challenge for India's water security, therefore, is not so much physical water scarcity, but mismanagement and limited storage facilities.

India's per capita water storage capacity is 200m^3, well below the world average of 900m^3 per capita. Estimates suggest as much as 65 percent of India's rainwater flows out to sea un-captured, presenting a huge opportunity for improving the situation by capturing those water flows.

8. What are the prospects of Blue Revolution? Illustrate its impact on rural economy of India.

(200 words)

Approach

1. Give a detailed description of Blue Revolution ***(70 words)***

2. Steps taken by Government ***(70 words)***

3. Its impact on rural economy of India ***(60 words)***

Hints

- Blue Revolution means the adoption of a package programme to increase the production of fish and marine products. The Blue Revolution in India was started in 1970 during the Fifth Five-Year Plan when the Central Government sponsored the **Fish Farmers Development Agency (FFDA)**. Subsequently, the Brakish Water Fish Farms Development Agency were set up to develop aquaculture. The Blue Revolution has brought improvement in aquaculture by adopting new techniques of fish breeding, fish rearing, fish marketing, and fish export. Under the Blue Revolution programme, there had been a tremendous increase in the production of shrimp. Andhra Pradesh and Tamil Nadu have developed shrimp in a big way. The Nellore District of Andhra Pradesh is known as the 'Shrimp Capital of India'.
- There are more than 1800 species of fish found in the sea and inland waters of India, of which a very few are commercially important. The important sea fish include catfish, herring, mackerels, perches, mullets, Indian salmon, shell fish, eels, anchovies, and dorab. Similarly, the main fresh water fish include catfish, loaches, perches, eels, herrings, feather backs, mullets, carps, prawns, murrels, and anchovies.
- Marine fisheries contribute about 50 per cent of the total fish production of the country. Kerala is the leading producer followed by Maharashtra, Karnataka, Gujarat, and Goa. The fishing season extends from September to March. The higher fish production in the Arabian Sea is due to the broader continental shelf. The important fish varieties include sardines, mackerel and prawn. The East Coast contributes about 28 per cent of the total production of marine fish in the country. The fishing activity along the East coast is mainly carried on from Rameswaram in the south to Ganjam in the north, with fishing season from September to April along the Coromandal Coast.
- The National Fisheries Development Board has been set up to realise the untapped potential of fishery sector with the application of modern tools of research and development including biotechnology

Government Initiative

- Under the – India Norway Project (INP); traditional fishing crafts have been mechanised and modernised.
- Refrigeration and cold storage facilities.
- Insurance facilities have' been extended.
- Deep-sea fisheries programme has been given priority.
- Various co-operative organisations have been set up for providing technical and financial support.

Impact on Rural Economy: Blue Revolution has played an important role in the rural economy of India. By causing a substantial increase in the fish catch and fish products,

- Augmenting food supply.
- Raising nutritional level especially of the rural folk
- Generating employment particularly in rural areas
- Earning valuable foreign exchange.

Fish forms an important part of diet of the people living in the coastal 'areas of Kerala, West Bengal, Orissa, Andhra, Tamil Nadu. etc. Fishing provides sustenance to-over 1 million persons in the country most of whom are rural people Inland fishing, has emerged as an alternate Source of income for rural farmers it also imparts security to their economy in case of failure of crops.

9. In addition to affecting the huge rural and urban population, the water scarcity in India also extensively affects the ecosystem and agriculture. In this context, enumerate the major issues concerning the variabilities in water resources in India.

(250 words)

Approach

1. **Give brief introduction of water sources in India. Mention its availability and its utilization** ***(50 words)***
2. **Major issues concerning the variabilities in water resources in India** ***(150 words)***
3. **In conclusion suggest some measures to solve water crisis** ***(50 words)***

Hints

In India the distribution of rainfall is highly non-uniform both in terms of time and space. As a result water is required to be stored and utilized for meeting the demands of different sectors throughout the year. Climate change is expected to lead to an intensification of the global hydrological cycle and can have major impacts on regional water resources, affecting both ground and surface water supply.

In its Fourth Assessment Report, the IPCC suggests that average temperatures will climb 1.56 to 5.44°C in south Asia by 2099. Dry season rainfall will drop by 6 to 16 per cent, while wet season rains will increase by 10 to 31 per cent. Such shifts in temperature and precipitation patterns could carry major repercussions for India\'s freshwater resources and food production. Rising surface temperatures appear to be contributing to melting of snow and ice pack in the Himalaya, thus threatening the water supplies on which hundreds of millions of people depend.

There are three major issues concerning the variabilities in water resources in India are:

India has large temporal variability in water availability, leading to disasters such as floods and droughts:

- India faces large temporal variability in water availability, leading to, among other issues, disasters such as floods and droughts. Due to monsoon climate in India, more than 70% of the annual precipitation takes place in a limited period of about four months.
  - Consequently, this is the period when the rivers carry more than 70–75% of the annual flows, at times exceeding the capacity to safely pass this water. The remaining eight-month period accounts for the balance 25–30% of river flows and many rivers do not flow for some summer months.

- In addition to temporal variability, water availability in India also has huge variations with respect to location, resulting in surplus water in some river basins/regions and water scarcity in others, frequently at the same time. It will be better to address both types of variabilities together, since the tools are the same.
- Further the climate change has direct impact on variability. Climate change has threatened the water resources in multiple ways.

Increasing gap between water availability and demands:

- Population is the key determinant in water demand. As the population of India is increasing, lifestyles are changing and economic activities are increasing, the demand for water is also rapidly rising.
- Agriculture sector accounts for more than 85% of the annual water demand in the country.
- As there is no major trend in annual rainfall in India, the gap between demand and supply of water is increasing. In many regions, the demand is already much more than the supply, leading to water scarcity.

Unsustainable water withdrawals:

- Increasing withdrawals have adversely affected the health of many rivers in different reaches and some rivers in different stretches have stopped flowing round the year. This is highly detrimental to the river as well as the environment. Although groundwater use has provided the much needed drinking water and food security to India, due to unsustainable extraction at many places, water tables are falling resulting in wells going dry, rising pumping cost, falling base flows in the rivers, and entry of harmful substances (such as arsenic) in the water supply.
- A large number of districts in India have reported groundwater contamination of some form or the other. These include contamination due to fluoride, iron, salinity, arsenic, etc. Excessive withdrawal from groundwater also results in land subsidence, which may lead to a number of other harmful consequences.
- In the near future, India is likely to face a situation where water availability in an average year would be nearly the same or less than the demands. The situation will become really precarious in the years of below-normal monsoon.
- Rising pollution in many rivers and water bodies has directly impacted the water resources in our country. Demand and variability both has been impacted due to it.

Conclusion:

It is suggested that conservation of water and management of variabilities should be a cornerstone of water resources management in India. While attempting to solve the water crisis, it is important to look at the water resources in totality i.e. surface water and groundwater, rather than managing surface water and groundwater separately. Actions such as reducing demands conserve water and moving water across geographies could go long way.

10. What is meant by water resource management? Enumerate the challenges involved in water management. Discuss the measures in managing the water resources in India.

(150 words)

Approach

1. **Brief introduction about water resources management** ***(30 words)***
2. **Explain Challenges in water management and some measures such as store water on the surface, storage reservoirs etc. to be taken to manage water resources** ***(90 words)***
3. **Conclusion** ***(30 words)***

Hints

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management.

The field of water resources management will have to continue to adapt to the current and future issues facing the allocation of water. With the growing uncertainties of global climate change and the long term impacts of management actions, the decision-making will be even more difficult. Ideally, water resource management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands.

One of the biggest concerns for our water-based resources in the future is the sustainability of the current and future water resource allocation. As water becomes more scarce, the importance of how it is managed grows vastly. Finding a balance between what is needed by humans and what is needed in the environment is an important step in the sustainability of water resources.

Challenges in water management in India can be categorized as:

- Water availability, variability and increasing withdrawals
- Environment and quality
- Project construction
- Water sharing disputes
- Water governance and institutions
- Challenges induced due to climate and land-use cover changes

Some measures to be taken to manage water resources

Three distinct actions are required: reduce demands, conserve water and move water across geographies in managing water resources in India. Let us discuss them one by one:

Conserving flood flows:

- India has a monsoon climate and the rivers carry more than 70% of the annual flows during four monsoon months. Hence it is essential to conserve flood flows and use them to meet the demands in the lean season to a larger extent.
- Water can be stored on or below the surface. Actions are needed at various levels. At the macro level, it is important and essential to conserve surplus monsoon or flood flows, either in the storages on the ground or below ground, since the flows in the remaining months are inadequate to meet the various demands.

- To store water on the surface, storage reservoirs have to be developed. Good sites for storages are limited in the country and numerous problems arise due to the submergence of forests, displacement of population, threat to biodiversity, environmental issues, etc. To conserve water below the surface, suitable hydro-geology is a must and facilities for large-scale managed aquifer recharge (MAR) need to be created.

Rationalizing cropping patterns:

- Analysis of data shows that in the past five or six decades, cropping patterns across the country have dramatically changed. Sugarcane which requires a large quantity of water is being cultivated at many regions of low rainfall where it was not grown earlier.
- Similarly, rice is also cultivated in many such places. Therefore, to control agriculture water demands, it is essential to review the cropping patterns, particularly at places where annual rainfall is below or annual pumping from groundwater exceeds recharge and yet high water-consuming crops such as sugarcane and paddy are being grown.

Long-distance water transfer:

- India also faces substantial spatial mismatch between demand and supply as the places where water is needed and those where it is available are frequently far apart. A viable and tested way to overcome spatial supply–demand mismatch is by transferring water from surplus regions to deficit regions by way of long-distance water transfer. This requires construction of reservoirs to store surplus water and transfer links (canals or pipes) to move water.
- Interbasin water transfer involves both technical and non-technical problems. Experiences with projects such as Ken–Betwa and others show that technical matters are comparatively easy to solve; difficulties lie in resolving water-sharing, political and funding issues. In addition to long-distance water transfer, short-distance water transfer may also to investigated since here the expenditure, gestation period and opposition will not be much less.

Recycle and reuse:

- Any resource that is provided free is commonly wasted, water being no exception. Hence it is important to charge the users for the water supplied, covering the cost of providing services, with expenditure for maintenance of facilities and some amount for future expansion. All the water supplied should be metered.

Managing floods:

- To satisfactorily manage floods, a range of actions is required. High flows likely to cause damage which may be temporarily stored in reservoirs and subsequently released at lower rates. A number of storage reservoirs have been created in India to control floods – Hirakund, Rihand, Tehri, and so on.

Conclusion:

Challenges in water resource management arise due to a range of causes – technical, socio-political and financial. Political will to urgently and firmly address the issues is necessary to find and implement the solutions. Creation of additional water storage capacity to ensure full utilization of the utilizable surface water resources potential of 690 bcm, ensures long-term sustainability of finite groundwater resources, and ensure proper operation and maintenance of water infrastructure with active participation of farmers/consumers.

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NOTES

SET-3: QUESTIONS

AGRICULTURAL RESOURCES

Q1. Discuss the problems and prospects of dry-zone agriculture in India and highlight schemes for its development.

Q2. Describe the factors that have contributed to the increase in cotton cultivation in Punjab despite the unfavourable soil and climatic conditions.

Q3. Pulse cultivation in India has witnessed a shift from northern and eastern states to southern and central states. Give reasons for this and also suggest ways to increase pulse production in India in the light of increasing pulse prices.

Q4. Why are North Eastern states preferred for palm cultivation in India? Discuss the government's measures to support this.

Q5. Analyze the prospects of plantation agriculture in India.

Q6. Compare and contrast the concept of Agro-Climate and Agro-Ecological Zoning. Which one do you think is better for agricultural planning in our country?

Q7. Agriculture production can be increased by reducing prevailing knowledge deficit of latest agricultural technologies with the farmers. Discuss the statement along with the steps taken by Government of India (GOI) for reducing knowledge deficit.

Q8. Do you think India need new 'White Revolution'? What are the scope and challenges in this endeavour?

Q9. Critically examine the need for Rainbow Revolution in India.

Q10. Critically examine the role of infrastructural and institutional factors in the recent transformation of Indian agriculture.

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SET-3: ANSWERS

1. Discuss the problems and prospects of dry-zone agriculture in India and highlight schemes for its development.

(200 words)

Approach

1. **Briefly introduce dry-zone farming** ***(30 words)***
2. **How its development is helpful for India** ***(60 words)***
3. **Discuss the problems and measures associated with it** ***(50 words)***
4. **Schemes launched by the government for its development** ***(40 words)***
5. **Conclusion** ***(20 words)***

Hints

Dry zone farming is meant rain-fed agriculture in regions where the environment is dry because of limited rain-fall and absence of adequate irrigation facilities and where only such crops are grown which are amenable to dry conditions. The limit has been set at 750mm isohyets Dry land farming areas have been distinguished from absolutely arid or desert part (with an average annual rainfall (375mm), Where areas having a relatively assured and higher rainfall (1125 mm and above) on the other hand. There are 128 districts in India which have a low to medium rainfall and very limited irrigation facilities. Dry land area accounts for 89.69 percent of the net cultivated area in Maharashtra, 87.7 percent in. M.P 82 percent in Gujarat, 81.2 percent in Rajasthan and 81.2 percent in Orissa.

Cropping in dry land is said to be gamble with monsoon. Crop production in dry land area is very low. Unstable and uneconomic yield to abnormality and uncertainty of monsoon rains. Even though, due contribution from dry land toward the national basket is only 47 percent. Its share in the production of millets, coarse cereals, pulses oil seeds and raw cotton is significant.

Development of agriculture dry land is required:

- To increase food grain production to ensure national food security. It is estimated that crop production in non-irrigated area can be trebled by introducing indigenous dry land farming technology.
- Correction of regional and nutritional imbalance.
- Potential of generating greater employment opportunities.

- Restoring ecological imbalance.
- To bring stability in production.
- Finally for industrial development.

Unlike the irrigated farming, the dry land agriculture has many constraints starting with-climate, soil, crops and socio-economic condition.

- Rainfall is the crucial factor among climate parameter having great influence on the crop to be grown. The rainfall is not only low but 'erratic, unpredictable and distributed in short period in rain-fed areas.
- The soils in dry land show great diversity in texture, Structure, depth, type of clay and organic matter content.
- The currently cultivated dry land crops are not stable. Also the present cultivations are not tolerant to drought, nutrient, status, pests and diseases and other soil related constraints hampering crop - cultivation.
- Majority of dry land farmers are very poor and economically unsound. This is due to non-availability of basic resources like inputs at a reasonable rate.
- Lack of infrastructural facility.
- Lack of credit.

The infrastructural support necessary for promoting dry land farming should given emphasis on the following:

- Soil and water conservation measures to effectively utilise the erratic, uneven and uncertain monsoon rain
- Selection of suitable tolerant early maturing crop varieties and it should be of high yielding varieties (HYV)
- Use of moderate level of fertilizer, plant protection, chemical etc.
- Stability and sustainability in farm income.
- Providing irrigation facilities.
- Provision of adequate infrastructure, particularly in communication marketing and storage facilities.

Thus in order to increase and stabilise agriculture produce:

- Dry zone agriculture has been included as part of 20 point programme.
- Special schemes have been drown up for the purpose. In order overcome the element of risk, the national strategy for the development of dry zone agriculture give better water management practices. The aim to reduce the runoff and maximize the seepage of rainfall into soil layers, so that the soil moisture is available to the development of dry land areas.
- Holistic approach for integrated farming system development on Watershed basis in rain fed areas would be main pursuit of the development activities under the National Watershed Development Project for Rain fed Areas (NWDPRA) is the 8th Plan. The projects aim is to achieve twin objectives:
  - Sustainable production of biomass; and
  - Restoration of ecological balance in the vast rain fed areas of the country.
- Other govt. sponsored several schemes such as the **Integrated Rural Development Programme, the Drought Prone Area Development Programme, the Food for Work and Employment Guarantee Programme, etc.** are launched to improve the lots of the rural poor in the dry land area. These programmes have infused some economic stability but the fundamental problems have remained unsolved.

- Dry land farmers can be moderated only by the introduction of quick-maturing crops, new technique, soil mixture conservation, animal based activities and small scale industries. The international Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Central Avid Zone Research Institute (CAZRI) has taken up some of these issues.

2. Describe the factors that have contributed to the increase in cotton cultivation in Punjab despite the unfavourable soil and climatic conditions.

(200 words)

Approach

1. **Give a brief description of the crop cultivation** ***(40 words)***
2. **Discuss the factors that have contributed to the increase in cotton cultivation in Punjab despite the unfavourable soil and climatic conditions** ***(120 words)***
3. **Conclusion** ***(40 words)***

Hints

Cotton is the crop of tropical and sub-tropical areas.

- **Condition for growth:**
- It requires uniformly high temperature varying between 21°C and 30°C. The growth of cotton is retarded when the temperature falls below 20°C.
- It is grown in areas having at least 210 frost free days in a year.
- The modest requirement of water can be met by an average annual rainfall of 50- 100 cm.
- Moist weather and heavy rainfall at the time of boll-opening and picking are detrimental to cotton as the plant becomes vulnerable to pests and diseases.
- High amount of rainfall in beginning and sunny and dry weather at ripening time are very useful for a good crop.
- Cotton cultivation has increased in Punjab despite the unfavourable soil and climatic conditions (the climate is adverse at sowing season with high temperature and the growing period is limited to six months (May to October) because of following factors:

Fertile alluvial soils,

- Close network of irrigation facilities, hence the productivity is higher than the other zones.
- Heavy dose of fertilizers and pesticides are available
- Enterprising spirit of the farmers.
- Being irrigated

3. Pulse cultivation in India has witnessed a shift from northern and eastern states to southern and central states. Give reasons for this and also suggest ways to increase pulse production in India in the light of increasing pulse prices.

(200 words)

Approach

1. **Briefly introduce , Why Pulse cultivation in India has witnessed a shift from northern and eastern states to southern and central states** ***(80 words)***
2. **Suggest measures to increase pulse production in India in the light of increasing pulse prices** ***(80 words)***
3. **Conclusion** ***(40 words)***

Hints

India has not been able see a net increase in land under pulses cultivation since the 1960s. Though land under pulses cultivation has seen an increase in southern and central India, the gains made have been neutralised by the loss in cultivated area in the Indo-Gangetic belt. As a result pulse production did not see a major boost for a large part of the past 60 years.

- After introduction of high yielding, short stature, photo and thermo-insensitive varieties of wheat and rice in sixties, the entire agricultural systems of country witnessed a change. The low productive, risk prone legumes and oil seed crops were diverted on marginal and fragile land of dry areas, whereas the cereal based multiple cropping systems covered irrigated areas in North.
- The reason behind the decline in pulses production in the northern states is improved irrigation facilities, which allowed these states to grow water-intensive crops, such as rice and wheat. These crops also give assured returns because they are procured by the government.
- Southern states, which were mostly rain-fed and where irrigation facilities are not good, started growing pulses. Development of heat tolerant varieties, such as JG11 (a chickpea variety), also helped.
- Increasing production of pulses in the country can happen either by increasing land under pulses cultivation or by using better quality seeds. But there are major structural issues and demand-supply gaps. There is another major reason-centralised seed production. States in India had their own seed farms catering to regional demands.
- Cropping patterns should be developed according to the local conditions. The government needs to make production of pulses lucrative. Unlike rice and wheat, the government does not procure pulses, leaving farmers dependent on the vagaries of the market. If the government decides to start procuring pulses, it would give a big boost to production. It should be made a part of the public distribution system (PDS).
- The market supply chain of pulses is quite long and unorganised-farmer to small traders, commission agents, wholesale dealers and retailers before reaching consumers. In this process, the profit margin of farmers shrinks. This needs to overhaul according to the demand and supply and decent profit to the farmers.

4. Why are North Eastern states preferred for palm cultivation in India? Discuss the government's measures to support this.

(200 words)

Approach

1. **Briefly introduce palm cultivation** ***(40 words)***
2. **Discuss the reasons why North Eastern states are being pushed for palm cultivation** ***(100 words)***
3. **Government's measures to support this** ***(60 words)***

Hints

Palm oil/palmolein constitutes about 80 per cent of all edible oil imports. To reduce its import bill on edible oils, which is estimated close to US $10 billion, government of India is building capacity for local production.

Reasons why North Eastern states are being pushed for palm cultivation are:

- **Geographical factors:**
- **Suitable climate:**
  - Best growing conditions for palm trees exist in a small band around the equator, limiting the number of places the crop can be successfully farmed. These regions coincide with the rainforest zones. Palm requires humid weather throughout the year which might be provided by India's north east naturally unlike the irrigated cultivation in AP.
  - Fertile land, abundant water resources, dependable rainfall and vast biodiversity the north-eastern region holds tremendous potential on the agricultural front.
  - Not only is palm oil the cheapest vegetable oil in the world, but from a farmers perspective, it is also perhaps the most rewarding, with yields of four to six tonnes of crude palm oil per hectare
- **Policy and government's push:**
  - Government support In Mizoram, the government has instituted a New Land Use Policy (NLUP) vowing to stamp out "wasteful shifting cultivation" and replace it with settled agriculture, especially oil palm monocultures.
  - In palm cultivation harvesting occurs all the year-round, producing a continuous supply of oil this can provide alternate source of employmentin these states.
- **Economic reasons:**
  - With rising competition over finite agricultural land among different crops, only higher productivity can bridge the demand-supply gap. The answer is oil palm that produces 4-6 tonnes of crude palm oil and 0. 4- 0. 6 tonnes of palm kernel oil per hectare during its productive lifespan of 20 years, compared to a yield of less than 1 ton per hectare from other oilseeds. This also gives palm oil a distinct price advantage
- **Government measures:**
- Although India's Oil Palm Development Programme (OPDP) dates back to 1991, it is only recently (2011) that the government has begun to seriously view oil palm as important to India's edible oil security and is aggressively pushing for increased cultivation under the **Special Programme on Oil Palm Area Expansion (OPAE).**

- The OPAE has budgeted Rs 300 crore to expand oil palm cultivation by 600 km2 in 12 states over five years.

- The government has announced a package of 10, 000 crore over three years, which is intended to support farmers until the trees begin to yield. The government has identified nine States with suitable climatic conditions including north east.
- The government also allowed 100 per cent FDI in palm oil plantations
- In a relatively recent development, Rs 3, 507 crore were sanctioned to **National Mission on Oilseeds and Oil Palm in 2014.**
  - One of the aims of this scheme is bring 125, 000 hectares of area under oil palm cultivation through area expansion.
  - Nineteen states are a part of oil palm expansion plan, of these seven Mizoram, Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland and Tripura are from India's northeast.
- Most recently, Ruchi Soya Industries Ltd signed a **Memorandum of Understanding (MoU**) with Arunachal Pradesh government to development oil palm in 25, 000 hectares in four districts of the state.

Way Forward:

- India must insist that all oil palm cultivation conforms at least to **Roundtable on Sustainable Palm Oil (RSPO) standards.**
- The need is to establish appropriate checks, balances and punitive measures for socially disruptive and ecologically destructive practices. In this process, consultations with local communities, state governments and social and environmental scientists is essential, rather than limiting policy formulation simply to the central agricultural ministry.

5. Analyze the prospects of plantation agriculture in India.

(200 words)

Approach

1. **Briefly introduce what are plantation crops, their status and issues related to them** ***(50 words)***
2. **Discuss the economic importance of plantation crop & present scenario of it in India** ***(100 words)***
3. **Suggest some measures** ***(50 words)***

Hints

The term Plantation crops refers to those crops which are cultivated on an extensive scale in a large contiguous area, owned and managed by an individual or a company. The crops include tea, coffee, rubber, cocoa, coconut, areca nut, oil palm, Palmyra, cashew, cinchona, etc. These plantation crops are high value commercial crops of greater economic importance and play a vital role in our Indian economy. The main drawback with this sector of crops in India is that major portion of the area is of small holdings (except Tea) which hinder the adoption of intensive cultivation. In the case of coffee 97.13 per cent of the growers have holdings below ten hectares and in Rubber, 82 per cent of the total area is of small holdings having an average size of 0.5 hectares.

The Economic Importance of these Crops is:

They contribute to national economy by way of export earnings. These crops occupy less than 2 per cent of the total cultivated area (i.e., 3.82 per cent of total crop land) but they generate an income of around Rs. 16,000 million or about 12.72 per cent of the total export earnings of all commodities or 75 per cent of total earnings from the export of agricultural produces.

India is the leading country in the total production of certain plantation crops in the world. For instance, our production meets the share of 47 per cent in tea and 66 per cent in each of cashew and areca nut.

Plantation industry provides direct as well as indirect employment to millions of people. For instance, tea industry offers direct employment to and indirect employment to 10 lakh people, while-cashew processing factories alone provide employment to 3 lakhs people besides 2 lakh farmers are employed in cashew cultivation.

Plantation industry supports many by-product industries and also many rural industries. For example, coconut husk is used to produce coir fiber annually to a tune of 2,19,600 tones in India.

These crops help to conserve the soil and ecosystem. Tea planted in hill slopes and cashew in barrel and wastelands protect the land from soil erosion during the rainy season or due to heavy winds.

Area of Plantation Crops in India:

- The area and production is more in Kerala (1073000.7 ha and 4359000.9 MT) followed by Karnataka (679000.2 ha and 1401000.0 MT), Tamil Nadu (503000.0 ha and 3810.6 MT), Andhra Pradesh (289000.0 ha/and 1021000.2 MT).
- But, in India, plantation crops have been continuously facing the problem of lack of investment and depressed yields, and are in great need of modernisation. Their total coverage is comparatively less and they are mostly confined to small holdings.
- Adequate cold storage facilities are available for just about 10 per cent of India's horticulture production. Of the total annual production, 30-40 per cent is wasted before consumption. During the peak production period, the gap between the demand and supply of cold storage capacity is a mind-boggling 25 million tonnes.

The steps needed are:

- Ensure an end-to-end holistic approach, having backward and forward linkages, covering production, post harvest management, processing and marketing to assure appropriate returns to growers/producers.
- Promote R&D technologies for production, post-harvest management and processing.
- Enhance acreage, coverage, and productivity through:-
- Diversification from traditional crops to plantations, orchards, vineyards, flower and vegetable gardens.
- Extension of appropriate technology to the farmers for high-tech horticulture cultivation and precision farming.
- Set up post harvest facilities such as pack house, ripening chamber, cold storages, Controlled Atmosphere (CA) storages etc, processing units for value addition and marketing infrastructure.

- Adopt a coordinated approach and promotion of partnership, convergence and synergy among R&D, processing and marketing agencies in public as well as private sectors, at the National, Regional, State and sub-State levels.
- Thus, the Government of India has identified some prominent crops as high-value crops of great economic importance. It is taking all possible steps and initiatives to commercialize the sector. Tea, coffee, rubber and coconut industries are providing greater business opportunities to the investors worldwide.

6. Compare and contrast the concept of Agro-Climate and Agro-Ecological Zoning. Which one do you think is better for agricultural planning in our country?

(200 words)

Approach

1. **Compare and contrast the concept of Agro-Climate and Agro-Ecological Zoning** ***(70 words)***
2. **Which one do you think is better for agricultural planning in our country** ***(70 words)***
3. **Conclusion** ***(60 words)***

Hints

An ecological region is characterized by distinct ecological responses to macro - climatic as expressed in vegetation and reflected fauna and equatic systems. Therefore an agro-ecological region is the land unit on the earth surface covered out of agro-climatic region, which it is super imposed on land form and the kinds of soils and soil conditions those act as modifiers of climate and LGP (Length of growing period).

Within a broad agro climatic region local conditions may result in several agro - ecosystems, each with its own environmental conditions. However, similar agro ecosystems may develop on comparable soil, and landscape positions. Thus a small variation in climate may not result in different ecosystems, but a pronounced difference is seen when expressed in vegetation and reflected in soils.

An “Agro-climatic zone” is a land unit in terms of major climates, suitable for a certain range of crops and cultivars. The planning aims at scientific management of regional resources to meet the food, fiber, fodder and fuel wood without adversely affecting the status of natural resources and environment.

Agro-climatic conditions mainly refer to soil types, rainfall, temperature and water availability which influences the type of vegetation. An agro-ecological zone is the land unit carved out of agro-climatic zone superimposed on landform which acts as modifier to climate and length of growing period.

Planning Commission in 7th Plan (1985-1990) divided the country into 15 ACZs based on physiographic and climate:

- Western Himalayan Region
- Eastern Himalayan Region
- Lower Gangetic Plains Region
- Middle Gangetic Plains Region
- Upper Gangetic Plains Region
- Trans-Gangetic Plains Region
- Eastern Plateau & Hills Region
- Central Plateau and Hills Region
- Western Plateau and Hills Region
- Southern Plateau and Hills Region
- 1East Coast Plains and Hills Region
- 1West Coast plains & Hills Region
- 1Gujarat Plains & Hills Region
- Western Dry Region
- The Island Region

- However, the government of India was not satisfied with the classifications done so far. It further entrusted ICAR to prepare an agro-ecological region map of the country based on the parameters (rainfall, temperature, vegetation, potential evapo-transpiration) which form the "Bio-climate" and parameters (rainfall, potential evapotranspiration, soil storage) which constitutes the "Length of the Growing Period" (LGP) and parameters (soils and physiographic) which form the "Soil or Land Scape."
- Physiographic features, soil characteristics, bio-climatic types (rainfall, potential evapotranspiration, soil storage) and length of the growing period. Based on the 4 parameters India is divided into **20 agro-ecological regions.** On the basis of research support from these classifications it can be said we shifted to the agro-ecological zones as they classify land better than the agro-climatic zones.

7. Agriculture production can be increased by reducing prevailing knowledge deficit of latest agricultural technologies with the farmers. Discuss the statement along with the steps taken by Government of India (GOI) for reducing knowledge deficit.

(200 words)

Approach

1. **Briefly introduce the Agriculture production in India** ***(40 words)***
2. **Discuss the reasons behind the low inputs due to lack of technological knowledge** ***(60 words)***
3. **Discuss the statement along with the steps taken by Government of India (GOI) for reducing knowledge deficit** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

India has about 45 per cent of its total area under cultivation while the world average is 10.7 percent. The output per hectare, which is a common measure of agricultural productivity, remains low for many crops when compared to many other countries. There are also large regional variations within the country. Reasons include low and faulty input uses, poor access to modern technology and no real technological breakthrough in recent times.

- Despite the presence of national level institutes like IARI involving in strategic research and state agricultural universities engaging in education & extension services there exist huge knowledge deficit of latest agricultural technologies with the farmers.
- The illiteracy & backward socio-economic status of Indian farmer has also been responsible for his inclination towards the traditional methods of agriculture.
- So, the solution lies in increasing productivity of agriculture which is largely a function of the advancement in technology & knowledge with the farmers.

In this context, the steps taken by the GOI to reduce the knowledge deficit of farmers are as follows:

- The **setting up of KrishiVigyanKendras** to work in a holistic approach with agriculture, horticulture and other sister departments in the district for effective delivery of the technology and inputs in an effective way.
- Promoting **Community Radio station** for agriculture and rural development in PPP model. Community radio, Call centres and Mass media to be harnessed for wider dissemination of best practices.
- The government launched **SMS based weather information system** for farmers to make informed choices about cultivation.
- Launching of **DD Kisan** as the channel dedicated to agriculture and related sectors to disseminate real-time inputs to farmers on new farming techniques, water conservation and organic farming etc.
- The establishment of **village based farm schools** supervised by government.
- Setting up of central and satellite **farm production training institutes in each state** to train and certify farm school instructors. Agricultural graduates and lead farmers to be certified as instructors and offered incentives for establishing private farm schools to train local farmers. Multimedia training materials to be developed for training farm school instructors and for farmer training.
- Farm schools to be linked **to Rural Knowledge Centres** to provide access to multimedia training materials, computerized expert systems, and web-based technical and marketing information.
- Development of **national database on pests and diseases** to enable farmers to choose need based technologies.

Thus to bring the awareness about technologies following steps should be taken:

Government and research institutes should endeavour to embark on enlightenment campaign on the usefulness of these technologies, that is, the source of information to farmers should be increased.

Pre-test of these technologies should be carried out in the areas where they are to be introduced. This will help the research institutes to relate the relevance of their technologies to the target area.

The research institutes should endeavour to send out agents from time to time to get the view of the farmers on technologies being promoted.

The needs of farmers should be assessed before any technologies are introduced to them as this would enable the researchers to know better the farmer needs.

Livestock, crops and equipment that are traditionally used by farmers should be made the basis of new technologies, as this would entice the farmers to use what they are already familiar with.

8. Do you think India need new 'White Revolution'? What are the scope and challenges in this endeavour?

(200 words)

Approach

1. **Briefly introduce the 'White Revolution'** ***(40 words)***
2. **Discuss the need for a new 'White Revolution'** ***(60 words)***
3. **Discuss the challenges** ***(60 words)***
4. **Steps taken by the government** ***(40 words)***

Hints

The white revolution in 1970s catapulted India from a milk deficient nation to largest producer of milk and in the process achieving inclusive growth co-operative sector and ensuring food security. However new challenges and new opportunities have emerged in the dairy sector which have the possibility of transforming the dairy sector and making Indian agriculture growth more sustainable and entrepreneurship driven. This demands a new 'white revolution'.

Need for a new 'White Revolution'

Though India has become the largest milk producer of the world but new dynamics are evolving which mark the layout of the 'new white revolution', which are:

- As Indian urbanization level increases and demographic and economic profile changes there is going to be greater demand for processes animal fats.
- The quality standards of the milk products are not up to the world class level and many instances of food adulteration have been found.
- The foreign trade of Indian diary sector is limited.
- There is a need to extend the white revolution to the eastern sector and especially north-east India.
- The level of processing in the dairy sector is limited to nearly 30%, which is very low as compared to western countries.
- The white revolution of 1970s was achieved with the help of co-operatives, but after the liberalization of 1991 large number of private sector companies have been established and driving the sectors growth there is a need to strengthen the regulatory mechanism to ensure that milk producers, consumers interest are protected and small entrepreneurs are promoted.

A whole set of challenges remain in this regard:

- The productivity of Indian livestock is very low as compared to global standards.
- Animal rearing in India is practiced as ancillary activity and most of the farmers have small number of cattle. This increases the cost of milk collection.
- The feed, fodder for animals is not available sufficiently. India has 16% of world cattle but just 0.5% of world's pasture land. With increasing urbanization, industrialization these lands are further under stress.

- Certain areas like Eastern states, Andhra Pradesh contribute very minimal to the milk collected.
- The tropical climate makes Indian livestock vulnerable to health problems.
- The credit and insurance penetration in the sector is low.

However, government is seized of the situation and has taken a number of steps in this regard, some of them like:

- A new scheme "RashtriyaGokul Mission" has been initiated for the first time in the country under which 18 Gokul Grams in 12 different States are being set up.
- Also, two awards 'Gopal Ratna Award' for upkeep of the best dairy animals of indigenous breeds and 'Kamdhenu Award' for institutions maintaining best herd of indigenous breeds. This year on World Milk Day 10 Gopal Ratna and 12 Kamdhenu awards have been awarded.
- Two "National Kamdhenu Breeding Centers" one each in Andhra Pradesh and Madhya Pradesh are being setup for conservation of indigenous breeds. In these centers 41 cattle and 13 buffalo breeds would be conserved.
- In order to make dairy business more profitable "National Bovine Productivity Mission" has been in initiated with creation of e Pashuhaat portal. This is playing an important role in linking milk producers and breeders for indigenous breeds.
- Union Agriculture & Farmers' Welfare Minister further said that a scheme titled Dairy Processing & Infrastructure Development Fund (DIDF) for dairy cooperative sector has been initiated with an outlay of Rs.10881 crore. This scheme would focus on creation of additional milk processing infrastructure and chilling infrastructure through setting up of Bulk Milk Coolers.
- Also, provisions have been made for providing Electronic milk adulteration testing equipment and facilities for manufacturing value added products.
- Vaccination programme for foot and mouth disease are being conducted.

Though these efforts are laudable a set of new steps like:

- Making co-operatives work more professional as competition from private sector is increasing.
- Making Indian dairy sector entrepreneur driven so as to make it capable of taking on global industry.
- Incentivizing the setting of animal feed plants and sourcing best practices from developed countries
- And clubbing all these initiatives under new name of 'New White Revolution' with special attention to eastern India, as it will bring greater collaboration and awareness.
- With six lakh villages housing about 90 crore people, dairying is not just a large economic activity but also an integral part of our social and cultural heritage. The transformation of this sector can help in building New India which is much more healthy, equitable and prosperous.

9. Critically examine the need for Rainbow Revolution in India.

(200 words)

Approach

1. Briefly introduce What is Rainbow Revolution ***(50 words)***

2. **Discuss the importance of it in maintaining food security and impediments related to it** ***(100 words)***

3. **Conclusion** ***(50 words)***

Hints

India attained food security in 1982 with cereals production stabilizing around the annual requirement of the population. It was a milestone in national history. However, India has to look beyond excelling in one particular domain and should focus on crops diversification which includes main crops, cereals, milk, fish, fruits and vegetables, and poultry and meat and so on, to achieve comprehensive growth.

The rainbow revolution was first announced as part of national agricultural policy 2000 and its objective is to bring a broader change in both production and consumption pattern of Indians, while earlier agricultural revolutions aimed at increasing production in the respective sectors. While there has been an emphasis on controlling the calorific malnutrition and lack of proteins in diet. The micro-nutrient deficiencies have assumed public health importance in children, over 50 per cent of apparently healthy (at par or above normal weight) children have sub-clinical deficiencies of Vitamin A, B2, B6, folate and Vitamin C. Iron deficiency remains a major nutritional problem among infants and children. Other micro-nutrients that have found a focus lately include zinc, copper and Vitamin B12. Thus, diversifying the food consumption basket away from cereal dominated diet is an important way to deal with the micro-nutrient deficiency. Thus, a focus on production of fish, fruits and vegetables, and poultry and meat is very important.

However, the focus of rainbow revolution should not only be at increasing the production, but also to create an overall infrastructure and environment towards increased consumption and price stability as it is good for both farmers and consumers. It is not that we do not produce enough of fruits and vegetables but, much of it, almost 30 per cent of vegetables, fruits, and fish especially, goes waste as we do not have the required post-harvest technology and skill to process, package, transport, and market them. While farmers in south routinely dump tomatoes on the highways to protest dip in prices, potato growers in Uttar Pradesh turn their potatoes into manure by not extracting them when production exceeds the demand. Similarly, on the other side, whenever there is slight dip in production or even the doubt regarding the same, the prices suddenly double and quadruple, creating problems for the consumer. This problem is there, because of the very small shelf life of these products compared to grains and cereals.

The problem is not merely regarding the absence of cold storages. It is also about the insufficient development of the food processing industry. Thus, unless food processing industry develops sufficiently, it would be difficult to meet the objectives envisaged by the rainbow revolution. Similarly, a renewed focus on the transport sector is required as for fast perishable commodities, reducing transport time; especially loading and unloading time is key, which is infrastructure dependent. Thus, the farm productivity, though a necessary factor, is not sufficient and requires intervention in many other areas and a coordinated policy for the successful implementation of Rainbow Revolution.

10. Critically examine the role of infrastructural and institutional factors in the recent transformation of Indian agriculture.

(200 words)

Approach

1. **How infrastructural and institutional factors influence Indian' agriculture** ***(50 words)***
2. **Examine the role of infrastructural and institutional factors in the recent ransformation of Indian agriculture.** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Apart from physical factors, the infrastructural and institutional factors have strongly influenced the Indian' agriculture, bringing about a remarkable transformation. Changes and improvements in infrastructural and institutional factors have given the Indian agriculture a modem outlook, enabling it to change from underdeveloped subsistent type to commercial and market oriented intensive agriculture production system.

Infrastructural Factors: It is because of developments in infrastructural factors that the previous dependence of one crop farming to double cropping has been replaced by multiple cropping patterns which led India to become self sufficient in Rice and other agricultural production. These factors include irrigation, fertilizers, seeds, farm machinery and financial-institutions, etc

- **Irrigation:** Irrigation assumes much importance in view of scanty rainfall in many parts, of the country erratic-rainfall else-where and failure of monsoon some years. Irrigation not only helps to extend the net sown area in areas of inadequate rainfall but it also promotes multi-cropping by making it possible to raise a second crop in the dry seasons. Area under irrigation has registered a threefold increase, from a mere 18.8 million hectare in 1950-51 to 57 million hectare now which is 40% of net cropped area.
- **Fertilizers:** The new agricultural strategy also improves the way in which the inputs are effectively combined and agricultural operations managed so as to get maximum returns. Specifically, the new agricultural technology encompasses the use of high yielding variety seeds fertilizers, manures, pesticides, machines etc. Of the various components of agricultural technology, use of fertilizer is most important in boosting agricultural production and productivity. Introduction of HYV s and hybrid varieties brought optimism about fertilizer response superiority of modern varieties.
- The increased use of chemical fertilizers is attributed to factors such as:
- Compensating the adverse effects of a decline in per-capita arable land
- Meeting the deficiency of soil arising out of various forces including intensive cultivation of land in all the different regions in the country and
- Exploiting the prevailing potential for higher use of chemical fertilizers and the need for its exploitation in Indian agriculture.
- **Seeds:** Prior to 60's farmers were using traditional poor quality seeds which-yielded very low returns. High Yielding Variety (HYV) of seeds, introduced under Green Revolution programme, not only help in increasing production by 10 to 20%, but also have some special qualities such as quick maturing, insect/pest resistance, drought resistance etc.
- Regional disparity in use HYV seeds is also reflected in agricultural Production Punjab and Haryana with developed agriculture have 88% and 75% respectively of their area under HYV seeds while Assam (15%) and Orissa (12%) lag far behind

- **Power:** Power is required for irrigation, especially in energizing pump sets agriculture operations in many farm equipments. Again states like Punjab and Haryana who consume 30%- and 40% respectively of their power in the agricultural sector are agriculturally most developed.
- **Importance of farm mechanization:** The efficiency of mechanization can be judged from the fact that modern plough is about 200 to 300 % efficient than indigenous plough, efficient machinery helps in increasing productivity by about 30% besides, enabling the farmers to raise a second crop or multi crop making the Indian agriculture attractive and a way of life by becoming commercial instead of subsistence. There is a need to double the food production by 2020. This will call for raising more crops in a year thus limiting the turnaround time. Increased production will require more use of agricultural inputs and protection of crops from biotic and abiotic stresses. This will call for greater engineering inputs which will require development and introduction of high capacity, precision, reliable and energy efficient equipment.
- **Credit and insurance:** peasants need credit for a variety of purposes like purchase of seeds, fertilizers, electricity, implements etc. Improved credit facility through co-operatives.,, commercial banks, regional rural banks and NABARD have transformed the Indian agriculture by freeing it from the exploitative tendencies of money lenders and traders. However the reach of this facility is very limited.
- Thus these infrastructural and institutional factors have transformed the nature and characteristics of Indian agriculture to a great extent. Agriculture was in deplorable condition characterized by old unscientific farming methods and very little use of modern techniques, improved seeds, fertilisers, pesticides, machineries, etc.

Institutional Factors

- **Development of food-processing industry:** Given the high growth and value addition in the sector, it contributes hugely to agriculture by providing fairly high prices for agricultural products and also reliving the pressure on central government to purchase the products on MSP. It provides a mechanism to bring farmers, processors and retailers together and link agricultural production to the market so as to ensure maximization of value addition, minimize wastages and improve farmers' income.
- **Contract-farming:** Contract farming has emerged as one of the biggest institutional support for farmers. Whether this system leads to egalitarian-distribution of farm income is a matter of debate, but it has increased agricultural productivity for sure.
- Examples: 'e-chaupal' initiative by ITC in Madhya Pradesh, which has provided highly successful and has also lead to emergence of brand like, AashirvadAata, on the lines of Amul, although it is by private sector. It has lead to digitalization of 'Mandi System' (agricultural markets) in India and also to overall development through modern infrastructure. Similarly, PepsiCo India in respect of potato, tomato, groundnut, and chili in Punjab, Safflower in Madhya Pradesh, oil palm in Andhra Pradesh, seed production contracts for hybrids seed companies etc. which helped the growers in realization of better returns for their produce.

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NOTES

SET-3.1: QUESTIONS

AGRICULTURAL RESOURCES

Q1. Examine the impact of advanced agricultural technologies on the environment. Support your answer with examples.

Q2. Do you think the increase in Minimum Support Prices (MSP) for farmers and waiving off their loans will solve the problem of agriculture distress? What other steps would you suggest in this regard?

Q3. What do you mean by Soil Quality? How does soil get deposited over the time? How Soil Health Card Scheme does aims to rejuvenate the nutrient status soil?

Q4. What are the reasons behind water scarcity in India? Even though India has many dams, rivers to provide irrigation to the fields, farmer suicides is a never ending problem especially in dry land farming areas. Why? What are the compelling steps needed to be taken?

Q5. More than 2/3rd of Indian agriculture is dependent on erratic Indian monsoon. Discuss the importance of soil moisture map, water productivity mapping of Indian crops and role of institutions such as Revitalizing Rainfed Agriculture (RRA) Network in improving Indian agriculture.

Q6. Explain social and agro forestry. Can they be utilized as a form of economic empowerment in the rural sector?

Q7. From both economic and environmental perspectives, Organic Farming can be the optimal choice. Comment. How is government of India promoting Organic Farming through its policies?

Q8. Despite dual pressure of increasing population and expansion of net sown area, India's forest cover has increased by 1% but contributes meagerly 1.7% of Indian GDP. Critically analyze reasons behind low contribution of Indian forestry to Indian GDP and existing framework for trade in forest products?

Q9. "Location of Indian Islands in tropical regions provides India an alternative to substitute its palm oil import from domestic production". Critically analyze India's dependency on palm oil and possibility of cultivation in the fragile ecosystem of these Islands.

Q10. In this era of climate change, which has distorted our weather pattern, millets come as a redeemer for farmers. Discuss the factors that make millets more sustainable as crops. Also, elucidate the challenges and strategies to increase production of these crops in India.

SET-3.1: ANSWERS

1. Examine the impact of advanced agricultural technologies on the environment. Support your answer with examples.

(200 words)

Approach

1. **Briefly introduce the advanced agricultural technologies** ***(100 words)***
2. **Discuss its positive and negative impacts on the environment with suitable examples** ***(100 words)***

Hints

Modern agriculture is an evolving approach to agricultural innovations and farming practices that help farmers increase efficiency and reduce the number of natural resources like water, land, and energy necessary to meet the world's food, fuel, and fibre needs

Advanced agricultural technology includes:

- Efficient and adequate irrigation facilities.
- Chemical fertilizers
- Agricultural mechanization such as tractors, harvesters etc.
- High yielding variety of Seeds (HYV)
- Insecticides and Pesticides.

These advanced framing techniques have brought revolutionary changes in the cropping pattern and farm productivity. It has provided food to the rapidly growing population and raw materials to the agro-based industries.

But the advanced agricultural technology caries some ecological implications also. Widespread use of modern farming inputs has resulted into many environmental problems.

The major ones among these environmental problems are:

- Destruction of forests and pastures for agricultural purposes.
- Salinization and alkalization of soils.
- Water logging
- Soil Erosion

- Pollution
- Lowering of Underground water table
- Reduction in Biodiversity
- Loss of soil fertility
- Health Hazards

These environmental problems are being examined in details which are as follows:

- **Stalinization and Alkalisation:** High yielding variety of Seeds requires increased availability of water which necessitates irrigating of the farms several times. Use of increased irrigation facility especially in the arid and semiarid region results in the capillary action of water and the soil is salinized and alkalinized. More and More use of irrigation which is often not required in that quantity has led to salinity and alkalinity of soil.
- Introduction of Green Revolution in India (especially in the North-western part) has resulted in similar kind of problem. According to one estimate, 50% of agricultural land of Punjab is facing some sort of salinity or alkalinity.
- **Water logging:** Water logging is another problem caused by irrational use of marginal lands for growing water intensive crops such as rice. Water logging apart from making the land unsuitable for farming, also leads to other ecological problems. Water logging and salinization is a serious problem in Indira Gandhi Canal region of India.
- **Soil Erosion:** With the Use of advanced technology, three to four crops are obtained from within a single agricultural year. Ploughing the field so many times coupled with absence of trees result in soil erosion. Intensive ploughing done with the tractors and power tillers leaves the soil loose, thus making it vulnerable to soil erosion. According to one estimate, about 6000 million tonnes soil is eroded every year in India.
- **Pollution:** HYV seed is water intensive requiring assured supply of adequate water along with heavy doses of chemical fertilisers. These chemical fertilisers are adding toxicity in the soil. Moreover the heavy use of insecticides and pesticides are polluting the soil from where these pollutants reach the nearby streams and -rivers through run-offs, there by resulting into water pollution.
- **Excessive use of Pesticide:** There are many pesticides are used for destroying pests and boosting crop production. Earlier arsenic, sulphur, lead and mercury was used to kill pests. For Example- Dichloro Diphenyl Trichloroethane (DDT) content pesticides were used, but unfortunately, it also targeted the beneficial pests. Most importantly, many pesticides are non-biodegradable, which also linked to the food chains which are harmful to human being.
- **Lowering of Underground Water Table**: Nature of tube well irrigation suits more to the advanced agricultural technology since it provides water supply at the desired location, that too at the free will of individual farmer in whatever quantity he wants .There have been reports of lowering of water by four to six feet in the North- Western part of India.
- The unintended environmental consequences of intensive agricultural practices and inputs are varied and potentially severe. In some cases, sustaining or increasing agricultural productivity depends upon reducing impacts to the environment, such as maintaining productive soils by avoiding salinization from irrigation water. In other cases, however, eliminating negative environmental impacts may involve unacceptable tradeoffs with providing food and viable livelihoods, or other development goals.

2. Do you think the increase in Minimum Support Prices (MSP) for farmers and waiving off their loans will solve the problem of agriculture distress? What other steps would you suggest in this regard?

(200 words)

Approach

1. **Briefly introduce the problem of agriculture distress** ***(50 words)***
2. **Discuss Why increase in MSP and waiving of the loans is not the solution** ***(70 words)***
3. **Suggest some measures** ***(50 words)***
4. **Conclusion** ***(30 words)***

Hints

Indian farmers are facing a crisis situation which is reflected in the increasing number of suicides, protests by the farming community for remunerative prices and reservation in jobs. Though government have MSP policy to safeguard the interest of the farmers and sometimes even waive of the loans, however, both of them are unsustainable in long term as the need of the hour is boosting food processing sector with well managed supply chains, which directly links farms to market and assure remunerative prices for farmers.

Why increase in MSP and waiving of the loans is not the solution:

MSP (Minimum Support Price) as a policy instrument of balancing the needs of the producers and consumers was started in 1960s, during Green revolution period when government performed the task of distributer of food.

However, in modern times when government is moving away from the universal procurement and distribution function increase in MSP cannot be implemented on ground, as:

- Only government is bound by MSP and not the private sector.
- If government increases MSP and private players don't buy then it will increase the financial burden of government, which will impact the capital expenditure of the government.
- It also has the potential of distorting the food supply market and may violate the WTO subsidy norms if procurement is more than those needed for food security. This will go against the policy which India has been trying to follow post 1991 reforms.
- Shanta Kumar Committee has said that there is insufficient storage capacity with FCI (Food Corporation of India), increased level of government procurement will create problems of storing of these food grains and leading to wastages.

Frequent loan-waivers also are a problem in itself as:

- They create moral hazard for farmers and incentivize them not to pay in future.
- These steps also dissuade banks not to distribute loans to the farming community, as there always chances of them being waived of and if the farmers are not paying loans the working capital of the banks erode.

- It also is a burden on the state governments as they have to cut their expenditure of certain important items like health, education, women or road building etc., which negatively impact the growth in long term. This was evident in case of Loan waiver by the UP government.

Both of these steps do not take care of all the farming community of India.

- Tenant farmers, women farmers, agriculture labourers are neglected in all these policies.
- Regional imbalances in government procurement on MSP are self-evident.
- Both of these are populist in nature and dissuade policy planners to shy away from the long-term measures which are essential for the agriculture sector.

Some of these long-term steps can be like:

- Increased focus on food processing sector which will help in commercialization of agriculture sector. This will bring greater investment in supply chain management, reduce post-harvest losses and can help in establishing direct links between industries and farmers providing greater income to farmers.
- Smoothing the marketing facility through greater investments in sorting, grading and storage facilities at the agriculture produce market and amending the APMC Act to suit the new times.
- Facilitating all India sales through e-NAM, avoiding distress sale through Negotiable warehouse receipt, providing insurance facility, assured and timely climate advisories, building rural roads etc.
- Helping farmers to diversify to horticulture crops, having stable policies for agriculture trade,
- Liberalizing land leasing, contract farming, reducing cost of farming through affordable mechanization, efficient irrigation etc.
- Government has a host of programmes like RashtriyaKrishiVikasYojana, eNAM, PM Gram SadakYojana, Gramodya se Bharatodaya which focus on holistic development of agriculture sector. However there is a need to focus on their efficient implementation if farming crisis is to be solved.

3. What do you mean by Soil Quality? How does soil get deposited over the time? How Soil Health Card Scheme does aims to rejuvenate the nutrient status soil?

(200 words)

Approach

1. **What do you mean by Soil Quality** ***(50 words)***
2. **How does soil get deposited over the time** ***(60 words)***
3. **How Soil Health Card Scheme does aims to rejuvenate the nutrient status soil** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

- Soil quality is a measure of the condition of soil relative to the requirements of one or more biotic species and or to any human need or purpose. According to the Department of Agriculture Natural Resources Conservation, "Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation."
- Soil quality reflects how well a soil performs the functions of maintaining biodiversity and productivity, partitioning water and solute flow, filtering and buffering, nutrient cycling, and providing support for plants and other structures. Soil management has a major impact on soil quality.
- Soils are the fundamental resource supporting agriculture and forestry, as well as contributing to the aesthetics of a green planet. They are also a base from which minerals are extracted and to which solid wastes are disposed. In addition, soils act as a medium and filter for collection and movement of water. By supporting plant growth, soil becomes a major determinant of atmospheric composition and therefore earth's climate.
- Soils are formed by weathering of rocks due to mechanical disintegration or chemical decomposition. When a rock surface gets exposed to atmosphere for an appreciable time, it disintegrates or decomposes into small particles and thus the soils are formed. Also biotic factors help in development of soil. Animals like earthworms help in burrowing of soil. Cattles ships and human being help in breaking rocks, loosening soil through feet and other work. Added to this, further the water, wind, glaciers acts as main agent of weathering, movement, and deposition of soil.
- But over the time soil going through many processes which affect the quality of soil. Deposits of infertile sand on highly productive silt loam that is high in organic matter and nutrients can significantly decrease the quality of the silt loam. However, soil quality would change little if similar deposits occurred on a sandy soil that had a low content of organic matter, and low levels of nitrogen, phosphorus, and potash. The rate of deposition also affects soil quality.
- Soil degradation is the decline in soil quality caused by its improper use, usually for agricultural, postural, industrial or urban purposes. Soil degradation is a serious global environmental problem and may be exacerbated by climate change. It encompasses physical, chemical and biological deterioration.
- The main reason is soil deterioration. Soil has not only deteriorated in many parts of the country but also has been tendered useless for irrigation. The main reasons for soil deterioration include mindless use of chemical fertilizers, low use of organic matter and non-replacement of depleted micro and secondary nutrients in the soil. Due to all these, the nutrient deficiencies and decrease in soil fertility made farming unproductive.
- For example, green revolution demanded use of chemical fertilizers for increasing production. However, mindless use of fertilizers led the soil in many regions useless for farming. This is mainly because of unwise distortion of the ideal NPK (nitrogen, phosphorous, potassium) proportion (4:2:1). For example, in 2011, the ratio was 19.2:5.5:1 and 20.6:6:1 respectively in Punjab and Haryana. The over-use of Urea is mainly because it comes with a government subsidy. Excessive use of Nitrogen reduces the health of crop and productivity goes down year after year.
- To boost productivity and bring about increased prosperity, it has become necessary to nurture the soil. The Soil Health Card scheme has been launched with this ideal.

- Soil Health card is a report card that provides vital information about the quality of soil by giving comprehensive information about type of soil, nutrient content, fertilizer required, crop suitability to ambient temperature and rainfall condition.
- The **'Soil Health Card'** would carry crop-wise recommendations of nutrients or fertilizers required for farms in a particular village, so that the farmers can improve productivity by using inputs judiciously.
- Awareness of soil health position and the role of manures would help in higher production of food grains in eastern India too and this would help tackle the decline in production in central and peninsular India. The growth in food grains, rice and wheat, from eastern India would provide an opportunity to procure and create food grain reserves locally.
- Thus the Soil Health Card mechanism definitely aims to help herald some essential revolutionary changes and salutary effect in country's agricultural scene. There are actually many path-breaking initiatives associated with the scheme. Under this, the government can help farmers adopt crop diversification. Farmers would understand the fertility factor of the land better and can be attracted towards value added newer crops. This would help reduction in risk in farming and also the cost of overall cultivation process would get reduced.

4. What are the reasons behind water scarcity in India? Even though India has many dams, rivers to provide irrigation to the fields, farmer suicides is a never ending problem especially in dry land farming areas. Why? What are the compelling steps needed to be taken?

(250 words)

Approach

1. **Briefly introduce water scarcity in India** ***(40 words)***
2. **Discuss the reasons behind the water scarcity** ***(60 words)***
3. **Discuss, Why farmer suicides is a never ending problem especially in dry land farming areas** ***(60 words)***
4. **Steps needed to be taken** ***(40 words)***

Hints

Water scarcity:

- Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region.
- The water scarcity is mostly man made due to excess population growth and mismanagement of water resources.
- More than 300 districts in 13 Indian states are grappling with drinking water shortages
- **Reasons behind water scarcity are:**
- A **deficiency in monsoon rainfall** for two successive years resulted in serious water shortages in many states

- **Inefficient use of water for agriculture:**
- Consumption of water for irrigation is amongst the highest.
- Traditional techniques of irrigation cause maximum water loss due to evaporation, drainage, percolation, water conveyance, and excess use of groundwater. As more areas come under traditional irrigation techniques, the stress for water available for other purposes will continue.
- **Excessive cultivation of water-intensive crops** such as rice, wheat and sugar cane has exacerbated the water scarcity. As much as 70% of water delivered through India's limited irrigation infrastructure goes to water sugar cane fields in some states.
- **Massive deforestation** since the 1990s has had a huge bearing on the South Asian monsoon, causing an 18% decline in precipitation over India.
- **Rain water harvesting is patchy in India** so much of the huge amount of water dumped on the country during the monsoon every year just dries up or flows into the ocean.
- Government's **policies are also to blame** for the country's chronic water issues. Its subsidies and price supports encourage the over use of water while it continues to fail to build the nationwide network needed to conserve and distribute water.
- **Reduction in traditional water recharging areas**. Rapid construction is ignoring traditional water bodies that have also acted as ground water recharging mechanism.
- **Sewage and wastewater drainage into traditional water bodies**: Release of chemicals and effluents into rivers, streams and ponds.
- **Lack of on-time de-silting operations in large water bodies** that can enhance water storage capacity during monsoon.
- **Lack of efficient water management and distribution** of water between urban consumers, the agriculture sector and industry.
- The problem has been compounded with **increased concretization due to urban development** that has choked ground water resources.

Why are there more farmers' suicides in dry farming areas?

- The country witnessed **two straight years of severe drought in 2014** and 2015, with central Indian states the worst-hit. Official sources said the agrarian crisis was worsened due to **deficient rain** continuing in 2015 as farmers suffering from the previous drought could not recover.
- Dependence of farmers in Marathwada and other areas on **water-guzzling cash crops** such as sugarcane has been cited as one of the reasons for the distress
- In Karnataka **increased compensation to the next of kin of farmers** who commit suicide have been cited as reasons for the spike in suicide rate in the state
- In places like Vidharbha which is home for approximately 3. 4 million cotton farmers and 95% of these are **struggling with the massive debt**.
- Majority of suicide cases are from **cotton growing areas**. The cotton farmers in India paying more prices for inputs like seeds, pesticides, fertilizers, electricity, water, and labour whereas the price of cotton has gone down along with decreased productivity.
- **Absence of adequate social support infrastructure** at the level of the village and district
- Since long time, **Indian farmers have been facing a number of socioeconomic problems**, such as harassment by moneylenders, inability to repay debts following crop loss, inability to get medical treatment for the family, etc. The problem is compounded by lack of positive and cooperative support from banks especially in the face of inclement weather and market fluctuations.

- In **Maharashtra** the reasons for such a pathetic state of farmers include below average rainfall, heavy load-shedding, lack of small irrigation projects, poverty, pressure of private moneylenders and banks.
- The **promotion of But-cotton since 2006** has, however, increased the capital cost incurred on cotton production exponentially.
- Imbalance in water distribution is part of the policy neglect the region has been facing from the ruling political classes.
- The ground reality is that majority of the farmers in India own as little as two acres of land. **Cultivation on such small area is not economically feasible.** Such small farmers have become vulnerable.

Inadequate storage facilities:

- ASSOCHAM estimates that each year 30-40% of the entire agricultural produce in India is damaged because there are not enough cold storages. In monetary terms, this translates to INR 35, 000 crore
- Most of the subsidies and welfare schemes announced by the Central and State governments do not reach the poor farmers. On the contrary, only big land lords are benefited by those schemes

Facts:

- In a country of 70 million farmers, it is 10 in every 100, 000 farmers committing suicide.
- Farmer suicides in the country spiked by over 40 per cent between 2014 and 2015. While 2014 saw 5, 650 farmer suicides, the figure crossed 8, 000 in 2015, government sources told.

Measures needed are:

- Urgent need for **increased public awareness among farmers** regarding agricultural policies both financial and those extended by the government
- **Marketing and storage infrastructure** will have to be built.
- **New crop patterns** that answer to emerging needs will have to be introduced.
- Better rural credit delivery system will have to be evolved.
- **Self-help grou**ps need to be encouraged.
- The government should promote the plan called "**ulavarsanthai"** (Farmers Market), where the farmers can directly sell their products at reasonable price to theconsumers.
- Need to implement **strict measures to prevent land grabbing**.
- **Multiple crops**
- Cultivation of multi crops such as coconut, turmeric, pine apple, banana, apple, papaya, ginger will yield profitable results to the farmers.
- **Special agricultural zone**
- Just like industrial zone, there is an urgent need to establish special agricultural zones, where only farming and agriculture related activity should be allowed.
- **Need to modernize agriculture**

- By introducing farm techniques which guarantee a definite success, an increase in youth participation on agricultural fields is economically possible.
- This can be attained only by implementing new technologies. Research efforts should continue for the production of crops with higher yield potential and better resistance to pests.
- Technological advancement in agriculture should be passed down to the small farmers.
- **Need for meaningful crop insurance policies**
- Crop insurance is must and the claim should be settled easily under the supervision of the district collectors.
- In most cases, **it is not the lack of water but the lack of proper water management** that causes water shortage. Improved modern methods of rain water harvesting should be developed.
- **Alternate source of income for farmers**
- Small farmers should be encouraged to develop alternative sources of income and the government should take up the responsibility for providing training to the farmers to acquire new skills.
- In drought affected areas, the government should start alternative employment generation programs to reduce the dependence on agriculture as the sole source of income. Such programs should be standardized.
- **Need for national weather risk management system/disease alert system**

5. More than 2/3rd of Indian agriculture is dependent on erratic Indian monsoon. Discuss the importance of soil moisture map, water productivity mapping of Indian crops and role of institutions such as Revitalizing Rainfed Agriculture (RRA) Network in improving Indian agriculture.

(150 words)

Approach

1. **Discuss briefly state of India's irrigation sector in agriculture and inter-regional disparity in terms of availability and expenditure on water resources.** ***(20 words)***
2. **Discuss the role of initiatives such as soil moisture map, water productivity mapping of Indian crops and role of institutions such as Revitalizing Rainfed Agriculture (RRA) Network in improving Indian agriculture.** ***(60 words)***
3. **Briefly underline the challenges faced by agriculture sector in India in terms of overuse of water resources** ***(50 words)***
4. **Conclude with importance of initiatives by government which has exclusively focused on irrigation.** ***(20 words)***

Hints

India has been constantly facing drought in recent years due to erratic monsoon which has affected is agricultural productivity to a large extent. 60% of the Indian farmers are dependent upon rainwater for irrigation. Despite poor state of these farmers government spends 20 times lesser on irrigation infrastructure of these areas. Due to lack of irrigation facilities farmers of these areas get 40% less income as compared to those farmers of area having canal and tank irrigation. This regional disparity shown by agricultural atlas has drawn government's attention and signifies importance of institutions such as Revitalizing Rainfed Agriculture (RRA) Network.

Importance of different institutions and initiatives in improving Indian agriculture

- Findings of institutions such as Revitalizing Rainfed Agriculture (RRA) Network will help government to make policies related specific areas such as rain fed areas. It will also help government to analyze policy gap in funding these areas.
- India has got its first soil moisture map developed using hydrological model. This map has been prepared by analysis of moisture in soil across India which has culminated various factors such as soil, vegetation, land use, land cover and rainfall data of a region.
- Owing to vast and diverse nature of Indian mainland, these data will help to formulate tailor made solutions for specific regions and will help policy formulation on the basis of agro-ecological or agro-climatic zones.
- These data will also be helpful in identifying techniques for land management, command area development, water conservation e.t.c for different areas.
- Similarly, 'Water Productivity Mapping of Major Indian Crops' will provide amount of rainfall and water required for different crops. It will provide a roadmap to farmers to grow particular crops in specific areas.
- Unethical raising of water intensive crops such as sugarcane in Anantpur district of Andhra Pradesh and Marathawada region of Maharashtra has caused lowering of water table.
- The report also highlights the overuse of water in different parts of India and optimum amount of water required for specific crop.

Challenges faced by agriculture sector due to overuse of water for irrigation

- More than 80% of the water resource is utilized by agriculture sector alone in India which is very high.
- Farmers of water scarce regions grow water intensive crops such as sugar cane and paddy, which causes scarcity of drinking water in related areas.
- Flood irrigation for crops such as paddy and unethical pumping out of water has reduced the ground water level in India, which is dangerous for a country like India.

Conclusion:

Owing to dependence of 67% of population of the country on agriculture sector and large rural population, it becomes evident to use water optimally. There have been different initiatives by government such as " Per Drop, More Crop" , which aims to promote drip irrigation, 'Command Area Development Programme', and promotion of dryland farming by schemes such as 'Millet Village Scheme' has promoted sustainable use of water. These steps will help India to achieve sustainable development goals such as Responsible Consumption and Production (Goal 12) and availability of clean water (Goal 6) apart from meeting domestic commitments such as supply of clean drinking water to every household.

6. Explain social and agro forestry. Can they be utilized as a form of economic empowerment in the rural sector?

(150 words)

Approach

1. **Define the term - social and agro forestry** ***(20 words)***
2. **Analyse if social and agro forestry can be gainfully utilised for boosting economic empowerment in the rural sector.** ***(60 words)***
3. **Discuss the Challenges of economic empowerment in the rural sector** ***(50 words)***
4. **Conclusion** ***(20 words)***

Hints

Agro forestry is any sustainable land-use system that maintains or increases total yields by combining food crops (annuals) with tree crops (perennials) and/or livestock on the same unit of land, either alternately or at the same time, using management practices that suit the social and cultural characteristics of the local people and the economic and ecological conditions of the area. Pastureland- It helps in managing land efficiently so that its productivity is increased and restored.

Social forestry refers to the management and protection of forests and Afforestation on barren lands. Lands are managed with the help of local village communities. These communities take care of forests and can also utilise forest resources to some extent for fulfilling their own needs and requirements. Conceptually Social forestry deals with poor people to produce goods such as fuel, fodder etc. to meet the needs of the local community particularly underprivileged section.

Can social and agro forestry be utilised for boosting economic empowerment in the rural sector.

- Agricultural activities have been kept outside taxation system. Hence, there is a lack of concerted effort by either the government or the private sector in bringing any large scale capital.
- Land reforms are long due. Since there are nearly 86% of the marginal farmers, economics of scale is seldom used. Cost of input weighs much higher than output income.
- Due to sheer size of Sarva Shiksha Abhiyan and emphasis on rural literacy, the youth now is educated but not skilled enough to be gainfully employed in large scale industries. Hence, there is a great availability of manpower, what is required is to match the need of rural economy with the needs of the land and its people.
- Here, agro forestry should be promoted to help diversify the income of the farmers and also help increase skill sets of the cultivators. The youth can take farming activity like pest management and create avenues of entrepreneurship.
- Social forestry can help the landless get some secured source of fuel, fodder etc. to meet their immediate needs. This can help them acquire better skill sets and take other vocational roles than heavily relying on agri labour works.

Challenges of economic empowerment in the rural sector.

India's agricultural and rural sector has gone through massive reforms with both input and output subsidies being an important part of the government budget. But the crisis in this sector has perpetuated despite a seven decade or so journey since independence.

- Unemployment
- Poor educational standards
- Poor Infrastructure
- Inequality has risen rather than decreased.
- Inefficient agriculture
- Inequality within regions

The yield of crops in India is far lower than potential yield or that of several other countries. The allied sector too suffers from several constraints. For example, dairy is a very important economic activity which spurred a white revolution but though India is a world leader in milk production, the quality of breeds is mainly indigenous which have low milk yielding capacity.

Added to this is shortage of green fodder, improper veterinary care and poor supply chain. The success of Amul has been achieved not by mass production but production by masses which helped small and marginal farmers to reap the benefit of economies of scale in marketing.

Conclusion:

Social and agro forestry are tools and not panacea of economic empowerment in the rural sector. Tax reforms, skill building exercise, farm activity diversification and roping in of SHG are pre-requisites before these tools can be put to gainful use.

7. From both economic and environmental perspectives, Organic Farming can be the optimal choice. Comment. How is government of India promoting Organic Farming through its policies?

(250 words)

Approach

1. **Introduce with definition of organic farming.** ***(30 words)***
2. **Discuss the economic and ecological benefits of Organic Farming under separate headings covering multiple dimensions.** ***(150 words)***
3. **Discuss the policies of government of India promoting the Organic Farming.** ***(40 words)***
4. **Conclusion** ***(30 words)***

Hints

Organic farming is a type of agriculture that avoids the use of synthetic fertilizers, pesticides, and other chemical inputs. Organic farming systems relies on crop rotation, crop residues, animal manures, legumes, green manure, biofertilizers, biopesticides etc.

Economic benefits of Organic Farming

- **Reduced Production Cost:** By switching to organic farming, conventional farmer can actually reduce **its production cost by over 25%** as compared to the cost of conventional farming. And organic products command higher prices among the health conscious buyers from developed countries. **Thus, farmer's income is improved.**
- **Decreased subsidy burden**: It'll curb the excessive demand of Urea. Government's **subsidy burden will decline**. The public money thus saved could be used for other developmental activities.
- **Decrease in fertiliser import**: For Potash fertilizer, India is 100% import dependent. For Urea production, we've to import natural gas. Organic farming will reduce their imports, and thereby **improve our balance of payment (BoP) and reduce our current account deficit (CAD).**
- **Health benefits:** Organic food has variety of health benefits. It will lead to decline in **malnutrition, improved life expectancy**, **decreased disease burden, improved labour productivity, improved Learning outcomes** and so forth.
- **Special economic relevance for North Eastern Region:** NE's niche crops like Assam lemon, Bhut Jolokia pepper, Joha rice, medicinal rice and Passion fruits have high market for their medicinal properties. If 'organic' tag is also attached, their prices and demand will further improve, thus NE-states' economic prosperity can improve. It'll create the enabling atmosphere for food processing companies specializing in the "Organic Value Chains". This will improve the **investment and direct & indirect employment in the region.**

Ecological benefits of Organic Farming

- **Crop Residue Burning (CRB)** in Punjab and Haryana results into heavy air pollution, smog and respiratory ailments in Delhi. If these states become "organic", farmers will be encouraged to turn crop residues into manure and animal feed instead of burning.
- Organic farming relies upon heavy demand of compost and manures. So, state government will be forced to optimize the urban municipal waste collection & treatment processes. Thus, less environmental pollution from landfill sites.
- Organic farmers enrich the soil with biofertilizers (Azospirilium, Azotobacter, Mycorrhiza fungi, Rhizobia) and earthworms. These **worms, bacteria and fungi improve the soil structure and soil's water-holding capacity**. Such 'good' soil helps preserving biological diversity.
- Rampant use of pesticides, e.g. **"Endosulphan" pesticide,** leads to variety of physical, mental and genetic disorders among the residents. Aerial spray of pesticides even harms the fishes and wildlife. Such crisis can be averted through the use of biocontrol agents and biopesticides instead of artificial pesticides.
- Organic farming strictly controls veterinary medicines so that no traces of banned chemicals are found in its milk, cheese, fish, prawns etc. exports. As a result, **Diclofenac, Ketoprofen** and other banned drugs will not be used in treating cattle. Thus, it'll indirect **prevent the death of vultures and scavengers** who eat dead carcasses of cattle.
- Since organic farmers can't use chemical pesticides, they rely on biocontrol agents such as **lady beetles, wasps, snakes, owls, sparrows and cats. People's respect for wildlife increases**, and it helps in protecting the food chain and food web of an ecosystem.
- No use of chemical fertilizers. So, agriculture run-off water is free of excessive amounts of nitrates and phosphates. Thus, lakes, rivers and other waterbodies will be **less vulnerable** to **algal blooms** and associated ecological problems.

The Government of India is promoting organic farming through various schemes like

- National Project on Organic Farming (NPOF)
- National Horticulture Mission (NHM),
- Horticulture Mission for North East & Himalayan States (HMNEH)
- National Project on Management of Soil Health and Fertility (NPMSH&F)
- Rashtriya Krishi Vikas Yojana (RKVY)
- Network Project on Organic Farming of Indian Council of Agricultural Research (ICAR).

Conclusion:

Our ability to feed the world is intertwined with the environment and ecosystems. With proper management, organic farming could contribute to global food security agriculture without significantly affecting yields, as well as producing a wider array of foods.

8. Despite dual pressure of increasing population and expansion of net sown area, India's forest cover has increased by 1% but contributes meagerly 1.7% of Indian GDP. Critically analyze reasons behind low contribution of Indian forestry to Indian GDP and existing framework for trade in forest products?

(250 words)

Approach

1. **Discuss briefly expansion of Indian forest according to ISFR, 2017 and diverse nature of Indian forest products.** ***(30 words)***
2. **Analyze reasons behind low contribution of Indian forestry to Indian GDP and Existing framework for trade in forest products.** ***(120 words)***
3. **Discuss initiatives to be taken to institutionalize forestry and multiple advantages for government and tribal areas.** ***(70 words)***
4. **Conclusion** ***(30 words)***

Hints

According to India State of Forest Report (ISFR), 2017, India has recorded a one percent jump in overall forest and tree cover between 2015 and 2017 despite population and livestock pressures, even as the green footprint in the northeast region shrunk by 630 square km. Total forest cover has been recorded at 24.39 percent of the geographical area of the country. India produces a range of processed forest (wood and non-wood) products ranging from sawnwood, panel products and wood pulp to bamboo, rattan ware and pine resin. Diverse nature of Indian forest produces hundreds of Minor Forest Produce (MFP) which includes bamboo, canes, fodder, leaves, gums, waxes, dyes, resins and many forms of food including nuts, wild fruits, Honey, Lac, Tusser, herbal medicinal plants etc. Despite all these advantages, Indian forest yield meagerly 1.7% of Indian GDP.

Reasons behind low contribution of Indian forestry to Indian GDP

- Lack of Institutionalization of Indian forestry is the biggest hurdle in sucking out revenue from this sector.
- Although Minor Forest Products are allowed to be collected by tribals under 'The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006', it has not been regulated.
- Smugglers use the act as a shield to procure valuable forest produce from forest dwellers at low price and sell them to pharma companies at high price. This leads to loss of revenue to state.
- There is need of strict monitoring of trade of forest produce in domestic and international market to ensure the revenue to the state.
- Illegal trafficking of forest products such as red sanders and other valuable timber to be checked and a national framework should be brought to ensure sustainable use of forest resources.

Existing framework for trade in forest products

- Forest Act, 1927 gave preference to timber production and logging for revenue generation but the decrease in forest cover and biodiversity raised concerns, and in 1988 the National Forest Policy (NFP) was formulated, which put timber logging secondary to biodiversity conservation.
- There was a complete ban by an order of Supreme Court in 1996 on the unregulated felling of trees or timber logging in government forest areas, except those in which a working plan was prepared by the state government and approved by the central government.
- However, forest remained the only source of timber and thus cleared illegally without any revenue generation for the state.
- Government of India has provided for Minimum Support Price to a number of 'Minor Forest Products' , collected by tribals to ensure fair price for them.
- Forums such as TRIFED (The Tribal Cooperative Marketing Development Federation of India) help the tribals to earn maximum for their collected forest products.

Initiatives to be taken to institutionalize forestry

- Guidelines must be made to institutionalize forestry and strict regulation on trade of timber, Minor Forest Produce, Herbal Medicine e.t.c should be done.
- There must be rules and regulations adhering to felling of dried and non-green trees, collection of gums, resins, leaves e.t.c for industrial use so that revenue should be generated for the state.

Conclusion:

Steps taken by Indian government to put essential forest products such as bamboo out of tree category is appreciable. It has now been kept in Minor Forest Produce Category and has also been included in Minimum Support Price list. Similarly, tendu leaves which is used for making cigarettes and bidis has been included in MSP list. These steps will ensure fair price for tribals and purchasing companies will pay revenue to state in form of different taxes. Enhancing regulation mechanism for forest produce will not only help India to eradicate poverty in unprivileged areas but will also help to attain multiple sustainable development goals.

9. "Location of Indian Islands in tropical regions provides India an alternative to substitute its palm oil import from domestic production". Critically analyze India's dependency on palm oil and possibility of cultivation in the fragile ecosystem of these Islands.

(250 words)

Approach

1. **Briefly discuss the palm oil consumption and imports in India and opportunities with India to grow it in its tropical areas.** ***(50 words)***
2. **Discuss India's dependency on palm oil import and opportunities with it to promote cultivation and challenges posed by its cultivation.** ***(150 words)***
3. **Conclude with need of sustainable cultivation of palm oil considering the fragile eco-system, biodiversity and presence of PVTGs.** ***(50 words)***

Hints

India imports significant portion of its domestic edible oil requirements from other countries. Palm oil both crude and refined palm oil constitutes larger portion of its import bill, which it imports from south-east Asian countries such as Malaysia and Indonesia, which are located in the tropical region. Indian Islands especially the Andaman and Nicobar Islands is located in tropical region at about 6° 45' N to 13° 45' N latitude. It can cater the demands of the India's edible oil if cultivation of the palm oil is carried out in these islands. But, fragile ecosystem of these islands prevents India from implementing its policies.

India's dependency on palm oil import and opportunities with it to promote cultivation

- India is the largest importer of Crude Palm Oil with an annual average imports of approximately 50 lac MT.
- India imports bulk of its palm oil requirement from Indonesia. Palm oil being the cheapest among the edible oil segment is widely consumed among the Indian household.
- This leads India to pay heavy import bill despite the fact that it can grow palm trees in Andaman and Nicobar Islands.
- India started cultivation of palm in Andaman and Nicobar Islands in 1979. In 1979, the agriculture department of the union territory sanctioned the first oil palm plantation project over 2,400 ha in Little Andaman to Andaman and Nicobar Islands Forest Plantation and Development Corporation (ANIFPDC) to implement it in a phased manner.
- However, it was stopped by central government in 1986 owing to fragile ecosystem of the Island.
- Further in 2002, Supreme Court ordered to stop monoculture of Palm in Andaman and Nicobar Island.

Challenges posed by palm tree cultivation to these Island

- Monoculture of the palm severely impacts the biodiversity of the region as other flora and fauna are wiped out due to it.

- Secondly, tropical evergreen forests if cut once can't be grown again due to which the area is turned into a desert.
- Thirdly, these Islands are inhabited by vulnerable tribal groups who have their own culture and traditions and are isolated from the mainstream society. Economic activities in these Islands will lead to external interference in their lives.

Conclusion:

Although cultivation of palm oil is banned in these Islands owing to various factors, centre has planned to revive oil palm plantation and the Indian Institute of Oil Palm Research has conducted feasibility study. In 2019, Andaman and Nicobar Administration approached Supreme Court to lift ban on palm cultivation. However, these steps will help India to cater its oil needs and fulfill its ambitious target of net zero import of palm oil but at the same time environment and biodiversity concerns of the Island groups must be taken into consideration owing to lives of Particularly Vulnerable Tribal Groups (PVTGs) and strategic location of the Islands.

10. In this era of climate change, which has distorted our weather pattern, millets come as a redeemer for farmers. Discuss the factors that make millets more sustainable as crops. Also, elucidate the challenges and strategies to increase production of these crops in India.

(250 words)

Approach

1. **Briefly introduce with importance of millet and mention resolution adopted U.N. General Assembly in this regard** ***(50 words)***
2. **Explain the factors that make millets more sustainable as crops** ***(75 words)***
3. **Challenges and strategies to increase millet production in India** ***(75 words)***
4. **Conclusion** ***(50 words)***

Hints

Today, a lot of efforts are being put to increase the demand of millets in India and the world, including changing the mindset of the people. The U.N. General Assembly adopted a resolution, sponsored by India declaring 2023 as the International Year of Millets. The resolution is intended to increase public awareness on the health benefits of millets and their suitability for cultivation under tough conditions marked by climate change.

Factors that make millets more sustainable as crops

Climate-resilient crop

- Known as C4 crops, millets are highly efficient in absorbing and using carbon dioxide. Most varieties of millets are well known for their hardiness and have the capacity to withstand prolonged periods of drought, high temperatures and still produce grains and fodder.

- A crop that can grow in areas with less than 350mm of rainfall and with a cultivation cycle completed within 70-100 days, has resulted in farmers in dry regions of Chitradurga, Dharwad, Tumakuru, Chamraj Nagar, Mandya and Raichur witnessing a millet revival. Farmlands in these districts are being planted with the small millet family, which includes Foxtail Millet, Brown Top Millet, Little Millet, Kodo Millet, Barnyard Millet and Finger Millet.

Low inputs required

- Farmers prefer to shift to small millets, which help them adapt to climate change, and give an assured yield of around 8-10 quintal per acre with low input costs.

Assured yield

- Increasingly erratic rainfall patterns and crop losses due to climate change factors has forced farmers who were following to conventional agriculture to return to sorghum, little millet and foxtail millet cultivation, having realised that this crop is much more resilient to environmental stress, gives an assured yield in both low and excess rainfall conditions, while keeping input costs low.

Health benefits of millets:

- Millets are nutritionally superior to wheat & rice owing to their high protein, fibre, vitamins and minerals like iron content.
- Millets are also rich in calcium and magnesium.
- Millets can provide nutritional security and act as a shield against nutritional deficiency, especially among children and women.
- Its high iron content can fight high prevalence of anaemia in India women of reproductive age and infants.
- Millets are also rich in antioxidants.
- Millets can help tackle lifestyle problems and health challenges such as obesity and diabetes as they are gluten-free and have a low glycemic index.

Challenges in increasing millet production in India

- Wheat has gluten proteins that swell and form networks on adding water to the flour, making the dough more cohesive and elastic. The resultant chapattis come out soft, which isn't possible with millets that are gluten-free.
- India has seen a jump in consumer demand for ultra-processed and ready-to-eat products, which are high in sodium, sugar, trans-fats and even some carcinogens.
- With the intense marketing of processed foods, even the rural population started perceiving mill-processed rice and wheat as more aspirational.
- In rural India, the National Food Security Act of 2013 entitles three-fourths of all households to 5 kg of wheat or rice per person per month at Rs 2 and Rs 3 per kg, respectively, thus reducing the demand for millets.

Suggestions to increase millets production in India:

- Millets can withstand high temperature. In times of climate change Millets are often the last crop standing and, thus, are a good risk management strategy for resource-poor marginal farmers.
- Help Indian millet farmers get decent revenues by capitalising on their crop and getting international recognition.

- The government should implement various schemes to increase millets production.
- Generating awareness about efficacy of millets will create a demand pull which will ultimately push farmers to produce more millets.
- Incorporate nutrition and processing qualities into cultivation process.
- Boosting research activities to enhance production.

Conclusion:

There is no doubt that a rapid shift in the cropping pattern and eating habits incorporating millets in today's population is vital. Since India, which supports more than 15% of the world's population but only has 4% of its water resources, promotion of millets is the need of the hour. If proper initiatives are taken at an early stage, the adverse effects of climate change can be mitigated and perhaps, a healthy atmosphere could be created where there will be food security so that the coming generation will feel more safe and secure.

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NOTES

SET-4: QUESTIONS

MINERAL & ENERGY RESOURCES

Q1. It is said Most of the Earth's coal made all at once during the Carboniferous period. Discuss.

Q2. Minerals formed in geosynclines are the drivers of the global economy. Elucidate.

Q3. Locate the major mineral belts in India. The story of India's development cannot be written without coal power. Substantiate.

Q4. Renewable energy is emerging as anchor of Indian economic development. What is the spatial distribution of renewable energy resources in India? What efforts have been made to augment these resources?

Q5. What do you understand by energy security? How India should develop its energy mix to assure sustainable energy access to its people? Also discuss the steps taken by government in this direction.

Q6. Critically analyze the role of wind power in India's future energy mix.

Q7. India still relies on coal for 58% of its primary energy needs. The energy consumption and demand in India is not being met by the coal production. Critically analyse on the causes and consequences of this trend.

Q8. Analyse the challenges and constraints faced by coal sector in India?

Q9. Discuss the critical issues involved in realizing the potential of hydropower in India?

Q10. Discuss why some rocks in India are rich in fossil fuel deposits while others are highly metalliferous? Also, explain the factors influencing the relationship between geology and biodiversity.

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SET-4: ANSWERS

1. It is said Most of the Earth's coal made all at once during the Carboniferous period. Discuss.

(200 words)

Approach

1. **Briefly introduce the Carboniferous period** ***(50 words)***
2. **Discuss with example why most of the coal was formed during the Carboniferous period** ***(100 words)***
3. **Conclusion - based on discussion, form a fair and a balanced conclusion on the given issue.** ***(50 words)***

Hints

The Carboniferous is a geologic period and system that spans 60 million years from the end of the Devonian Period 358.9 million years ago (Mya), to the beginning of the Permian Period, 298.9 Mya. The name Carboniferous means "**coal-bearing**". The Carboniferous coal beds provided much of the fuel for power generation during the Industrial Revolution and are still of great economic importance.

Formation of Coal

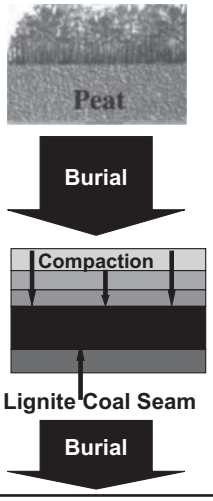
The Formation of Coal Involves Several Steps:

1) Formation of Peat.

- **Swamps are areas where organic matter from plants accumulate. as the plants die and get buried they compact to become peat. with time and more compaction, almost all of the water is lost and three different grades of coal result.**

2) Formation of Lignite Coal.

- **Compaction of the peat due to burial drives off volatile components like water and methane, eventually producing a black-colored, organic-rich coal called *lignite.***
- **Soft brown coal which consist of about 40% carbon and do not burn efficiently.**



Reason behind formation of coal in carboniferous period

- Due to abundance of lignin causes evolution of the wood fiber lignin and the bark-sealing, waxy substance suberin opposed decay organisms so effectively that dead materials accumulated long enough to fossilise on a large scale. Most organisms couldn't eat the tough barks, except for the white rot fungus that lives on dead trees.
- The second factor was the lower sea levels that occurred during the Carboniferous as compared to the preceding Devonian period. This promoted the development of extensive lowland swamps and forests in North America and Europe.
- Another factor was Biotic Evolution in which coal deposits were formed both before and after the Carboniferous as this period provided the mother lode (rich *source of mineral*). It occurred a bit over 300 million years ago and species of club mosses grow to the size of trees. Insects also reached comparatively gigantic proportions due to the higher-than-modern oxygen concentration.
- Due to abundance of oxygen the vast burial of organic material before it could be eaten by oxygen-respiring organisms the atmospheric CO2 fell, eventually leading to glacial conditions. It was a massive carbon-cycle experiment with carbon moving in the opposite direction, from the atmosphere into the ground, where it formed the coal.

Last factor was due to late evolution of bacteria i.e. based on a genetic analysis of mushroom fungi, it was proposed that large quantities of wood were buried during this period because animals and decomposing bacteria had not yet evolved enzymes that could effectively digest the resistant phenol lignin polymers and waxy suberin polymers. They suggest that fungi that could break those substances down effectively only became dominant towards the end of the period, making subsequent coal formation much rarer.

Conclusion:

However, there are objections to the above theory as lignin isn't even the only type of organic matter in Carboniferous-age coals. Thus, all the Carboniferous world's lignin couldn't have made its way into coal and at least some of it must have decayed. In India, the Gondwana coal (about 250 mya) belongs to the carboniferous period. Gondwana coal makes up to 98 per cent of the total reserves and 99 per cent of the production of coal in India.

2. Minerals formed in geosynclines are the drivers of the global economy. Elucidate.

(200 words)

Approach

4. **Briefly introduce geosynclines** ***(60 words)***
5. **Discuss, How it helps to the global economy** ***(100 words)***
6. **Conclusion** ***(40 words)***

Hints

- Mineral deposits are not uniformly distributed in the Earth's crust nor did they all form at the same time. In certain regions conditions were favourable for the concentration of useful minerals.

- Geosynclines are linear trough of subsidence of the Earth's crust within which vast amounts of sediment accumulate. The filling of a geosynclines with thousands or tens of thousands of feet of sediment is accompanied in the late stages of deposition by folding, crumpling, and faulting of the deposits.
- The classic geosynclines is divided into two parts, namely a miogeocline, and a eugeocline which lies to the seaward side.
- The miogeocline is made up of sediments which form the continental shelf. The eugeocline consists of sediments on the continental rise in deeper water some distance offshore.
- In the present scenario its significance can be assessed by the mineral oil accumulated in the continental shelves. Example: Gulf of Mexico.

3. Locate the major mineral belts in India. The story of India's development cannot be written without coal power. Substantiate.

(200 words)

Approach

1. **Give a brief description of the major mineral belts in India** ***(50 words)***
2. **Discuss the significance and importance of coal power in India's development** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

India is endowed with a rich variety of mineral resources due to its varied geological structure. Bulks of the valuable minerals are products of pre-Palaeozoic age. They are mainly associated with metamorphic and igneous rocks of the peninsular India. The mineral resources provide the country with the necessary base for industrial development. Minerals are generally concentrated in three broad belts in India. These belts are

- **The North-Eastern Plateau Region:** This belt covers Chotanagpur (Jharkhand), Orissa Plateau, West Bengal and parts of Chhattisgarh. It has variety of minerals viz. iron ore coal, manganese, bauxite, mica.
- **The South-Western Plateau Region:** This belt extends over Karnataka, Goa and contiguous Tamil Nadu uplands and Kerala. This belt is rich in ferrous metals and bauxite. It also contains high grade iron ore, manganese and limestone. This belt packs in coal deposits except Neyveli lignite. Kerala has deposits of monazite and thorium, bauxite clay. Goa has iron ore deposits.
- **The North-Western Region:** This belt extends along Aravalli in Rajasthan and part of Gujarat and minerals are associated with Dharwad system of rocks. Copper, zinc has been major minerals. Rajasthan is rich in building stones i.e. sandstone, granite, marble. Gypsum and Fuller's earth deposits are also extensive. Dolomite and limestone provide raw materials for cement industry. Gujarat is known for its petroleum deposits. Gujarat and Rajasthan both have rich sources of salt.

- **The Himalayan belt** is another mineral belt where copper, lead, zinc, cobalt and tungsten are known to occur. They occur on both the eastern and western parts. Assam valley has mineral oil deposits. Besides oil resources are also found in off-shore-areas near Mumbai Coast (Mumbai High).
- To enhance the economic growth increasing the installed capacity of power is critical to any nation. In India coal is one of the important minerals which is mainly used in the generation of thermal power and smelting of iron ore.

Significance and advantage of coal in India's development:

- The primary energy consumption in India is the third biggest after China and USA with 5.5% global share in 2016. In India, coal is the bulk of primary energy contributor with 56.90% share equivalent to 411.9 Mton in 2016.
- Coal fired thermal power contributes nearly 50% of India's installed power capacity. About 80 per cent of the coal deposits in India is of bituminous type and is of non-coking grade. The most important Gondwana coal fields of India are located in Damodar Valley.
- India has the world's 4th largest coal reserves. it has abundant coal reserve of nearly 300 billion tones which is easily accessible and is main contributor to energy need as India lacks on petroleum reserves.
- Despite ambitious journey to achieve renewable energy capacity of 175 GW by 2022, the generation from coal will not come down at least for few decades. For existing plants, coal-based generation is the cheapest mode and most affordable [source of] power in the country.
- According to analysts, renewable energy sources and coal will coexist, as the availability of coal is abundant in India and it can provide affordable power to propel India's growth and light every household.
- Successful coal block auction with captive power plants purchased 80% of the coal offered on a five-year contract at an auction at an average premium of 25% over the notified price highlight the importance of coal for energy needs.
- However, challenge with thermal power is generation of huge amount of Green House gases like CO2 which has to be reduced under Paris agreement. The plant load factor (PLF) for India's thermal power capacity has dropped to 52% from 79% in 2007-8. Efficiency is another major challenge. Under INDC India's renewable capacity should be 40% of the total capacity by 2030 but technological breakthrough and high cost is challenge in renewable especially in solar power.

Once the power sector begins to use increasing amounts of power from solar and other renewable sources, then coal can be put to use elsewhere: e.g., coal can be deployed in the manufacture of ammonia and for conversion of ammonia to fertilizer. Thoughts are being channelized now to come up with methods to produce chemicals such as methanol and others of its ilk from coal. So, the significance of coal in near future will still remain high.

4. Renewable energy is emerging as anchor of Indian economic development. What is the spatial distribution of renewable energy resources in India? What efforts have been made to augment these resources?

(200 words)

Approach

1. **Give a brief description of emergence of Renewable energy** ***(50 words)***
2. **Discuss the spatial distribution of renewable energy resources in India** ***(60 words)***
3. **Discuss the efforts made in the field of Renewable energy** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

Energy is the key to development. In fact, the amount of energy production and consumption is sometimes considered as an index of a country's economic development. In recent days due to threat of climate change and increasing pollution from fossil fuel use of renewable energy has gained prominence and countries including India are focusing on increasing the share of renewable energy in their energy mix.

Renewable Energy:

Spatial distribution of renewable energy resources in India:

Wind power:

- The Potential for wind power generation for grid interaction has been estimated at about 1,02,788 MW taking sites having wind power density greater than 200 W/sq. m at 80 m hub-height with 2% land availability in potential areas.
- The wind power potential in India is maximum in coastal states. Gujarat, Karnataka, Maharashtra along the western coast and Andhra Pradesh, Tamil Nadu is the states with major wind energy potential in India.
- In the interior states the state of Rajasthan and Madhya Pradesh are the major potential areas.
- Wind power generation capacity in India has significantly increased in recent years. As of the end of March 2017 the total installed wind power capacity was 32.17 GW, mainly spread across the South, West and North regions, with Tamil Nadu, Rajasthan, MP and Maharashtra being the main utilizers of their potential.

Solar Potential:

- India is endowed with vast solar energy potential. Based upon the availability of land and solar radiation, the potential of solar power in the country has been assessed to be 750 GW. India being a tropical country is abundant in solar energy and it is uniformly distributed across the country, with the major restriction on generation being the land use for different purposes.
- In recent a number of large solar plants have been installed or auctioning has been done and new policy initiatives have been taken.
- As of 30 April 2017, the country's solar grid had a cumulative capacity of 12.50 GW. Region wise Southern, Western and Northern regions have installed nearly 75% of country's potential with Rajasthan, Gujarat, Tamil Nadu, and Andhra Pradesh being the leading generators.

Geothermal Energy:

Geothermal Energy in India in India, exploration and study of geothermal fields started in 1970. The GSI (Geological Survey of India) has identified 350 geothermal energy locations in the country. The estimated potential for geothermal energy in India is about 10000 MW. The most promising of these are

- Himalayas: J&K, HP and Sikkim; PUGA hot spring in J&K and Manikaran in HP.
- Sohna: Haryana, Rajasthan.
- Son-Narmada-Tapi (SONATA): MP, Chhattisgarh and Jharkhand; Tattapani spring in Chhattisgarh.
- Cambay: Mainly Gujarat and some parts of Rajasthan
- Godavari: AP
- Mahanadi: Orissa, Taptapani Spring in Orissa.

Hydroelectricity:

- Diverse topography with mountain ranges, monsoonal climate has bestowed India with plenty of water resources which can be used for generation of hydro-power. India's economically exploitable and viable hydroelectric potential is estimated to be 148,701 MW. An additional 6,780 MW from smaller hydro schemes (with capacities of less than 25 MW) is estimated as exploitable.
- North East region (Brahmaputra River) of India along with Northern states (J&K, Himachal, Uttarakhand) in Himalayan region have majority of the hydro power potential. However significant amount of hydropower potential is available in Peninsular India and has been exploited.

Apart from these new renewable energy resources like bio-fuel resources, hydrogen fuel, tidal and wave energy are being exploited or in developmental phase.

Despite such huge potential India lacked in the exploitation of renewable resources because difficulty in evacuation of renewable (wind and solar) energy, high cost of production and low level of technological development in solar and wind, requirement of land acquisition and displacement in case of hydro power.

However, because of consistent efforts in recent years significant momentum has been achieved in renewable sector.

- The decision to install 175 GW of solar power by 2022,
- Focus on off-grid power component in National Solar Mission.
- Decision to create Green Corridor to evacuate renewable energy.
- Establishment of International Solar Alliance to strengthen international co-operation in solar energy field.
- Initiation of new instruments like Renewable Energy Certificates, Renewable Generation Obligations and Renewable Purchase Obligation, deemed generation status to renewable energy and focus on Solar Parks has helped in increasing the efficiency of renewable energy generation and helped in reduction of the cost of production.
- In light of the immense potential of the renewable sector in bringing balanced regional growth, bringing equity in society, ensuring energy security and sustainable development for India the momentum must be maintained and India must emerge as a leader in renewable sector.

5. What do you understand by energy security? How India should develop its energy mix to assure sustainable energy access to its people? Also discuss the steps taken by government in this direction.

(200 words)

Approach

1. **Briefly introduce energy security** ***(50 words)***
2. **Discuss, How India should develop its energy mix to assure sustainable energy access to its people** ***(60 words)***
3. **Discuss the steps should be taken by the government** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

The IEA defines energy security as "the uninterrupted availability of energy sources at an affordable price". Energy security has many dimensions: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and sustainable environmental needs. Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes within the supply-demand balance. Lack of energy security is thus linked to the negative economic and social impacts of either physical unavailability of energy, or prices that are not competitive or are overly volatile.

Energy Consumption and sustainable energy mix:

- Currently energy mix in installed capacity of power sector is 60% coal based 14% hydroelectricity, 15.9% renewable, 8% natural gas and 1.8% nuclear.
- The primary energy consumption in India is the third biggest after China and USA with 5.3% global share in 2015; however, per capita consumption of energy in India is quite low. India has very low on oil and gas reserves which are.4% and.6% respectively so India has to depend upon imports for its need to fulfil. India imports near 70% of its demand which is expected to increase to 80% in next decade. Though India has significant reserve of coal yet there are mining and logistic issues which hampers its efficient utilisation.
- Due to rapid economic expansion, India has one of the world's fastest growing energy markets and is expected to be the second-largest contributor to the increase in global energy demand by 2035, accounting for 18% of the rise in global energy consumption. Given India's growing energy demands and limited domestic fossil fuel reserves, the country should plan to expand its renewable and nuclear power.
- To reduce its dependence on imported fossil fuels India should focus on renewable sources of energy, nuclear energy and exploration and optimal exploration of domestic energy resources and promote small hydro.
- Target of 175GW of renewable energy resource including 100GW from solar and 60GW from wind is quite ambitious. It would enhance the contribution of renewable energy to near 20% of installed capacity.
- There is focus on nuclear energy; government is trying to achieve 63GW of Installed capacity by 2032.

Steps taken by Government:

- Under INDC submitted in Paris climate agreement, India targeted to achieve 40% share of non-fossil fuel in the total installed capacity by 2030.
- Ultra-Mega solar power projects and canal top solar projects has been planned.
- Establishment of International Solar Alliance's (ISA), which will provide India a platform to showcase its solar programmes, and put it in a leadership role in climate and renewable energy issues globally.
- Near 10,000 Mw of Jaitapur, nuclear power project and 6000 Mw Kudankulam nuclear projects are in different phases.
- Strategic shift towards Natural Gas and Liquefied Natural Gas: The natural gas and Liquefied Natural Gas has emerged as the new frontier for energy supply in India. The government has taken steps for the expansion of gas supply sources and distribution of infrastructure.
- In a major drive to enhance the petroleum and hydrocarbon sector, Government of India has introduced initiatives like the Hydrocarbon Exploration Licensing Policy (HELP), which would provide for uniform license for exploration and production of all forms of hydrocarbon, an open acreage policy, easy to administer revenue sharing model and marketing and pricing freedom for the crude oil and natural gas produced. Thus, promote investment in sector.
- Government is promoting for small hydro projects and off grid solar projects to provide electricity in inaccessible areas through main grid.
- Apart from these India need to take three steps together i.e. diversification of supply sources, acquiring oil fields, and financial hedging-that can help cap India's oil import bill. Government need to take a multi-pronged strategy both in the area of energy demand and supply, along with multiple facets of energy policy including pricing, regulation, distribution and an overseas strategy to obtain secure energy supplies at stable prices.

6. Critically analyze the role of wind power in India's future energy mix.

(200 words)

Approach

1. **Briefly introduce the potential of wind power of India** ***(40 words)***
2. **Challenges Wind energy faces** ***(60 words)***
3. **Discuss the role of wind power in India's future energy mix** ***(60 words)***
4. **Way Forward** ***(40 words)***

Hints

- India has pledged under Paris climate deal that by 2030 40% of India's Energy demand would be satisfied by Renewable energy.
- To meet the target mentioned above Wind energy will have a major role to play. Currently the total wind energy potential in India has been estimated at over 50,000 MW.
- India's wind energy sector has seen significant investments spurred by the development potential, availability of wind farm equipment at competitive prices and conducive government policies.

- With installed capacity of over 21,000 Mw, India is fifth-largest wind power producer in the world after China, US, Germany and Spain. According to Centre for Wind Energy Technology India has potential to install over one lakh mw of wind turbines.
- Being a tropical Country India has a considerable on-shore and off-shore wind potential, particularly in Tamil Nadu and Andhra Pradesh-which is yet to be exploited.

Challenges Wind energy faces:

- Even though Wind energy has the potential to Help India Achieve 40% Renewable energy target, However Wind energy itself is facing number of challenges which needs to be rectified if it has to play a significant role in India's future energy mix. These challenges include:
- In wind power, growth has decelerated in the past three years. Seen as a tax haven, the investment in wind dropped once the government pulled the plug on the accelerated depreciation tax benefit for the sector in 2011.
- There are issues of Land acquisition in India also as solar power farms and wind farms require large amount of land and acquisition of these lands have become difficult after the passage of new Land Acquisition Act.
- Wind potential is unevenly distributed across the country; only Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and Gujarat have significant potential.
- Like other power gear makers, Indian wind turbine makers too are facing competition from Chinese counterparts that also offer cheaper finance to the investors in wind energy.
- Power produced by Wind energy is costly and therefore over-leveraged DISCOMS are unable to buy it.
- Wind power has significant seasonal and even intra-day variations. It may lead to a situation, where either the wind generation cannot be utilized, or when the wind suddenly dies down, thus the loss of electricity generation will impact grid stability and operation.

Way Forward:

- Developing off-grid powered micro-grids have the potential to change the way communities generate and use energy, and can reduce costs, increase reliability and improve environmental performance.
- Aggressively invest in a smart, two-way grid (and micro-grid). Invest in smart meters, as well as reliable networks that can accommodate the two-way flow of electricity. Such networks need to be resilient enough to avoid blackouts and accommodate the advanced power generation technologies of the future.
- If we want to utilize wind potential, we need careful regional level planning and coordination. Hence We need to set up a National Wind Energy Mission, similar to the National Solar Mission for effective formulation and implementation of policies both at the National and State levels.
- We need to complete the Wind capacity addition by other energy sources, which have a quick ramp-up time. For example pumped storage hydro, open-cycle gas turbines, and compressed air and high power density batteries.
- Develop favourable government policies to ease the permitting process, and to provide start-up capital to promote the exponential growth of Wind energy. Create and fund a national smart infrastructure bank for wind energy.
- Hence there is a need to tap wind as source of energy to meet energy requirements of the country and protect the environment from greenhouse gases.

7. India still relies on coal for 58% of its primary energy needs. The energy consumption and demand in India is not being met by the coal production. Critically analyse on the causes and consequences of this trend.

(200 words)

Approach

1. **Briefly introduce the status of coal reserves in India** ***(40 words)***
2. **Discuss Causes and consequences** ***(60 words)***
3. **Suggest measures** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

India has world's fifth largest coal reserves and is the fourth largest coal producer, but still imports almost equivalent to 50%of its total production which undermines energy security and comes along with geo-political risks.

Causes:

- **Geographical:**
  - Majority of areas have drift-origin coal with inconsistent quality and many fault lines which render application of new technology difficult as mechanized extraction is suitable for thick and continuous deposits.
  - The non-implementation of critical rail links to some of the major coal fields has been a major constraint on coal production.
- **Administrative:**
  - The moratorium due to the enforcement of CEPI norms and the introduction of the **concept of 'Go' and 'No-go' areas** for projects in this sector not only resulted in considerable uncertainty for projects already in the pipe line implementation in the coal sector but also slowed down the production of coal from PSU companies.
  - Coal sector has been **faced by increasing difficulty in acquisition of land and related R&R issue**s, delays in obtaining statutory clearances on account of a number of new requirements introduced by the Ministry of Environment in terms of seeking NOC under the Forest Rights Act, 2006, need for submitting DGPS maps, need for seeking stage 1 forest clearance before seeing environment clearance (EC) in the case of a project involving diversion of forest land adversely affected the projected production.
  - Majority of coal production in India is still managed by public sector and private sector is allowed only in captive mining. Lack of competition, scams, presence of coal mafia and trade unions further reduce the production capabilities. 80% share by PSU
  - Mismanagement by DISCOMS - LOSS during transmission and distribution
  - Scrapping of COAL BLOCKS ALLOCATION - by Supreme court
- **Quality:**
  - India has major deposits of low calorific value-non coking bituminous coal making imports a compulsion for efficient power production.

- **Infrastructure**
  - Open pit mines with high labour demand, poor connectivity/high transport costs and lack of R&D in technology suitable to Indian scenario render cheaper imports a better alternative. Alternative source of energy are yet to become cost competitive in India to become a suitable replacement.
  - Over utilization/ineffective harnessing - For instance, Ennore thermal power plant closed down due to exhaustion of coal resources
  - Outdated technologies: Stagnation in the evolution of underground mining technology

Consequences:

- The consequence of this trend is **heavy reliance on import of coal for meeting energy demands** along with the burden of an unsustainable industry with poor utilization of natural resources.
- Threatens India's energy security
- **Burgeoning CAD** hence impacting currency strength and inflation.
- People struggle for electricity still continues especially in core rural areas

Positives:

- Government took proactive measures like district mineral foundations - to address issues of regions affected by coal exploration
- Alternatives to coal are being explored like extraction of coal bed methane which is adsorbed on coal surface, making coal extraction more profitable
- Super critical thermal plants - works at critical temp (water) for better efficiency
- Transparent e-bidding of coal blocks will be done
- Government is trying to increase share of renewable energy from 12 to 14%
- Encouraging private players to buy coal blocks abroad for easy access to bituminous and anthracite for example investment of Adani group in Australia

Way Forward:

- Coal Regulatory Authority Bill, 2013, Mines and Mineral Amendment Bill, 2016 and setting up of NEAMA are few steps in the right direction.
- Another measure that could be taken is of considering allowing captive mines and mines allowed to be operated in the Private sector to mine coal for merchant sale.

8. Analyse the challenges and constraints faced by coal sector in India?

(200 words)

Approach

1. **Briefly introduce the coal sector of India** ***(40 words)***
2. **Discuss the challenges faced by coal sector in India** ***(60 words)***

3. **Future prospects of the sector and steps needed for its improvement** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Coal use currently accounts for more than 50% of total primary commercial energy consumption in the country and for about 70% of total electricity generation. It is likely to remain a key energy source for India, for at least the next 30-40 years, as India has significant domestic coal resources (relative to other fossil fuels) and a large existing installed base of coal- based electricity capacity, although recent experiences have thrown into sharp relief the uncertainties and concerns regarding the adequacy of coal supplies to satisfy the growing hunger for power.

The Indian coal sector faces two key challenges for the future:

- Meeting the high demand for coal, particularly in the power sector
- Resolving current and past environmental and social issues.

Coal production has increased nearly six-fold since the sector was nationalized between 1971 and 1973, with an annual production of 431 MT (raw coal) and 30 MT (lignite) in 2006-07.

The production has been mostly from the state-owned collieries of Coal India Limited (CIL) and Singareni Collieries Company Limited (SCCL) – CIL and SCCL account for about 95% of current coal production.

The demand for coal in the country is expected to continue to increase, especially driven by the power generation sector. Other energy resources are uneconomical (as in the case of naphtha or LNG), have insecure supplies (diesel and imported natural gas), or simply too complex and expensive to build (nuclear and hydroelectricity) to make a dominant contribution to the near-to-mid term growth.

Recent scenario-based projections of coal demand indicate that coal consumption in the power sector could be in the range of 380-500 MT by 2015 end.

Longer-term scenarios have indicated that annual coal consumption by the power sector might range between 1 to 2 billion tons (BT) by 2031-32, with the total coal demand varying anywhere between 1.5 and 2.5 BT.

The increasing demand for coal (particularly for power generation) requires an expansion and speeding up of coal exploration, production, and processing in the country. Although the Indian coal sector does have significant exploration and resource assessment capacity, this capacity is increasingly under strain. The key limiting factors for increasing exploration capacity at present are the limited domestic technological capacity and low availability of suitable human resources.

Further, there has been very little investment for upgrading drilling machines and associated technologies, adapting and deploying new exploration technologies, and carrying out more indigenous exploration R&D.

Expanding production from existing and new mines has been constrained by a lack of investment in underground mining and inability to resolve appropriately socio-environmental problems associated with opencast mining.

Environmental damage from open cast mining is a key constraint for future open cast mining projects, and so many analysts have called for more investments and planning in underground coal production in the country. However, increase of underground mining requires significant new investment in manufacturing and human resources.

Finally, not only is there a high demand for coal, but it is increasingly for consistent, high quality of coal. The quality of coal in India has been worsening over the decades because of increased opencast mining combined with disincentives inherent in the grading structure used to characterize quality of coal.

Therefore, improving coal quality is an important issue, as better and consistent coal quality improves the performance of coal power plants.

9. Discuss the critical issues involved in realizing the potential of hydropower in India?

(200 words)

Approach

1. **Briefly introduce the potential of India for hydro power** ***(40 words)***
2. **Discuss the critical issues involved in realizing the potential of hydropower in India** ***(60 words)***
3. **Suggested measures** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Development of hydroelectric projects has thrown up a number of important challenges, the world over and particularly in Indian context. The issues related to coal sector are:

Major challenges and responses:

Development of hydroelectric projects has thrown up a number of important challenges, the world over and particularly in Indian context. Over a period of time, experiences have been acquired and India is responding to these challenges in the following manner.

- **Impact on environment:** Hydroelectric projects do create environmental issues emanating from submergence of large areas also involving forest. The Govt. of India has a comprehensive legislation on environmental issues and based on this legislation, there are well laid down principles and guidelines.
  - It needs to be ensured that if the forest area is affected, sufficient amount of forest is created. Ministry of Environment & Forest is working on a plan to create Forest Bank which would entail creation of huge afforestation with funding from project development agencies in advance so that this issue could be adequately responded. The mechanism of compensatory afforestation through the Forest Bank will enable quicker clearances of projects.
- **Rehabilitation & Resettlement (R&R) of Project Affected People** (PAP) is another major issue affecting the smooth execution of Hydroelectric projects particularly where in submergence areas, the number of project affected people are large.
  - Govt. of India is contemplating a national policy on R&R for Project Affected People. In cases, where large projects are involved, specific monitoring mechanism has been put in place at senior most level in the Govt. so that proper implementation of R&R plans by project agencies is done in letter and spirit.

- **Another issue of concern is in relation to safety of dams:** Here again, experiences from some of the very large projects of the country have led to considerable amount of knowledge base and it is expected that in future projects, studies and findings on dam safety could provide much higher degree of confidence. Some of the Indian institutions have equipped themselves both with hardware and software to properly address these concerns. Where required, project development agencies do depend on expertise available anywhere in the world for in depth studies and guidance.
- **In view of complexity in development of Hydroelectric projects**, particularly large ones, emanating from dam height, submergence, ramification of submergence, dam safety, drinking water schemes, irrigation, and infrastructure etc., the process of clearances obviously gets linked with multiple agencies and authorities.
- **Construction time is another area of concern,** which needs to be compressed. Large projects have taken inordinately long time. There are two major aspects which could make a difference – one is relating to construction management techniques starting from planning to monitoring and another relate to construction technology.
- Thus, due to the above factors, India is not able to utilise the potential of hydropower sector irrespective of presence of huge amount rive resource.

10. Discuss why some rocks in India are rich in fossil fuel deposits while others are highly metalliferous? Also, explain the factors influencing the relationship between geology and biodiversity.

(150 words)

Approach

1. **Briefly discuss the geographical vastness and diverse rock system of Indian sub-continent.** ***(30 words)***
2. **Discuss the diversity in rocks and mineral of Indian Sub-continent and factors influencing relationship between geology and biodiversity.** ***(90 words)***
3. **Conclude with limitations of rocks in determining the biodiversity of a region and localization of minerals.** ***(30 words)***

Hints

Vast geographical extent of India due to its vast size and varied topography and changes in landforms due to various events in its geological history has caused formation of different types of rock system such as Archean rocks, The Purana Rocks, The Dravidian rocks and the Aryan rock system. All these rocks have been formed at different period of the earth's geological history and has thus different properties and mineral contents. This diversity of rock system in India has also caused evolution of varied biodiversity across Indian mainland.

Diversity in rocks and mineral of Indian Sub-contienent

- The Archean rocks, Gneiss and Schist comprises of mica, talc, hornblende , chlorite e.t.c While mica is used in various industries due to thermal stability and lower heat conductivity, talc is used in cosmetics. These rocks are devoid of metallic ores and crude oil. These rocks have been formed due to eruption of lava from earth's interior in large area during Archean time and are devoid of fossils.
- Hence, these rocks are devoid of sedimentary materials such as coal, limestone and other fossil fuels.
- The Dharwar rock system contains high grade iron ore, manganese, copper, lead, gold, quartzite, slates and mica. Dharwar- Bellary-Mysore belt of Karnataka possess these types of rocks. They are also the part of Archean rock system. These rocks were formed due to metamorphosis of sedimentary and igneous rocks which led to formation of mineral deposits over hundreds of year.
- The Purana rock system also contains valuable minerals and gemstones. The Cuddpah rocks of this origin contain ores of iron, nickel, copper, nickel, cobalt e.tc. While the Vindhyan system of this origin contains precious gemstones such as diamond and ruby but at the same time are devoid of metallic ores or petroleum reserves.
- These rocks are metamorphosed form of sedimentary rocks and hence has reserves of diamond and other gemstones.
- The Gondwana rock system which is part of the Aryan rock System is the most important rock system having 98% of the coal reserves of India and also have rich deposits of uranium, titanium, antimony, and copper. Rich deposit of iron ore is also found in this region.
- Coal is formed due to subsidence of large area of forest under the earth's crust during the Gondwana time.
- Most of the mineral oil deposits are found in tertiary rock system which is youngest of all the rock systems in India. They have formed by the lipids and fats of marine organisms under high heat and pressure under superincumbent load.

Factors influencing relationship between geology and biodiversity

- Rocks form an important part of the biogeography as they are parent materials for soil. Properties of the soil are closely linked to the parent rocks. Hence, different types of soil contain different minerals and hence diverse flora and fauna are supported by it.
- Sugar Cane and cotton cultivation is prominent in the areas of black soil formed due to Deccan trap. Similarly, Karewas of Kashmir Valley which formed due to glaciations during the Pleistocene period is suitable for cultivation of specific crops such as Saffron.
- Khadar and Bhangar which were formed by tertiary rocks are very fertile and suitable for cultivation of diverse crops ranging from maize and millets in Punjab plains to rice in Gangetic plains.

Conclusion:

Rocks in India contain diverse range of minerals which influences the properties of soil and hence the biodiversity of the region to some extent. As biodiversity is not solely dependent upon soil as temperature and rainfall along with other physical factors play an important factor in determining the biodiversity and vegetation of a region. Hence, two different rock systems can also have similar biodiversity. Different rocks belonging to different geological periods in India yield different metallic ores and also contain deposits of mineral oil. However due to superimposed and overlain layers of different rocks in form of layers different minerals belonging to different rocks can be found at single place.

NOTES

SET-5: QUESTIONS

LOCATION OF INDUSTRIES AND TRANSPORT

Q1. What factors are behind the growth and present location pattern of automobile industry in India?

Q2. India's sugar industry is the second largest agro-based industry in India; however, the production of sugar is skewed towards the states like Maharashtra, Tamilnadu, and Karnataka, which are not very suitable for sugarcane cultivation and have been suffering from water shortages. Analyse the reasons behind this trend? What are the problems faced by the sugar industry in India and the possible measures to overcome the crisis?

Q3. Discuss the problems of agro-based industries in India. Do you think agro-based industry could be a better option to absorb shift of labour force from agriculture. What steps has government taken to promote agro-based industries in India?

Q4. The food processing industry in India is not developed as per the resource endowments of different regions, many resource rich areas have practically no industry, whereas some states like Haryana and Maharashtra have high concentration of these industries, despite relatively less resources compared to some other regions. Critically analyze.

Q5. Assess the impact of agro-based industries on cropping pattern in India with example.

Q6. Examine why despite having a long historical tradition, the handicraft industry in India is on a decline? How the government policies related to Agro-based industries can revive the handicraft industry?

Q7. The contribution of Gujarat to India's pharmaceutical and health sectors can be gauged by the fact that this Western State, having only 4 per cent of the country's population, accounts for more than 40 per cent of medicines manufactured in India. Why is the pharmaceutical industry concentrated in the western region?

Q8. Compare and contrast Dairy industry of the tropical area with respect to temperate region.

Q9. Explain the variety and value of tourist resources of India.

Q10. Industrial development is a key for regional development thus economy and geography is interrelated to each other. Illustrate the statement.

SET-5: ANSWERS

1. What factors are behind the growth and present location pattern of automobile industry in India?

(200 words)

Approach

1. **Briefly introduce automobile industry in India** ***(60 words)***
2. **Discuss the factors behind the growth and present location** ***(100 words)***
3. **Conclusion** ***(40 words)***

Hints

The Indian auto industry became the 4th largest in the world with sales increasing 9.5 per cent year-on-year to 4.02 million units (excluding two wheelers) in 2017. It includes all vehicles like commercial, passenger, two wheelers, three wheelers etc. It is an indicator increasing prosperity and also boosts growth by providing mobility.

Locational factors:

- In India, the automobile industry has decentralized locational pattern with presence in Noida, Guru gram, Mumbai, Chennai, and Kolkata. However, this industry is located near to major urban areas across the country. This brings certain critical factors which determine its location:
- **Raw material:** The automobile industry tends to be located near iron and steel producing centres because steel is the basic raw material used in this industry. The proximity of places producing tires, tubes, storage batteries, paints and other ancillary industries is considered to be an added advantage. The location of Chittranjan, Jamshedpur, and Asansol can be categorized under this factor.
- **Market:** generally, nearness to market is considered as important factor to reduce transportation cost. With urban areas as major market centres these are located near to them. For e.g. Guru Gram, Noida to cater to NCR regions.
- **Exports:** with India emerging as major exporter of automobiles to ASEAN and African nations, the port cities or those cities which are connected to ports through rail or road route has emerged as major hubs. Kolkata, Chennai catering to ASEAN, Mumbai catering to Africa are examples of this.

- **Availability of inputs like** power supply, land, SME cluster, and skilled labour has resulted into the concentration of this industry in southern and western states of Haryana, Gujarat, and Ludhiana etc. Land policy of Gujarat was factor for relocation of Tata's Nano unit from West Bengal to Gujarat. Similarly, the labour unrest in Haryana has forced many auto-companies to invest in other states.
- **Government Assistances** like soft loans, lands for SEZs, relaxed labour laws, electricity, tax holidays and setting up ITI and Diploma colleges nearby are other factors which determine its location.

Factors behind growth:

The production of automobiles has increased at CAGR of 9% since 2006, which is quite remarkable. A number of factors have been behind the growth of auto industry in India in recent.

- Indian economy has maintained an avg. of 7%, barring few years. This has increased the spending capacities of large section of population.
- Increase in public spending post 6th Pay Commission.
- During these years Indian rural economy also clocked significant growth rates, which boosted buying of two-wheelers in rural areas.
- Increases urbanization levels, which increased from 28% to 32% during 2001-11.
- **Globalization and integration** of India into international supply chains, with Indian companies exporting to ASEAN and Africa.
- FDI liberalization, increased focus on transport infrastructure, power capacity creation is some of the other factors which helped in quick expansion of the auto industry.

2. India's sugar industry is the second largest agro-based industry in India; however, the production of sugar is skewed towards the states like Maharashtra, Tamilnadu, and Karnataka, which are not very suitable for sugarcane cultivation and have been suffering from water shortages. Analyse the reasons behind this trend? What are the problems faced by the sugar industry in India and the possible measures to overcome the crisis?

(250 words)

Approach

1. **Briefly introduce India's sugar industry** ***(50 words)***
2. **Analyse the reasons behind the trend** ***(80 words)***
3. **Discuss the problems faced by the sugar industry in India** ***(80 words)***
4. **Suggest the possible measures to overcome the crisis** ***(40 words)***

Hints

India is the second largest producer of Sugar in the word after Brazil. In India, Sugar Industry is one of the largest farm based industry, only next to textiles and plays a very important role in the Indian Economy.

Reasons behind the trend are:

- The **tropical climate of Peninsular India** results in higher yield per unit hectare of land higher sucrose content in peninsular cane.
- **Long crushing season in south:**
  - In North India, it lasts from November to February (4 months); while in South it lasts from October to May or even June (nearly 8 months)
- The mills in peninsular India are larger. Though Uttar Pradesh has more sugar mills than Maharashtra yet Maharashtra's sugar mills are larger in size & Capacity. Most of the mills here are new, advanced and well managed.
- Another reason for shift was presence of more co-operatives in the Southern/Deccan regions
- Further, the mills in cooperative sector in south are better managed.
- Proximity to the Ports ex. Mumbai port to export the sugar produced.
- The changing trend is evident from the fact that previously north India used to produce about 90 per cent of India's sugar which is reduced to 35-40 per cent now.

Problems of Sugar Industries:

- Policy issues:
  - It is **one of the most politically sensitive commodities.** Despite having a very small share in the monthly household budget, the slightest price increase can trigger inflation in other commodities
  - The cyclicality in the sugarcane production:
  - The sugar cycle in India gives three years of good production in a row followed by consecutive years of bad crop. This creates difficulties in policy making.
  - **Problem with the state advised price:**
    - It is generally politically motivated. In the example of Uttar Pradesh, successive governments kept SAP high for electoral gains. Consequent to this, the Sugarcane became the most attractive crop to grow.
    - On the one hand, farmers increased the cultivation of sugarcane crops; while on the other hand, the mills were forced to pay higher prices. The result was that arrears to farmers kept rising until they reached record high.
  - **Cane pricing issue:**
    - Generally the sugarcane prices are linked to sugar prices. In India, there is disconnecting between the two.
    - Numerous committees have tried to design a formula linking sugar and sugarcane prices, but as of now, none of such formulae is perfect.
  - **Levy Sugar and Minimum distance between mills:**
    - Under the dual price mechanism, the government fixed the ratio of Levy sugar and free sale sugar quota. By doing so, every sugar mill was allocated a command area in its vicinity. The mill is bound to purchase any sugarcane grown in that area and the cane farmers are also expected to sell only to the designated mill. A part of produce of these sugar mills is required to be sold to the Government. This part is known as Levy Sugar.

- The levy sugar is sold to the consumers through fair price shops of the public distribution system. This ratio initially was fixed 45:55, later kept revising till reached 20:80, before finally getting abolished in April 2013. At present, there is no levy sugar in India**s**

➤ **Regulations relating to by-products:**

- Certain restrictions have been placed on by-products of sugarcane such as molasses and bagasse.
- State governments fix quotas for different end uses of molasses and restrict their movement, particularly across state boundaries.
- Some states have also imposed restrictions on the mills that can sell power generated from bagasse to users other than the local power utility.
- Mills are also restricted from selling power generated from bagasse to other states. Such restrictions impede the revenue realization from cogeneration and reduce economic efficiency

⊙ Low Yield of Sugarcane:

➤ India has the largest area under sugarcane cultivation; the yield per hectare is extremely low as compared to some of the major sugarcane producing countries of the world.

➤ For example, India's yield is only 64.5 tons/hectare as compared to, 90 tons/hectare in Java and 121 tons/hectare in Hawaii.

⊙ Short Crushing Season:

➤ Manufacturing of sugar is a seasonal phenomenon with a short crushing season varying normally from 4 to 7 months in a year. The mills and its workers remain idle during the remaining period of the year.

⊙ Fluctuating Production Trends:

➤ Sugarcane has to compete with several other crops and also land available to it is not constant every year so the Production Fluctuates.

⊙ High Cost of Production:

➤ High Cost of Sugarcane, inefficient technologies all build up to the cost of Production.

⊙ Small and Uneconomic Size of Mills:

➤ Most of the sugar mills in India are of small size with a capacity of 1, 000 to 1, 500 tonnes per day. This makes large scale production uneconomic. Many of the mills are economically not viable.

⊙ Regional imbalances in distribution:

➤ Over half of the sugar mills are located in Maharashtra and U. P only and many other parts like Kashmir and North east are not so developed which lead to regional imbalances

⊙ Old and obsolete machinery:

➤ Most of the machinery used in Indian sugar mills, particularly those of Uttar Pradesh and Bihar is old and obsolete, being 50-60 years old and needs rehabilitation.

⊙ Competition from khan sari and gur:

➤ It is estimated that about 60 per cent of the cane grown in India is used for making khandsari and gur and the organized sugar industry is deprived of sufficient supply of this basic raw material

⊙ Low per capita consumption:

➤ The per capita annual consumption of sugar in India is only 16.3 kg as against 48.8 kg in the USA and the world average of about 21, 1 kg.

- Jute packaging materials act 1987:
  - As per this act 20% sugar needs to be packed in jute bags but sugar absorbs moisture in these bags and get wasted.
- Prolonged frost in the North destroys the crop.

Measures needed:

- Production cost can also be reduced through proper utilization of by- products of the industry.
- For example, bagasse can be used for manufacturing paper pulp, insulating board, plastic, carbon cortex etc. Molasses comprise another important by-product which can be gainfully used for the manufacture of power alcohol.

Incentivize bagasse electricity generation.

- Ethanol, which is a plentiful product in the sugar manufacturing process and is blended with petrol, can be a vital revenue earner for the mills.
- 12. 5% excise duty on ethanol need to be removed.
- Ethanol blending which is only 3% currently could be raised to 10%
- Sugar industry feels that increasing the import duty on sugar from the current 25 per cent to 40 per cent will be a solution for the longer-term
- The states demand 10% of total sugar production to be set aside to create a buffer stock on government account.
- Cane growing states wanted to reschedule repayment of interest free loans by the industry to 7 years instead of 5 years and extend financial assistance from Sugar Development Fund to industry for modernization and ethanol blending.
- There are demands for government to take steps like allowing import of sugar and domestic sale, create a price stabilization fund, create FRP on sugar and link it to FRP on cane, bring back monthly release quota, implement 75:25 sharing of sale proceeds of sugar and by-products.

3. Discuss the problems of agro-based industries in India. Do you think agro-based industry could be a better option to absorb shift of labour force from agriculture. What steps has government taken to promote agro-based industries in India?

(250 words)

Approach

1. **Give a brief description of agro-based industries** ***(50 words)***
2. **Discuss the problems of agro-based industries in India** ***(80 words)***
3. **Do you think agro-based industry could be a better option to absorb shift of labour force from agriculture** ***(80 words)***
4. **Steps has government taken to promote agro-based industries in India** ***(40 words)***

Hints

Agro based industries depends on the raw material produced by the agricultural sector. These include industries related to textiles, sugar, paper and vegetable oil etc. Agro-based industries play a vital role in the development of Indian rural economy. India's 70 per cent of total population directly depends on agriculture and agro-based industries. Agro-processing industries, especially food manufacturing, tobacco and textile processing dominate the commercial industrial sector. the scope of the agro-processing industry encompasses all operations from the stage of harvest till the material reaches the end users in the desired form, packaging, quantity, quality and price.

The problems faced by agro-based industries in India are:

- **Low Infrastructure-** Most Products are of perishable nature and thus it requires huge infrastructure in terms of cold storage, good road connectivity etc. Lack of required storage facilities, long and fragmented supply chains, Low level warehousing development are actually hampering the basic requirement of industry. India suffers on account of both forward and backward linkages.
- **Variability -** Agro industries have variability in the quantity and quality of raw materials. Quantity is uncertain because of fluctuations in weather, in soil condition etc. Quality varies because of standardization, of raw materials remain elusive even though there have been advancement in animal and plant genetics. These variations exert additional pressure on agro-industrial units in terms operations related to production, scheduling, and quality control.
- **Supply of Credit:** due to small size and lack of collaterals, many of small enterprises are denied of formal credit.
- Lack of modern technology to process the products.
- India is increasingly facing competition from other countries in the region such as Bangladesh, LCMV etc which offer similar advantages as India such as low labour cost, good soil etc.
- Over regulations on industries like sugar

In spite of these problems, Agro based industries have great potential to push forward India's economic and social growth. Agro based industry provide raw materials for several other industries. Thus, other industries are also dependent on this feeder sector. As agro based industries are located near the agriculture area thus promotes decentralised growth and eliminates regional imbalances. These industries required less skilled manpower and are labour intensive thus they can a great source of employment generation for landless labourers and unemployed youth of rural area. Thus, eliminating disguised employment in agriculture.

Government Initiatives to promote Agro based Industries:

Food Processing:

- Government is establishing Mega food processing parks to enhance value addition, reduce agriculture wastage and generate employment. In these areas, there is generally cluster of similar farmers, factories, and traders etc. who dominantly deal in same agro product. Scheme aims to strengthen such clusters by providing world class infrastructure facilities. This will result in smoothening of supply chain - 'Farm to Market.
- **Modernization of Abattoirs:** This is a comprehensive scheme, which includes establishment of modern abattoirs and modernization of existing abattoirs. Modernization of abattoirs will also include up scaling of infrastructure of existing abattoirs.

In Textile sector:

- Setting up Integrated Textile Parks, it aims to assist small and medium entrepreneurs in the textile industry to clustered investments in textile parks by providing financial support for world class infrastructure in the parks.
- 100% FDI is allowed under the automatic route in the textile sector;
- Technology Up gradation Fund Scheme (TUFS) TUFS has infused investment of more than USD 41.33 billion in the industry. Support has been provided for modernisation and up gradation by providing credit at reduced rates and capital subsidies.
- Scheme for Integrated Textile Parks (SITP) Scheme will provide funding for infrastructure, buildings for common facilities like design & training centre, warehouse, factories and plant & machinery, till now 74 textiles parks have been approved and are at various stages of implementation with 18 parks operational, 32 under implementation.
- Integrated Processing Development Scheme (IPDS) IPDS is being implemented to make Indian textiles more competitive and environment-friendly.

In Leather sector:

- The Integrated Development of Leather Sector (IDLS) sub-scheme implemented as part of the ILDP has significantly contributed to capacity modernisation and technological up-gradation of the leather sector.
- Capital goods (machinery) required by the industry can be imported without import duty under the Export Promotion Capital Goods (EPCG) Scheme of Foreign Trade Policy, subject to meeting the export obligation of six times the duty saved in six years.
- Agro based industries not only promote the economic growth but also social equality and improve regional imbalances. States like Uttar Pradesh, Assam, Bihar, Madhya Pradesh, Maharashtra which has significant potential for agro based industries should be focused as per regional growth plan and should be provided with basic infrastructure including forward and backward linkages to market.

4. The food processing industry in India is not developed as per the resource endowments of different regions, many resource rich areas have practically no industry, whereas some states like Haryana and Maharashtra have high concentration of these industries, despite relatively less resources compared to some other regions. Critically analyze.

(250 words)

Approach

1. **Briefly introduce food processing industry of India** ***(50 words)***
2. **Discuss, Why food processing industry in India is not developed** ***(80 words)***
3. **Reasons and steps taken by the Government** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

As per Ministry of Food Processing of India (MOFPI), the term 'food processing' is mainly defined as a process of value addition to the agricultural or horticultural produce by various methods like grading, sorting and packaging.

Food Processing Industry (FPI) in India is a sunrise sector that has gained prominence in the recent years. Easy availability of raw materials, changing lifestyles and favourable fiscal policies has given a considerable push to the industry's growth.

If there are good food processing industries in India, raw materials like grains or meat can be converted into food for domestic and foreign consumption. Food processing units acts as a link between agriculture and industries. Food processing industries can absorb a major share of workers from the agriculture sector, who face disguised unemployment. It can lead to better productivity and GDP growth.

The food processing industry in India is not developed as per the resource endowments of different regions. In many states like Maharashtra, Haryana where resource endowment is comparably low have high concentration of food processing industries. **FPI situated in an area where the following components get access easily:**

- Accessibility to raw materials.
- Modern extraction techniques.
- Centre of Demand, Haryana to Delhi NCR and Chandigarh and Maharashtra to Mumbai and Pune region.
- Storage facilities for raw materials like Grains, Meat, and Fish etc.
- Quality testing facilities.
- Transport facilities
- Skilled Work force

On the other hand, in many areas where natural resource endowments are richly available but occurrence of food processing industry is comparably low due to the:

- Small size companies: Indian food processing companies are small and can't compete with global giants which invest heavily on R & D.
- Lack of good laboratories in India: Food export to US and EU demands high quality standards. India lack good laboratories to check heavy metal and other toxic contamination in food.
- Lack of skilled work force. We have only a few graduates in Food Technology.
- Lack of right vision and support from the government at the right time.
- Lack of good transportation facilities. Roads are overburdened.
- Lack of storage facilities and good production techniques.
- Lack of organized retail.
- Limitations in supply chains.
- Limitations in the quality.
- Lack of modern regulations.

The industry is still in its nascent stage and contributes only 1.49% to the total Gross Domestic Product (GDP) of the economy. India is ranked 5th in the world in terms of production, consumption and export of processed food. In order to address the problem of infrastructure, various schemes specific to different segments of the FPI have been launched and implemented by the government in the following areas:

- Food Park Schemes
- Grading and Packaging Centres
- Integrated Cold Chain Facility
- Value Added Centres
- Irradiation Facilities
- Modernized Abattoir

5. Assess the impact of agro-based industries on cropping pattern in India with example.

(200 words)

Approach

1. **Briefly introduce the Concept of cropping pattern** ***(40 words)***
2. **Discuss the impact of agro-based industries on cropping pattern in India and how it changes according to economic parameters** ***(100 words)***
3. **Conclusion** ***(60 words)***

Hints

Cropping pattern has been defined as the proportion of area under different crops at a particular period of time. A change in the cropping pattern means:

- A change in the proportion of area under different crops.
- The cropping pattern depends upon changes in demand patterns, development of irrigation, availability of marketing infrastructure and new trade arrangements.
- More importantly, area allocation among various crops depends on the relative profitability.
- Shifting from one crop to another crop is also a strong tool to minimize the risk and maximize the profit from farm.
- On the demand side, the most important factor that determines the cropping pattern is the consumption in a country. In addition to this, demand is also generated by exports. Changes in the demand at national as well as at international market influence the cropping pattern of a nation or a village.
- The poor demand of products can impact the cropping pattern.

In addition to these, the settlement of agro based industries in a particular region also determines the cropping pattern.

Agro-based industry would mean any activity involved in cultivation, under controlled conditions of agricultural and horticultural crops, including floriculture and cultivation of vegetables and post-harvest operation on all fruits and vegetables

Impacts of agro based industries on rural economy are:

- The agro-processing sector has the vast potential in the development of an economy through its multiplier effect. The potential becomes manifold when the processing possibilities of the entire commodity system are taken into account. For example, a farmer cultivates paddy on his farm and the paddy plants produce paddy, straw, husk, bran, and rice kernel.

Thus, with an initial investment for growing paddy, produce of paddy has a potential of supporting a complex of processing industries (rice mills, solvent extraction plant for rice bran oil, processing of husk for variety of products and straw paper/ board mills). Similarly, in animal-based products we get the raw materials like meat, bones, hides, skins, wools, etc. and thus, the processing of these raw materials opens up large value addition possibilities. In India, the processing units based on grains, horticultural products, livestock products, fish have ample opportunities.

- The specificity of agro-industry vis-à-vis other industrial subsectors lies largely in the biological nature of the raw material. The raw materials used by agro-industry are generally characterized by the seasonal nature and the variability of their production as well as by their perish ability. These aspects put particular demands both on the organization of agro-industrial activities and on the agricultural base producing the inputs, thereby adding to the need for a close integration of raw material production and processing.
- For example, the increasing demand of Guar gum in United States, China, Germany, Russia and Australia (top five importers), people in western Rajasthan with a few acres to spare decided to jump on the guar bandwagon, forgoing even cash crops like cotton to grow more guar.
- Exports of guar gum from India, which stood at 2, 18,479.71 metric tonnes in 2009-10, rose 223 per cent to reach 7,07,326.43 MTs in 2011-12.

Thus the growth of agro based industries impacts the cropping pattern in the region.

6. Examine why despite having a long historical tradition, the handicraft industry in India is on a decline? How the government policies related to Agro-based industries can revive the handicraft industry?

(200 words)

Approach

1. **Briefly introduce the handicraft industry** ***(40 words)***
2. **Discuss the reasons behind its decline** ***(60 words)***
3. **Steps taken by the government for its revival** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Handicrafts are a part of the country's rich cultural heritage and play a significant role in national economy. This industry is a small scale industry, the products of which is artistic in character and requires skill and craftsmanship in their manufacture.

Under the small scale sector, the handicrafts may be found either in the form of village industry or as cottage industry.

In 17th and 18th Century India was called the factory of the World because of its booming and well developed handicraft Industry. However Since 19th century Handicraft Industry has started declining. There are various reasons behind it.

The colonial government forced peasants to grow commercial crops such as tea, coffee, indigo, etc. in order to feed British industries with cheap raw materials. This commercialization of Indian agriculture reduced the raw materials for Indian handicrafts industry.

Indian agricultural sector also faced lack of irrigation facilities, insignificant use of fertilizers, lack of investment, frequent famines and other natural calamities, etc. that further exaggerated the agricultural performance and made it more vulnerable.

Recent Causes

- Raw material at reasonable price is not available. Government schemes work on paper only, due to infrastructural problems (roads connectivity, etc).
- No synergy between Government agencies responsible for handlooms, handicrafts, khadi and the cottage industry sectors which leads to inefficient utilization of resources. Some people get double benefits (Handicraft + Handloom) schemes while others don't get even one.
- Artisans still rely upon local moneylenders. They charge heavy interest rate, leaving the artisan in vicious poverty cycle.
- Outdated techniques of manufacturing.
- Defective Marketing.
- Competition from mechanized goods whether imported or locally made.
- The Indian Handicraft industry despite being labour intensive faces shortage of skilled labour.
- Products are high priced in big and metro cities, which are beyond the reach of people belonging middle and lower middle class.
- There is lack of awareness about new traditions and among craftsmen.
- There are inadequate training centres to develop skilled craftsmen.

Government polices needed to revive the Handicraft Industry

- Government should establish e-kiosks, a single-window based loan-clearance system via SIDBI and NABARD.
- Artisan Credit Card (ACC) should be promoted.
- Remove the artificial divisions between Khadi, Handicraft, and Handloom etc. that compartmentalize administration of common sectors. Just focus on a unified 'Handmade in India'.
- Social welfare schemes should be strengthened for ensuring better living conditions for weavers, artisans and ancillary workers.
- Women workers should be recognized as contributors and be included in various schemes/ programmes in their own individual capacities.
- Government should take initiatives for promotion of these products in domestic and foreign markets.
- Universities, corporate houses, government departments can contribute by sponsoring and also undertaking research, which results in new and innovative technologies that will enable up gradation of traditional tools and designs of local artisans."
- Government should develop and strengthen marketing linkages through direct sales, participation in sales expos and e-commerce.
- The handicraft industry is very important for the country as it is the second largest employment generator in the rural sector. Efforts must be made to revitalize and develop it to its full potential. It is also an industry that helps to showcase the rich cultural heritage of the country.

7. The contribution of Gujarat to India's pharmaceutical and health sectors can be gauged by the fact that this Western State, having only 4 per cent of the country's population, accounts for more than 40 per cent of medicines manufactured in India. Why is the pharmaceutical industry concentrated in the western region?

(250 words)

Approach

1. **Briefly introduced the status of pharmaceutical industry in India** ***(50 words)***
2. **Discuss reasons, why Pharmaceutical industry is concentrated in the western region** ***(80 words)***
3. **Government's efforts** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

In India, pharmaceutical manufacturing units are largely concentrated in two states viz, Maharashtra and Gujarat, which account for about 45 per cent of the total number of pharmaceutical manufacturing units in India.

- The contribution of Gujarat to India's pharmaceutical and health sectors can be gauged by the fact that this Western State, having only 4 per cent of the country's population, accounts for more than 40 per cent of medicines manufactured in India
- The State is home to global pharmaceutical behemoth Sun Pharma, and plays host to major players including India's second oldest drug-maker Alembic etc
  - **Reasons, why Pharmaceutical industry is concentrated in the western region:**
- **Suitable weather:**
  - The dry weather and the availability of good quality water make it attractive for the pharmaceutical industries. The weather makes it ideal for the pharmaceutical industry.
- **Good connectivity:**
  - This region is well-connected to Pharma hubs like Hyderabad, Mumbai and Ahmedabad
  - Proximity to ports (Kandla, Bhavnagar etc.) which facilitates easy export to Africa, Europe etc. Africa for long has been an important market for India's Generic Drug Industry. India exports cheap lifesaving drugs to African nations.
  - Proximity to petrochemical hubs near Gujarat Coast and Mumbai.
- **Good education and awareness related to Pharma:**
  - India's first pharmacy college, L. M. Pharmacy College, was established in Gujarat in 1947
  - Gujarat has six pharmaceutical Special Economic Zones (SEZs) and as many as 90 pharmacy colleges lead to higher availability of skilled manpower
- **Strong sense of self employment and culture of entrepreneurship**:
  - Easy availability of Capital. The western part of India has traditionally been the hub of trade and Capital

- Strong Low cost manufacturing sector
- Significant breadth and depth of product expertise
- Low cost of growing Human resources in the Pharma sector

- **Government's efforts:**
  - Other States have issues such as water shortage and lack of skilled staff.
  - Besides, the possible implementation of Goods and Services Tax (GST) will reduce the financial advantage of these States, and increase transportation costs due to frequent fuel price hikes. This will only speed up the return of many of these companies to the western region.
  - Favourable State policy like ease of doing business, stable policies of state government (Gujarat, Maharashtra).

8. Compare and contrast Dairy industry of the tropical area with respect to temperate region.

(200 words)

Approach

1. **Briefly introduce the Dairy industry** ***(60 words)***
2. **Compare and contrast Dairy industry of the tropical area with respect to temperate region** ***(100 words)***
3. **Conclusion** ***(40 words)***

Hints

The dairy sector contributes a large share to the agricultural gross domestic product (GDP).

There are many factors that affect the location of dairy farms as:

Availability of suppliers (vets, equipment, feed companies, etc.; Land and infrastructure availability; Cost, regarding to both ag availability and productivity; Proximity to areas that have productive land forage and grain crops; Location to processing plants. As we have a pooled rate for the transportation of milk, it would only really be an issue for outlining areas and Climate. The major products of the dairy farming are milk, milk powder, butter and cheese.

- Climate places an important role in the milk yield, reproductive efficiency, pastures, etc.
- In tropical region animal may often be under heat stress. When the environmental temperature exceeds the upper critical level (18 to 24°C, depending on the species) there is usually a drop in production or a reduced rate of gain.
- Dairy Cattle show a reduced feed-intake under heat stress resulting in lowered milk production and reduced growth. Reproduction is also adversely affected.
- The land for pastures are also few and grasses are not nutritious. Inadequate availability of fodder in all seasons occurs.
- Livestock diseases due to tropical climate are very common.
- Hence the dairy industries of temperate region are more developed. The most important dairying areas of the world are in Western Europe, North America and the temperate parts of the southern continents. Japan and South Korea are also important dairying countries.

- Milk is a perishable commodity and spoils very easily. Its low acidity and high nutrient content make it the perfect breeding ground for bacteria, including those which cause food poisoning (pathogens). Hence processing of milk in tropical regions requires huge scientific investments.
- Further dairy industries in tropical region are highly decentralised and are practiced as rural cottage industry rather than commercialised form in tropical regions.
- Though India is largest producer of milk in the world through the success of Operation flood but milk yield per animal is very low due to tropical climate as well as lack of use of scientific practices in mulching and unavailability of veterinary health services.

9. Explain the variety and value of tourist resources of India.

(200 words)

Approach

1. **Give a brief description of the tourist resources of India** ***(50 words)***
2. **Discuss how diversity of India ensures variety of tourism** ***(60 words)***
3. **How tourism helps to Indian economy and steps taken by government to boost it** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

The travel and tourism industry is responsible for 6.1 per cent of India's Gross Domestic Product, as of 2011. The tourism industry directly and indirectly employs more than 26 million citizens, which represents 5.7 per cent of the country's total employment, according to the World Economic Forum. Additional jobs related to tourism total over 37 million, or 7.5 per cent. This revenue directly impacts the economy, especially in sectors such as hospitality, hotels, construction, handicrafts, horticulture and agriculture.

- The diversity of India ensures variety of tourism such as:
  - **Adventure tourism***:* This involves exploration of remote areas and exotic locales and engaging in various activities. For adventure tourism in India, tourists prefer to go for trekking to places like Ladakh, Sikkim, and Himalaya.
  - **Medical tourism***:* Tourists from all over the world have been thronging India to avail themselves of cost-effective but superior quality healthcare in terms of surgical procedures and general medical attention.
  - **Eco tourism***:* Ecotourism entails the sustainable preservation of a naturally endowed area or region. This is becoming more and more significant for the ecological development of all regions that have tourist value. For ecotourism in India, tourists can go to places such as Kaziranga National Park, Gir National Park, and Kanha National Park.
  - **Historical/Cultural heritage tourism***:* The various fairs and festivals that tourists can visit in India are the Pushkar fair, Taj Mahotsav, and Surajkundmela.
- Hence the tourism has favourable impact on the balance of payment of aviation, transport, medical tourism, hotel and sports.

- The Indian government, in order to boost tourism of various kinds in India, has set up the Ministry of Tourism and Culture. This ministry recently launched a campaign called 'Incredible India!' in order to encourage different types of tourism in India.
- The government announced several measures for boosting tourism like streamlining of some service tax bottlenecks and focused effort for the development of a global scale Buddhist circuit and cleaning of the Ganga along with creation of world class amenities to enhance the spiritual experience along the holy river. Further, easing of the Indian tourism visa regime through the execution of tourist visa on arrival enabled by electronic travel authorization (ETA) for forty-three countries will provide a major boost to tourism.

10. Industrial development is a key for regional development thus economy and geography is interrelated to each other. Illustrate the statement.

(200 words)

Approach

1. **Briefly introduce, How economy and geography is interrelated to each other** ***(50 words)***
2. **Discuss the effects of location and climate on income and growth** ***(60 words)***
3. **Discus the regional effects in development and under development** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

Although various factors, such as culture, religion, and political structure among others, influence the rise and decline of a country in terms of economic wealth, there is one historical and unchangeable fact that has shaped the economy, namely geography.

Location and climate have large effects on income and growth, through their effects on:

- **Transport costs:** All the basic industries across the world follow the principle of low transport costs. The major iron and steel industries in US, Russia, UK, Germany, China and India are located in the regions of iron, manganese and coal mines and power sources. Similarly, the paper industries are found near forest areas with hydropower availability.
- **Disease burdens**: major industrial development cannot be found in areas of high disease burdens as in tropical areas e.g. sub-Saharan Africa.
- **Agricultural productivity:** Most of the industrial development has taken place in areas of high agricultural productivity like the western Gangetic plains of India, the Prairies of North America and the high yielding wheat regions of temperate grasslands across the world.
- **Extreme climate**: Difficult living conditions like the higher altitudes in the Himalayas and the uninhabitable regions of Northern Canada and Siberia restrict the overall human activity in general, and industrial development in particular.

- Localized nature of development processes and innovative activities is linked to the emergence of spatial inequalities in development levels. Such disparities at the geographical level appear to be even more relevant in the case of developing and emerging countries, where only a limited set of locations shows the capability to spur economic growth through industrialization, while the rest seems to stagnate or decline.

Regional effects in development and under development:

- Tropical regions are hindered in development relative to temperate regions, probably because of higher disease burdens and limitations on agricultural productivity.
- Coastal regions, and regions linked to coasts by ocean-navigable waterways, are strongly favoured in development relative to the hinterlands. It is a major cause of Mumbai, Chennai, Kolkata and Vishakhapatnam being highly industrialized.
- High population density seems to be favorable for economic development in coastal regions with good access to internal, regional and international trade. On the other hand, high population density in the hinterland is an industrial disadvantage e.g. Chhattisgarh and eastern MP.
- Natural disasters are also one of the determinants of industrial development of a region. That's why cyclone affected Orissa, landslides affected Uttarakhand and Himachal Pradesh, and flood affected northern Bihar have remained relatively poorly developed.
- Difficult terrain can hamper the industrial growth in an area. This is one of the main causes of underdevelopment of the north eastern India besides lack of peace.
- Furthermore, geography seems to be a factor in the choice of economic policy itself. When we identify geographical regions that are not conducive to modern industrial growth, we find that many of these regions have high population density and rapid population rise e.g. eastern UP and Bihar, thus showing high interdependence of economy and geography of a region.
- Transport and Communication -Modes of Transportation

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NOTES

SET-5.1: QUESTIONS

LOCATION OF INDUSTRIES AND TRANSPORT

Q1. Critically analyse the status of the triple transport system in the regional development of India?

Q2. Do you agree that a coordinated system of transport plays an important role in the sustained economic growth of a country? Substantiate with examples.

Q3. There is a need for holistic transport planning to improve the city's mobility, liveability and sustainability. In this light, suggest some of the climate friendly and sustainable public transport systems for the urban cities.

Q4. Population growth, increase in household income, and increase in commercial and industrial activities have placed heavy demands on urban transport systems, demand that many Indian cities have not been able to meet. Elucidate

Q5. Maleficent transport sector is the root cause of High-energy consumption and intense pollution of the environment. With an eye on Paris Climate goals and SDG 9, critically link India's preparedness on this matter.

Q6. A major problem of Indian roads is high traffic condition. Discuss the cause(s) behind such traffic conditions and suggest the way forward.

Q7. Our nation's inland waterways and rivers are the hidden backbone of our transport network. In the context of given statement, highlight the problems and prospects for inland waterways in India.

Q8. Ports are not just the facilitator of trade, but could be inclusive centres of economic development. In this light discuss the significance of Sagarmalaproject and its objectives.

Q9. Lack of professionalism and autonomy of the major port boards led to the dismal performance to the ports in India. Critically comment in the light of Major ports authorities act, 2016.

Q10. "The ocean cargo shipping owes its formidable economic efficiency to an unregulated and globalised system, provoking the question: how can it assume its environmental responsibility?" Explain.

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SET-5.1: ANSWERS

1. Critically analyse the status of the triple transport system in the regional development of India?

(200 words)

Approach

1. **Briefly introduce triple transport system and how it functions** ***(80 words)***
2. **How it helps in the regional development of India?** ***(80 words)***
3. **Conclusion** ***(40 words)***

Hints

- The triple transport system includes a transportation system comprising of waterways, rail-road network, and Airways. This transport network is established to facilitate the movement of goods and people.
- It functions as a lifeline of the spatial economy at all territorial levels-global, national, regional and local. A well-knit and coordinated system of transport plays an important role in the sustained economic growth of a region and the country.
- An integrated and coordinated transport network also reduces social distances, political fragmentation and economic isolation of a region.
- The most outstanding role of the transport network is the integrating the regional economy with the national economy. Because in our country, the production of specialization exist at local levels and these specialized products have local markets into our national markets.
- But the triple mode transport system in India has played an integrated role in the regional development of the country in general for long distance transport of bulk goods like food grains, metals, fertilizers etc. railways are preferred. On the other hand transportation of small parcels is preferred through roadways.
- Air transport is the fastest but costliest mode of transport. It is an important mode for a country like India which has big size where terrain and climatic conditions are so diverse and the commercial and industrial centres are located at great distances. Apart from transporting goods and services, passengers, air transport is essential for the defence of the regions in the country.
- The remote areas like the Himalayan region which is not served by railways or roads have to depend on air transport alone.

- As far as waterways transport is concerned, it was an important mode earlier but it declined after the coming of railways. The inland water transport is a cheap, fuel-efficient, environment friendly mode with a higher employment generation potential and is suitable for heavy and bulky goods. But its share is only 1% in India. But water transport still playing an important role in regional development of the country particularly coastal or port shipping transport in India, it is an easy and cheap means of exports and imports of heavy items. Of the total sea borne trade of India more than 85%is shared by Mumbai, Kolkata, Cochin, Chennai and Vishakhapatnam as result the commercial activities of these centres are increasing.
- However, the sector has not been able to keep pace with rising demand and is proving to be a drag on the economy. Major improvements in the sector are required to support the country's continued economic growth.

2. Do you agree that a coordinated system of transport plays an important role in the sustained economic growth of a country? Substantiate with examples.

(200 words)

Approach

1. **Briefly introduce the types and functions of developed transport system to the country** ***(50 words)***
2. **Discuss its role in the sustained economic growth of a country** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

- A Country cannot develop so fast without a developed transport system.
- It functions as a lifeline of the spatial economy at all territorial levels-global, national, regional and local.
- An integrated and coordinated transport network reduces social distances, political fragmentation and economic isolation of a region.
- The most outstanding role of the transport network is the integrating the regional economy with the national economy. Because in our country, the production of specialization exist at local levels and these specialized products have local markets into our national markets.
- But the triple mode transport system in India has played an integrated role in the regional development of the country in general for long distance transport of bulk goods like food grains, metals, fertilizers etc. railways are preferred. On the other hand transportation of small parcels is preferred through roadways.
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- However, the sector has not been able to keep pace with rising demand and is proving to be a drag on the economy. Major improvements in the transport sector are required to support the country's continued sustainable and economic growth

3. There is a need for holistic transport planning to improve the city's mobility, liveability and sustainability. In this light, suggest some of the climate friendly and sustainable public transport systems for the urban cities.

(250 words)

Approach

1. **Briefly introduce the contribution of road transport in climate change and air pollution** ***(50 words)***
2. **Discuss the initiatives taken by the government** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

- Road transport is a major contributor to air pollution and climate change. Transport contributes to 27% of energy-related CO2 emissions and is still growing.
- Policy initiatives need to encourage private investments in climate friendly and sustainable public transport systems like Metro rail, Non-motorised Transport and other low carbon emitting systems in urban areas.
- The smart infrastructure planning is done in such a way that it reduces the need for travelling, encourages use of non-motorised and public transport systems, reduces car size and considers using alternative fuels.
- Improved fuels: Switch to electricity, hydrogen, CNG, biofuels and other fuels. Diversification of the fuels used contributes to climate, air quality and/or energy security objectives.
- Bus rapid transport systems for moving people than moving cars.
- Transport systems that accommodate needs without growth in mobility: Demand Jobs/housing balance in subareas, affordable housing in employment centres promote telecommute program pricing.
- Accommodating mobility demand without expanding infrastructure: Ridesharing programs Increased transit service levels Bicycle sharing programs. Ex, car-pooling services provided by Uber and Ola.

- Maximize Efficiency of Existing Transportation Infrastructure: Incident management and response intelligent transportation systems access management operations and maintenance.
- Reduce energy consumption through traffic signal coordination or optimization, low energy lighting, dedicated transit lanes, bike Lanes transit signal priority.
- Non-motorised transport infrastructure for encouraging walking and cycling by providing dedicated pedestrian pathways and cycling tracks. Example as seen in New York. Denmark has a dedicated cycling track for its citizens.
- Urban transport planning shall be people centric and aim at moving people instead of moving cars. All sections of people shall be ensured access to efficient public transport through inclusive planning

Some of the initiatives under consideration are:

- Green Urban Transport Scheme: encourage growth of urban transport along low Carbon path for substantial and measurable reduction in pollution; provide a permanent and sustainable framework for funding urban mobility project.
- Provision of non-motorised transport infrastructure, increasing access to public transport, use of clean technologies, adoption of intelligent transport systems (ITS).

New Metro Rail Policy:

- This Policy mandates preparation of Comprehensive Mobility Plans of cities mandatory to ensure last mile connectivity with metro stations. It also seeks to bring in more innovative models of implementation besides increased standardization and indigenization to induce competition.
- New metro policy seeks to ensure integration of metro projects with over all mobility needs in urban areas.
- Revision of Metro Acts and
- Standardisation and Indigenisation of Metro systems.

4. Population growth, increase in household income, and increase in commercial and industrial activities have placed heavy demands on urban transport systems, demand that many Indian cities have not been able to meet. Elucidate

(250 words)

Approach

1. **Discuss the importance of transport sector in a civilization** ***(40 words)***
2. **Define multiple forms of transport and draw a distinction between "moving people" vs. "moving cars"** ***(60 words)***
3. **How far demand and supply network of urban transport system has been achieved** ***60 words)***

4. Conclusion ***(40 words)***

Hints

Importance of transport sector in a civilization

Transportation is a non-separable part of any society. It exhibits a very close relation to the lifestyle, the range and location of activities and the goods and services which will be available for consumption. Advances in transportation has made possible changes in the way of living and the way in which societies are organized and therefore have a great influence on the development of civilizations.

Multiple forms of transport:

The different modes of transport are air, water, and land transport, which include rail, road and off-road transport. Other modes also exist, including pipelines, cable transport, and space transport. Each mode of transport has a fundamentally different technological solution, and some require a separate environment.

Distinction between "moving people" vs. "moving cars"

Mobility is about keeping people as the only center and treating their issues of access, equity, sustainability as the core of life and living.

Transportation engineers and planners designed transportation networks with seemingly one goal in mind: to move vehicles as quickly as possible, has come to an end. As people and planners come to value walkability and access, transit will have to change. These trends signal a transition away from an outdated model focused on moving vehicles to a new approach focused on getting people where they want to go.

Demand and supply network of urban transport system:

- **Transport supply:** The capacity of transportation infrastructures and modes, generally over a geographically defined transport system and for a specific period of time. Therefore, supply is expressed in terms of infrastructures (capacity), services (frequency) and networks. The number of passengers, volume (for liquids or containerized traffic), or mass (for freight) that can be transported per unit of time and space is commonly used to quantify transport supply.
- **Transport demand:** While a realized transport demand cannot take place without a corresponding level of transport supply, a transport supply can exist without a corresponding transport demand. This is common in infrastructure projects that are designed with a capacity fulfilling an expected demand level, which may or may not materialize, or may take several years to do so.
- **Public sector:** Few other sectors of the economy have seen such a high level of public involvement than transportation, which creates many disruptions in conventional price mechanisms. The provision of transport infrastructures, especially roads, was massively funded by governments, namely for the sake of national accessibility and regional equity. Government control (and direct ownership) was also significant for several modes, such as rail and air transportation in a number of countries.

State of Urban Transport Systems

- Lack of funding and pricing strategy for integrated public transport systems and services is blocking progress. Public transport ridership sliding in cities, service providers running into losses, and services becoming unaffordable. No cohesive strategy to reverse this trend
- National Transport Development Policy Committee says by 2031, Rs 10,900-18,500 billion needed for urban transport, of which 55 per cent for public transport
- Of total allocation to Smart City scheme, share of urban transport projects is 21 per cent. Of this, road infrastructure takes 31 per cent; walking and cycling get only 8 per cent. Of total number of projects under AMRUT, only 7.4 per cent under urban transport, comprising only 1.75 per cent of the total cost of projects
- Imbalanced investments: Ministry of Housing and Urban Affairs budget for Metro increased from 12 per cent in 2009 to 54 per cent in 2017. No commensurate increase for busesor for system integration – though buses carry several times more commuters
- No strategy to increase ridership in cities. Ridership of Jaipur, Lucknow and Chennai Metros show a deficit of over 1,000 percent compared with projected ridership
- Modern public transport systems becoming unaffordable: 34 per cent of Delhi's population excluded from basic non-AC bus services as it cannot afford them
- Increase in Delhi Metro fares has stirred larger policy questions: Should Metros seek to meet their costs from fares, or look at other financing methods and non-fare revenue?
- Investments in transport systems cannot deliver if not supported by fiscal policies to mobilise resources, and keep fares affordable. Adopt innovative financing policy; ensure urban planning and transit-oriented development to increase ridership

Making modern public transport services affordable for the majority:

There is no absolute threshold to define affordability of public transport. Globally, it is generally accepted that about 10-15 per cent of household income can be spent on transport as the upper cap for a system to be accepted as affordable. For poor people, higher spending on transport leads to lower spending on housing, health and education, which therefore spirals them into greater poverty

Conclusion:

Discussion on urban transport improvement becomes meaningless without financial planning and accountability for transformative changes. Indian cities are still far from reporting effective and substantial shifts towards public transport systems.

5. Maleficent transport sector is the root cause of High-energy consumption and intense pollution of the environment. With an eye on Paris Climate goals and SDG 9, critically link India's preparedness on this matter.

(250 words)

Approach

1. **Give a brief about the carbon footprint of the transport sector.** ***(50 words)***
2. **Compare current situation with the INDC of India w.r.t clean mobility.** ***(80 words)***

3. **Bring out pointers stating cost and benefit analysis on "shift towards green mobility"** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

Carbon footprint of the transport sector

- Transportation sector is currently responsible for the fastest growth in CO2 emissions..
- Freight is responsible for 40% of total transportation emissions. About a third of this amount comes from maritime transportation, whose growth is perfectly illustrated by the boom in mega container ships, while two-thirds is attributable to road and rail traffic. Road traffic has been growing swiftly.
- Of the 60% of transportation emissions relating to passenger traffic, nearly half is generated by urban travel. Consequently, urban mobility policies are set to play a key role in the fight against global warming.
- Air travel (international and domestic) accounts for just 16% of passenger transportation emissions, and sea traffic makes an insignificant contribution. This means that land-based passenger travel (urban and non-urban) is the prime source of emissions.

INDC of India

- INDC include reduction in the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level and to create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030. India has also decided to anchor a global solar alliance, INSPA (International Agency for Solar Policy & Application), of all countries located in between Tropic of Cancer and Tropic of Capricorn.
- India declared a voluntary goal of reducing the emissions intensity of its GDP by 20–25%, over 2005 levels by 2020.

Clean mobility efforts taken by India:

- With 'clean' being seen as the way ahead, the automobile sector appears all set to ride this bandwagon and the government is keen to give its push in 2019 with a new National Auto Policy and an ambitious 'FAME II' scheme to leapfrog India to a future driven by clean mobility.
- The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME-India) scheme entails providing incentives for strong hybrid and electric vehicles
- A Perspective' prepared by the NITI Aayog and Boston Consulting Group (BCG) calls for efficient and convenient public transport to answer the twin problems of pollution and congestion.
- '7Cs' for the future of mobility: it stands for common, connected, convenient, congestion-free, charged, clean and cutting-edge..

Cost and benefit analysis on "shift towards green mobility"

- Decisions on transport plans and projects involve relevant public investments and may also determine radical changes in users' costs.

- Burning of fossil fuels such as gasoline and diesel releases carbon dioxide (CO2), a greenhouse gas, into the atmosphere, which causes the earth's temperature to warm up and result in climate changes.
- Sustainable mobility is not just about replacing fossil fuel-powered vehicles with modes of transportation propelled by electricity. It requires a drastic reduction in the number of personal vehicles in the country in favor of public transport, even if cars run on renewable electricity.

Corrective measures:

- India's electric vehicle industry is taking huge forward strides. The National Electric Mobility Mission Plan (NEMMP) 2020 was launched by the Central Government in 2013 to boost the manufacture of hybrid and electric vehicles in India and aims to achieve production of seven million electric vehicles by 2020. This initiative has been complemented by the Government providing demand-side incentives through its Faster Adoption & Manufacturing of Hybrid and Electric Vehicles in India (FAME) scheme.

Conclusion:

As the forces of demographic transition and continued economic growth run their course, the size of the Indian middle class is expected to surge. Consequently, Indian cities are expected to witness a huge rise in the demand for transportation services. An increase in personal transportation would spell doom for the already overcrowded Indian cities and also be environmentally disastrous. This indicates an urgent need for a rapid ramp up of public transportation infrastructure in Indian cities.

6. A major problem of Indian roads is high traffic condition. Discuss the cause(s) behind such traffic conditions and suggest the way forward.

(200 words)

Approach

1. **Discuss problems associated with Indian roads.** ***(40 words)***
2. **Analyze reasons behind clogged traffic conditions** ***(60 words)***
3. **Opportunities, benefits and course correction** ***(60 words)***
4. **Conclusions** ***(40 words)***

Hints

Problems associated with Indian roads:

- Most of the Indian roads are un- surfaced (42.65%) and are not suitable for use of vehicular traffic. The poor maintenance of the roads aggravates the problem especially in the rainy season.

- Even the National Highways suffer from the deficiencies of inadequate capacity, weak pavement, poor riding quality, distressed bridges, unabridged level crossings, congested cities (lack of by-pass roads), lack of wayside amenities and safety measures.
- Another major problem on the Indian roads is the mixing of traffic. Same road is used by high speed cars, trucks, two wheelers, tractors, animal driven carts, cyclists and even by animals. This increases traffic time, congestion and pollution and road accidents.
- There are multiple check-posts, toll tax and octoroi duties collection points on the roads which bring down the speed of the traffic and cause irritation to transporters.
- Way side amenities like repair shops, first aid centers, telephones, clean toilets, restaurants, rest places are lacking along the Indian roads. There is very little attention on road safety.
- There is very little participation of private sector in road development in India because of long gestation period and low-returns.
- There has been no stability in policy relating to highway development in the country. There are a number of agencies which look after the construction and maintenance of different types of roads. Since there is no co-ordination between these agencies their decisions are often conflicting and contradictory.

Analysis of reasons behind clogged traffic conditions:

- Mixed traffic, which include, personal vehicles, buses, trucks, three-wheelers, two-wheelers, including animal-driven carts and pedestrians. This creates problems for traffic management and leads to delays in movement of the traffic.
- Inadequate public transport system.
- Ongoing construction projects at various locations, damaged roads, repairing roads
- Low road density.
- Substantial increase in the number of vehicles.

Traffic congestion has also led to an increase in the number of accidents on the roads. Traffic congestion is resulting into unnecessary delays and reduction in speed.

It has resulted into a low-productive activity for most people as when they get stuck in traffic jams; they reach their workplace late or reach back home late.

Course - correction:

- Construction of Ring Road bypasses and elevated corridors.
- Construction of new roads, footoverbridges, flyovers and widening of existing road network
- Advanced Traffic Management Systems
- Advanced Public Transportation System
- Designing separate roads or lanes to control speeds and vehicles of different sizes, weights and velocities.
- Improvements in vehicle design.
- Ensuring safety and convenience to commuters of public transport and pedestrians.
- Promoting traffic safety and traffic rules through education, advertising and strict enforcement.

Conclusion:

The main objective of Mass Rapid transit system (or per say any transport network) is to provide safe, accessible, reliable, sustainable and user-friendly public transport for commuters and set up a mechanism to deliver public transport service that keeps pace with growth.

Implementation challenges can be rectified at executive level. Time has come to strengthen the efforts and comprehensively take steps to overhaul the crucial transport network.

7. Our nation's inland waterways and rivers are the hidden backbone of our transport network. In the context of given statement, highlight the problems and prospects for inland waterways in India.

(200 words)

Approach

1. **Briefly introduce the importance of inland waterways** ***(50 words)***
2. **Discuss the problems and prospects for inland waterways in India.** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Historically, location of industrial activity has been influenced by logistical convenience of riverine transport possibilities, at a time when road and rail networks were not so well developed. This is largely due to the fact that inland water transport (IWT) offers the most economical, energy efficient and environmental friendly means of transporting all types of cargo from place to place. It also offers safer and cheaper rates in areas where water exist naturally. This facilitates commerce, promotes wealth creation, poverty alleviation, and creates job opportunities for youths within such regions.

India is richly endowed with navigable waterways, comprising rivers, canals, backwaters, creeks, etc. It is estimated that a total of about 14500 km of the waterways could be used for passenger and cargo movement.

Problems

- This means of transport is important only in few States, namely, Assam, West Bengal, Bihar, Mumbai, Goa and Kerala. Also, it is operational only in restricted stretches of Ganga-Bhagirathi-Hooghly rivers; the Brahmaputra river; the Barak river; the rivers in Goa; the backwaters in Kerala; inland waters in Mumbai and the deltaic regions of the Godavari-Krishna rivers.
- Besides, the capacity of this sector is underutilized, because most navigable waterways suffer from hazards like shallow water and narrow width of channel.
- The peninsular rivers depend on rainfall for their volume of water. Thus during dry periods, these appear to be ribbons of water only.
- The peninsular rivers flowing westwards meet the sea through estuaries. Their courses are short and often they make waterfalls and have steep gradient.

- Silting of river beds and erosion of banks
- Most of the large rivers of the country enter the sea through shallow sand chocked delta channels.
- The low revenue and consequent negligence of the government
- Absence of adequate infrastructural facilities like terminals for loading and berthing and surface road links.
- Non-compliance with safety guidelines
- Volume of water in the rivers has lessened on account of construction of canals for irrigation purposes.
- Lower level of Research &Development
- Lack of trained and skilled manpower
- Low volume of human traffic arising from low patronage
- Inadequate cargo assets as most traders and industrialists generally prefer to transport their goods by roads.
- Minimal competition between limited water and transport operators incentives to passengers

Prospects

- Despite the evolution of high technology hybrids like hovercraft and hydrofoils, water transport will not attract high traffic where speed is the governing factor. Nevertheless, shipping is often the chosen mode when the congestion, inconvenience, and handling delays which contribute to total transit time are factored into the decision matrix of competing transport modes.
- The quality of service provided is a vital factor determining traffic volumes and types, and the capital cost of upgrading shipping channels to handle higher traffic volumes is often lower than modernizing roads, railways, or airfields to support the same traffic capacity.
- Fuel consumption is also lower, as is atmospheric pollution; stringent international standards have been evolved to control waste disposal, safety, and operator skill levels.
- It is quite clear that both rail and road capacity fall short of current high value traffic demand along transport corridors such as the Gangetic plain. This zone has the largest population concentration, the most fertile hinterland, and the richest mineral deposits. Both industrial and agricultural traffic will increase exponentially, as economic growth generates massive bulk transport requirements for construction materials, reefer cargo, petroleum and natural gas products, fertilizers, newsprint, foodgrains, coal, steel, bulk chemicals and road transport vehicles – items where speed of delivery from plant to regional distribution points is not as high a priority as it is for passenger traffic.
- There is potential for integration of coastal shipping with Inland water Transport and thereby to enhance its share in the total transport system of the country. The seamless integration of the coastal shipping and inland water transport can be effective only when the vessels can operate in both the sectors economically.
- The government should promote private sector participation in the industry by improving the investment climate, expanding and developing the country's water infrastructure, widening and deepening more river channels and building new roads to link agricultural and mining areas to the river ports.

8. Ports are not just the facilitator of trade, but could be inclusive centres of economic development. In this light discuss the significance of Sagarmalaproject and its objectives.

(250 words)

Approach

1. **Give a brief description of the Indian ports** ***(60 words)***
2. **How ports are helping in economic development** ***(70 words)***
3. **Define Sagarmala objective, its Key Activities. And also discuss its significance** ***(70 words)***
4. **Conclusion** ***(50 words)***

Hints

India has a rich history of trade across seas. Ports constitute an important economic activity in coastal areas. With around a 7500 Km coastlines beaming with more than 200 major and minor ports, the country can develop world class ports on one hand and developing smart cities, and transport infrastructure on the other hand. The higher the throughput of goods and passengers' year-on-year, the more infrastructures, provisions and associated services are required. These will bring varying degrees of benefits to the economy and to the country. As a supplier of jobs, ports do not only serve an economic but also a social function. In terms of load carried, seaway transportation is the cheapest and most effective transportation system compared to other systems.

Ports of India are very important gateway for international trade i.e. imports and exports. Maximum of the cargo that goes out of the country and that comes in the country is through these ports of India. India's international trade by sea amounts to over 90% of foreign trade that take place via 13 major including Mumbai, Kandla, Chennai, Visakhapatnam etc. and 187 minor ports of India.

Till recently India's logistic and transport was compartmentalised and was not integrated thus lacking the efficiency and cost effectiveness. Now government has embarked on seamless integration of logistic and transport sector including road, railway, waterway and airway to harvest fruits of economic development and efficiency. In this process government launched various programmes.

Sagarmala objective and Key Activities:

- it is one of the flagship programme of the government. The prime objective of the Sagarmala project is to promote port-led direct and indirect development and to provide infrastructure to transport goods to and from ports quickly, efficiently and cost-effectively. Therefore, the Sagarmala Project shall, inter alia, aim to develop access to new development regions with intermodal solutions and promotion of the optimum modal split, enhanced connectivity with main economic centres and beyond through expansion of rail, inland water, coastal and road services.
- It is a huge project with 150 initiatives and a total outlay of Rs. 4 lakh crores. The projects have been identified across the four broad areas of:

- Modernize port infrastructure, add up to six new ports and enhance capacity. (Port modernization and new port development)
- Improve port connectivity through rail corridors, freight-friendly expressways and inland waterways. (Port connectivity enhancement) with efficient evacuation to and from hinterland.
- Create 14 Coastal Economic Zones or CEZs and a special economic zone at Jawaharlal Nehru Port Trust in Mumbai with manufacturing clusters to enable port-led industrialization (CEZ is an effort to reduce cost by locating manufacturing centres closer to the ports, thereby making Indian trade competitive in the global market). (Port-led industrial development)
- Develop skills of fishermen and other coastal and island communities. (Coastal community development)
- For a comprehensive and integrated planning for "Sagarmala", a National Perspective Plan (NPP) for the entire coastline have been prepared which identify potential geographical regions to be called Coastal Economic Zones (CEZs). While preparing the NPP, synergy and integration with planned Industrial Corridors, Dedicated Freight Corridors, National Highway Development Programme, Industrial Clusters and SEZs have been ensured.

Significance:

- India is located along key international trade routes in the Indian Ocean and has a long coastline of over 7,000 Km. Yet, capacity constraints and lack of modern facilities at Indian ports tremendously increases the time taken to ship goods in and out of the country. This has held back India's share in the world trade. Thus, project would improve trade percentage of India, and help the development of coastal areas at a faster pace.
- Transportation by waterways has historically remained under-utilized in India although waterways are significantly cheaper compared to road and railways and thus Increase competitiveness of Indian goods and commodities in foreign markets. It will also boost the logistics and provide for better coastal security along with modernization.
- Sustainable development of people living in coastal economic zone. Community and rural development, fisheries, skill development, and promotion of tourism.
- Port infrastructure and linkages are in a bad state and initiatives like Make in India cannot take off without these.
- It is expected that the Project could boost India's merchandise export to $110 billion by 2025 and will create around 10 million new jobs.
- Though the project's remit is confined to infrastructure creation in Indian ports, it too has strategic significance, given the contested nature of Indian Ocean politics, it could well expand into a regional undertaking. Certainly, with the Chinese setting forth an ambitious plan for maritime infrastructure creation in the IOR, India will be keen on keeping its strategic options open. These would conceivably envisage the building of counter-leverages in the IOR to preserve India's geostrategic influence

The Sagar Mala project hence would be a game changer and envisaged to substantially increase the port activities and port becoming engines of economic growth. It will help India toward its vision of blue economy.

9. Lack of professionalism and autonomy of the major port boards led to the dismal performance to the ports in India. Critically comment in the light of Major ports authorities act, 2016.

(250 words)

Approach

1. **Briefly introduce the status of port boards** *(50 words)*
2. **Elaborate major ports authorities act, 2016** *(70 words)*
3. **Discuss related concerns** *(80 words)*
4. **Conclusion** *(50 words)*

Hints

- Major Port Authorities Bill, 2016 aims to empower 12 major ports by providing them full autonomy in decision-making in order to enhance their efficiency.
- It replaced Major Port Trusts Act, 1963.

Provisions and significance:

- **Could spur private investments in port projects**
  - **Seeks to infuse professionalism and increase the autonomy** of the 12 port boards and, more importantly, allow future public-private partnership operators to fix tariffs based on market conditions and only notify the port authority.
- **No need for centre's approval every time:**
  - The port authorities will get the **power to lease land for port-related use for up to 40 years** and for non-port related use up to 20 years
  - The Centre's approval will be needed only for longer leases.
  - Port boards would not need government approval for raising loans, appointment of consultants, execution of contracts and creation of service posts.
- **Divesting TAMPS:**
  - The proposal to divest the bungling Tariff Authority for Major Ports (TAMP) of the power to regulate tariffs is a big positive.
  - Port authority has now been given powers to fix tariff which will act as a reference tariff for purposes of bidding for PPP projects.
  - PPP operators will be free to fix tariff based on market conditions. The board of the port authority has been delegated the power to fix the scale of rates for other port services and assets including land.
- **Removes the string of PPP problems:**
  - Most of the following issues will be addressed:
  - Port trusts' inability to lease out land to private operators in time
  - delays in approvals from multiple agencies
  - rows over interpretations of the concession agreement, often leading to litigation
  - Although 100 per cent FDI is allowed, global tenders are still not the norm due to security threat perceptions.
  - Faster and transparent decision making will benefit stakeholders & better project execution capability

- **Composition of the board is simplified:**
  - The Bill proposes to simplify the composition of the port boards: These will comprise 11 members from the present 17 to 19 members representing various interests.
  - Introduce professionalism in governance of major ports.
- **Independent review board:**
  - An independent review board has also been proposed to be created to carry out the residual function of the erstwhile TAMP for major ports, to look into disputes between ports and PPP concessionaires, to review stressed PPP projects.
- **Concept of internal audit** of the functions and activities of the Central Ports has been introduced on the lines of Companies Act, 2015
- **Provisions of CSR**& development of infrastructure by Port Authority have been introduced.

Concerns:

- Future of the port employees would be at stake if the Act was implemented
  - Once the Act was implemented, no labour representation could be made to address their grievances.
  - Moreover, the Act empowered the port authority to either acquire new property or dispose of the existing property on its own. Even ports could be leased out
  - Around 45,000 employees of various sea ports had been relying on the Central government to protect their interests.

10. "The ocean cargo shipping owes its formidable economic efficiency to an unregulated and globalised system, provoking the question: how can it assume its environmental responsibility?" Explain.

(250 words)

Approach

1. **Briefly introduce the growth in cargo shipping in a globalized world** ***(50 words)***
2. **Discuss the environmental issues related to maritime shipping** ***(70 words)***
3. **How can the world's merchant fleet be regulated** ***(80 words)***
4. **Conclusion** ***(50 words)***

Hints

Growth in cargo shipping in a globalized world: Ocean freight shipping forms the backbone of international trade accounting for 80% to 90% of all volume: globalization could not occur without it.

International seaborne trade increased from only 550 million tonnes in 1950 to more than eight billion tonnes in 2008. In 1979, oil made up more than half of all shipments. Since then, containerized shipping has grown immensely, and represents more than 40% of all traffic and ocean cargo's average growth rate exceeded 10% per year.

Growth and Crisis: In 2009, the economic crisis resulted in a 10% contraction of world trade, a decline unprecedented since the Second World War. The maritime shipping industry suffered immediate repercussions: rates fell through the floor; ships were pulled out of circulation; orders for new ship construction faltered and seaport traffic dropped by 10% to 20%. However, post 80's story is different.

Ocean freight shipping follows specific routes: North America, Europe and East Asia account for more than 80% of oil imports: East Asia relies on the Persian Gulf for 80% of its supply, while North America and Europe draw less than 20% from this region. Most of Venezuela's oil is exported to North America, and North Africa's to Europe. West Africa's oil is split three ways, going to Europe, Asia and North America's eastern coast.

China's massive entry into shipping routes is the important maritime event of the last twenty years. It increases East Asia's role in global trade, and reflects the emergence since the 1970s of the so-called "Asian Tigers" - the rising economies of Hong Kong, South Korea, Singapore and Taiwan, and of the more recent "Tiger Cub Economies "Malaysia, Thailand, Philippines, Indonesia and China.

Maritime shipping is the backbone of globalization. Its efficiency allows it to support growth in international trade. The latter depends on the health of the global economy. Three principal economic poles North America, Europe, and East Asia—will structure worldwide ocean cargo flows, even as new growth areas emerge in South America, Africa and Southeast Asia. Their emergence will lead to more complex shipping networks in the future, and a stronger role for transhipment ports.

But the environmental issues related to maritime shipping is increasing.

- Though the number of spills has decreased since 2000 even while oil tanker traffic has increased, surpassing shipping levels achieved in the 1970s. The most serious marine pollution arises from intentional oil discharge, e.g. when deballasting, washing out tanks, draining fuel solids or water from holds. All ship types are guilty of these practices, following their owners' deliberate avoidance of portside waste treatment facilities in order to save money.
- Unlawful, hidden out of sight at night and in international waters, such gangster-like practices highlight the dark side of ocean cargo shipping — where anything goes, as long as it increases profits.
- Global warming concerns raise questions about ship's worldwide share of carbon dioxide emissions, estimated to be between 1% and 4%- comparable to the levels of a single country such as Germany.
- Even worse, freighters and tankers use heavy, unfiltered fuels, producing high emissions of nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). These pollutants concentrate in large port cities, around islands, and in countries with long seaport and harbour coastlines near the largest shipping routes.

The big question is: how can the world's merchant fleet be regulated?

- The seas and ocean are spaces of free circulation. For ship-owners, evading the most constraining national laws is both a principle and a necessity, due to the fierce competition. By using open registry, ship-owners can freely choose which countries flag to sail under, exploiting tax advantages and recruiting crews that require lower outlay in employment benefits.

- Regulation of ocean shipping should take place at the international level, via the International Maritime Organization (IMO). This entity proposes conventions aiming to ensure shipping security, minimizing environmental risks while preserving the industry's organizational freedom. Its two foundational conventions include SOLAS (International Convention for the Safety of Life at Sea) and MARPOL (International Convention for the Prevention of Pollution from Ships). These conventions have been updated several times.
- Questions remain as to when and how such laws will take effect. Their ratification requires thirty signatory states representing at least one-third of the world shipping fleet, suggesting very long timelines for implementation. This near paralysis motivates states to create their own laws.

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NOTES

SET-5.2: QUESTIONS

LOCATION OF INDUSTRIES AND TRANSPORT

Q1. What is the impact of trade liberalisation on the geographical distribution of industries?

Q2. Identify the factors responsible for the distribution of cotton textile industry in India and analyze its pattern?

Q3. Describe the various reasons for concentration of cotton textile industry in Northern Tamil Nadu (Coimbatore-Tiruppur). How are these factors different from the factors responsible for similar concentration in Gujarat (Ahmedabad-Surat)?

Q4. Sustainability of jute industry is being questioned on different occasions. But its utility has increased in recent time. Discuss the issues which are responsible poor performance of this industry. Also examine its potential in the scenario of climate change.

Q5. After partition, Cotton industry suffered a major recession. This was due to the fact that the most of the good quality cotton growing areas had gone to West Pakistan but still, this industry gradually recovered and eventually flourished. Discuss the Geographical conditions responsible for distribution of cotton cultivation and textile industry in India. Analyse the challenges this industry is facing.

Q6. What are the locational factors responsible for the distribution of cement industry in India? Elaborate on its backward and forward linkages.

Q7. India is largest producer of milk in the world and has the largest cattle population of the world." Discuss government's effort in development of dairy sector.

Q8. Our nation's inland waterways and rivers are the hidden backbone of our transport network. In the context of given statement analyze the problems and prospects for inland waterways in India.

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SET-5.2: ANSWERS

1. What is the impact of trade liberalisation on the geographical distribution of industries?

(200 words)

Approach

1. **Give a brief description of Trade liberalisation** ***(40 words)***
2. **Discuss the impact of trade liberalisation on the geographical distribution of industries** ***(100 words)***
3. **Conclusion** ***(60 words)***

Hints

Geographical distribution of industries historically has been determined by location factors which include availability of inputs like raw material, power, labour supply; availability of market, transportation facilities, regulatory environment and overall cost competitiveness, etc.

- But Trade liberalization has increased the scope of consideration of above factors from national boundaries to international level. This has led to fragmentation of value chain with emergence of sub-part mansufacturing industries.

New factors have been brought into consideration like:

- Availability of skill, transportation facilities have emerged as the major determining factors for location. For example the automobile industry in Tamil Nadu specifically caters to demand from South East Asian nations and availability of port facilities have been factor for their location.
- For countries like China, Taiwan availability of cheap and skilled workforce worked to their advantage in electronics manufacturing industries.
- Another important factor that has emerged is the regulatory policies of the countries. Easy entry, exit, low taxation and easy repatriation of profits have determined the location of industries in South East Asian countries.
- More focus on economies of scale as transportation costs have decreases, market is not fixed but is located worldwide. For example products are supplied from China world over instead of locating industries in destination countries.

- Therefore it can be said that trade liberalization has brought into greater dispersion of industries along the same vertical (different components of automobile like tyres, body, control system build in different locations) and greater concentration horizontally (i.e. for the similar components eg. Concentration of manufacturing of particular automobile part, electronic parts) for some industries.

2. Identify the factors responsible for the distribution of cotton textile industry in India and analyze its pattern?

(200 words)

Approach

1. **Give a brief description of cotton textile industry in India** ***(50 words)***
2. **Discuss the factors for localization of cotton industry** ***(75 words)***
3. **Discuss the distribution of cotton textile industry** ***(75 words)***

Hints

Distribution of an industry is determined by combination of geographical and non-geographical factors, which is also true for cotton industry in India. Combination of these factors have resulted into decentralized distribution of cotton industry in India with major centres being Mumbai, Ahemdabad, Surat, Tirunvelii, Chennai etc.

Factors for localization of cotton industry:

- **Geographical Factors**: Various factors like land, Raw materials, Power, Labour, Transport, Market, Water, climate and
- **Non-Geographical Factors**: Capital, Government policies: Insurance, banking facilities and financial institutions; stable economic and political situation tend to impact location of industries.
- With respect to cotton also the large availability for cotton growing hinterland in black soil region, availability of labour force; transportation facilities of road, rail and port; large market in form of Mumbai and opportunities for exports resulted into concentration of cotton industries initially in Mumbai region.
- These above factors were also aided by the availability of financial institutions in Mumbai, stable political environment provided by British during the initial periods.
- The suitability of environment for cotton mill operation was another added advantage for the region.
- Later on, because of de-agglomeration effects the industry spread to Ahmedabad–Surat regions of Gujarat, which has all the advantages of raw material hinterland, market, infrastructure, capital etc.
- Cotton textile industry further flourished in Southern India with Tirunvelli, Chennai etc. emerging as the main centres. These also had the advantages of cotton growing hinterland of Cauvery River, large market centred around populous Chennai city, port facilities for exports etc.

- With development approaching all the corners of India, commercialization of agriculture the cotton industry at present gives decentralized look having centers spread across India showing concentration towards markets.

Distribution of Cotton Textile Industry:

Maharashtra is the leading producer of cotton textile in the country. Mumbai is the major centre of textile mills. About a half of the Cotton textile mills are located in Mumbai alone. It is, therefore, rightly called as 'Cotton polis' of India. Sholapur, Kolhapur, Nagpur, Pune, Aurangabad and Jalgaon are other important centres in Maharashtra.

Gujarat, which ranks second in the production of cotton textiles, Ahmedabad is the major centre of the state. Surat, Bharuch, Vadodara, Bhavnagar and Rajkot are other centres in the state.

Tamil Nadu has emerged as an important producer of cotton textiles in southern states. Coimbatore is an important centre in the state. Tirunelveli, Chennai, Madurai, Tiruchirappalli, Salem and Thanjavur are other important centres here.

Apart from big three, Karnataka, U.P (Kanpur, Etawah, Modinagar, Varanasi,), Madhya Pradesh, West Bengal (Howrah, Berhampur and Murshidabad) and Rajasthan, Punjab, Haryana and Andhra Pradesh are the other states producing cotton textiles.

The location of cotton textile industry is an example of market forces transforming the character of agriculture of subsistence to commercial nature and bringing prosperity to the region by sucking excess labour force. There is a need to replicate this experience in eastern parts of India where still subsistence level of agriculture is practiced.

3. Describe the various reasons for concentration of cotton textile industry in Northern Tamil Nadu (Coimbatore-Tiruppur). How are these factors different from the factors responsible for similar concentration in Gujarat (Ahmedabad-Surat)?

(200 words)

Approach

1. **Give a brief description of textile industries in India** ***(50 words)***
2. **Discuss factors for localization of Industry in Tamil Nadu and Gujarat** ***(60 words)***
3. **Comparison between the cotton textile industry in both States** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

In addition to availability of large labour force with required skills at a comparatively cheap rate, Indian Textile Industry has a great advantage, in that India is the third largest cotton producing country in the World. Moreover, India has the largest area under cotton in the world.

Reasons for localization of Industry in Tamil Nadu

- The state has availability of cheap land in the areas the industry is concentrated, i.e., Tiruppur, Salem, Palladam, Karur and Erode.

- The industry here is less capital-intensive and small scale, much suited to the local entrepreneurs.
- The vicinity of Chennai port also supports the industry in exports.
- Availability of cheap hydel power is another important factor, which keeps the costs lower.

Reasons for localization of Industry in Gujarat

- Gujarat is one of the major cotton producers of India and there is no problem of obtaining raw cotton.
- Climate of the region is humid and is suited to this industry.
- Cheap power is readily available.
- Cheap and skilled labour is drawn from the nearby areas.
- Gujarat is served by a network of railways & roadways and Port.
- Gujarat is a capital-rich state and close to financial centre (Mumbai) and the industry there has easy access to capital.

Comparison between the cotton textile industries in both states:

- Tamil Nadu is well known for marketing of textile products of handloom, power loom and readymade garments. Thus, here the production pattern is different compared to Gujarat.
- The strength of industry in TamilNadu is the low cost of production, the availability of cheap and subsidized power and cheap labour, along with cheap land compared to Maharashtra and Gujarat, whereas in the case of Gujarat it is the tradition localization factors that play major role along with good infrastructure and number of ports in vicinity.

4. Sustainability of jute industry is being questioned on different occasions. But its utility has increased in recent time. Discuss the issues which are responsible poor performance of this industry. Also examine its potential in the scenario of climate change.

(250 words)

Approach

1. **Discuss the sustainability of jute industry in introduction.** ***(30 words)***
2. **Discuss various issues that are plaguing this industry.** ***(100 words)***
3. **Discuss it's potential in the time of climate change.** ***(90 words)***
4. **Conclusion.** ***(30 words)***

Hints

Since the establishment of this industry, most of the jute industries till today are being producing the age old products like jute sacking and hessian as packaging material and some extent carpet backing. But today with the advent of science, a lot of diversified products has been developed from jute and jute-based material, which has more cost-benefit ratio. The Indian Jute industry has been expanding really fast spanning from a wide range of lifestyle consumer products, courtesy to the versatility of Jute.

Various issues that are plaguing this industry

- In India, jute industry suffered a serious setback in 1947 due to the partition of the subcontinent. After partition about 80 percent of the jute growing areas went to East Pakistan (Bangladesh), while nearly 90 per cent jute mills remained in India. At present there are only 60 jute producing mills in India.
- **Still producing old products**-Only countable industries are involved in diversified product development process for commercial purposes. These products are mostly laminated jute fabric, geo-textile, industrial textiles, etc. Rests are still producing old products.
- **Using Old technology-**This specific industry is also using the age-old machinery to produce jute yarns and fabrics. Due to the use of very old primitive machinery, the efficiency of the machines is not up to the mark (in an average within 80 per cent). Due to frequent breakdowns, defective and inferior quality products are being made.
- **Competition with cheap synthetic materials**- there is stiff competition with synthetic industry for similar packaging material, as the synthetic material is much cheaper in nature.
- **Issue of poor capacity**-The Government of India, recently found that the jute industry could not match demands for supply of 13 lakh bales or 4.33 lakh tons of gunny bags for Rabi crop supply. Government said that with 10 mills remaining closed the jute industry is short in capacity by 1.5 lakh ton.
- Apart from the above problems, in India, jute industry suffers a lot from different political interference, labour problem, and shortage of jute fibre supply due to low rainfall among other issues leading to challenge the sustainability of the jute industry.

The potential of jute in the scenario of climate change.

- While relatively cheap synthetic materials in many uses are replacing jute, but jute's biodegradable nature is suitable for the storage of food materials, where synthetics would be unsuitable.
- Innovative ways of bleaching, dyeing and finished goods processes – the jute industry now provides finished jute products that are softer and have luster with aesthetic appeal.
- Today Jute has been defined as eco-friendly natural fiber with utmost versatility ranging from low value geo-textiles to high value carpets, decorative, apparels, composites, upholstery furnishings, etc
- Organised processing and cultivation of jute help farmers to earn and save substantial money from carbon credits. The valuation of the carbon credit of jute cultivation is pinned at farmers' savings made in purchasing inorganic fertilizer.
- Renewable resource application of Jute has made it a key raw material in the paper industry.

Conclusion:

All these problems and opportunities available for the Jute industry in India necessitate the Golden Fibre Revolution to enhance the value of India's Golden Fibre.

5. After partition, Cotton industry suffered a major recession. This was due to the fact that the most of the good quality cotton growing areas had gone to West Pakistan but still, this industry gradually recovered and eventually flourished. Discuss the Geographical conditions responsible for distribution of cotton cultivation and textile industry in India. Analyse the challenges this industry is facing.

(150 words)

Approach

1. **Briefly introduce with the brief history and mention cotton growing regions in India.** ***(20 words)***
2. **Explain the Geographical conditions responsible for distribution of cotton cultivation and textile industry in India like climate, soil, etc.** ***(55 words)***
3. **Explain different challenges faced by this industry** ***(55 words)***
4. **Conclusion** ***(20 words)***

Hints

The cotton textile industry is one of the traditional industries of India. In the ancient and the medieval times, it used to be only a cottage industry. India was famous worldwide for the production of muslin. By 1947, the number of mills in India went up to 423 but the scenario changed after partition, and this industry suffered a major recession. This was due to the fact that the most of the good quality cotton growing areas had gone to West Pakistan and India was left with 409 mills and only 29 per cent of the cotton producing area.

The northern region produces short and medium staple cotton; the southern region normally produces long staples cotton, while the central region produces long and medium staples.

The Geographical conditions responsible for distribution of cotton cultivation and textile industry in India.

- Climate exercises the most powerful influence on cotton industry. For a healthy growth, cotton requires uniformly high temperature (21°C to 30°C) and at least 210 frost free days in a year. Since it requires modest rainfall; a large part of cotton is grown in India in rain fed areas.
- Soils- The best soil to growth cotton are Black soils of Deccan and Malwa plateau; however, cotton also grows well in alluvial soils of the Satluj-Ganga plain and red and laterite soils of the peninsular region.
- For textile industry.
- Land : cheap and easy land acquisition procedures is very important;
- Raw materials: industries tends to be located where there is easy availability of raw materials
- Cotton industry requires significant power .Therefore it is generally located near power plants.

- The textile industry is preferably set up where market is close and easily accessible. Restrictions and regulation on imports and exports along with duties affect the choice of location of cotton industry.

All these are the reasons why we see cotton industries concentrated in coastal areas in

India like Mumbai, Tamil Nadu and Gujarat. They provide humid conditions, good markets and have excellent port facilities.

Although cotton textile is one of the most important industries of India, it suffers from many challenges:

- Scarcity of Raw Cotton: Indian cotton textile industry suffered a lot as a result of partition because most of the long staple cotton growing areas went to Pakistan. Although much headway has been made to improve the production of raw cotton, its supply has always fallen short of the demand.
- Impact of MSP on cost of raw materials: Once the cheapest in the world, cotton yarn produced in India is now among the most expensive in the world due to a 28 per cent rise per year in the minimum support price.
- Global competition: India faces competition from countries like Bangladesh which have competitive manufacturing costs and enjoy duty-free access to major textiles and apparel markets like Europe
- Market Reality - India's textile industry grapples with domestic issues including outdated technology, inflexible labor laws, infrastructure bottlenecks, and a fragmented nature of the industry.

Conclusion:

Thus the Government needs to focus on technology upgradation which will help Indian players to increase both their productivity and competitiveness. In addition, the government needs to carefully evaluate the various trade agreement opportunities Bangladesh and Vietnam benefit from favorable access to some of the big apparel markets.

6. What are the locational factors responsible for the distribution of cement industry in India? Elaborate on its backward and forward linkages.

(250 words)

Approach

1. **Introduce Cement industry and its importance** ***(40 words)***
2. **Elaborate on the locational factors for establishment of cement Industry** ***(80 words)***
3. **Explain the forward and backward linkages of cement industry and their importance in its development.** ***(90 words)***
4. **Conclusion** ***(40 words)***

Hints

Cement is one of the core infrastructure industries indispensible for growth of a country. The per capita consumption of cement is taken as one of the important indicators of wellbeing of the people. The Indian cement industry is the second largest producer of cement in the world after China but ahead of US and JapanLocational factors:

- It is primarily a raw material oriented industry. Limestone is the main raw material and comprises 6065 per cent of the total product. Hence, the location of a cement plant is based on the limestone deposits.
- The other raw materials used are sea shells, slag from steel plants and slag from fertilizer plants, Silica, Gypsum and these raw materials influence the localisation of cement industry in their own way.
- Availability of power, transportation facilities, market, government Policy, ecological and environmental Factors and availability of manpower are other factor in determination of location of this industry.
- There are at present seven clusters in India SANTA (Madhya Pradesh), CHANDRAPUR (North Andhra Pradesh and Maharashtra), GULBARGA (North Karnataka and East AP), CHANDERIA (South Rajasthan, Jawad and Neemuch in MP), BILASPUR (Chhattisgarh), YERRAGUNTLA (South AP), and NALGONDA (Central AP).

Development of forward and backward links is major requirement of growth and distribution of an industry:

- In cement industry coal is another major input (i.e. backward link) along with electricity and forms 40 per cent of the total cost. Cement and its raw materials are low value bulk materials and its transportation involves huge costs.
- Some of the cost of transporting limestone is reduced by beneficiating this mineral at the quarry heads. The transportation cost is also reduced if the manufacturing plant is located near the market. In fact ready market is the prerequisite for the proper growth of an industry, producing heavy commodity with low specific cost like cement.
- Each tonne of cement produced requires 60 to 130 kilograms of fuel oil or its equivalent, depending on the cement variety and the process used, and about 110 KWh of electricity. Thus good linkage to power is critical.
- With the development of modern automated machinery and continuous material handling devices, the cement industry has become a process industry using a limited amount of skilled labour. A modern plant is usually manned by less than 150 people.
- The cement industry in India comprises near 183 large cement plants and over 365 mini cement plants. Cement industry has forward link to major sectors like agricultural infrastructure sector, roads, bridges and ports, goods from nonmetallic materials, residential and non-residential buildings, the building sector and the installation of electricity, gas, water and communication. The demand for cement is being derived from the growth of these sectors.
- Robust development of cheap transportation like railways, waterways and ports provide for the forward links to distribution network and for export of cement.
- However, some factors such as scarcity of coal, decrease in demand, weakening economy, and rise in home loan rates can derail to growth of cement industry.

Conclusion:

Consumption of cement is closely linked to both the state of economic development in any given country or region and to the economic cycle. The growth prospect of cement industry is tremendous as the demand is picking up due to government initiatives as well as increase in the construction work.

7. India is largest producer of milk in the world and has the largest cattle population of the world." Discuss government's effort in development of dairy sector.

(150 words)

Approach

1. **Discuss briefly India's position in global trade in terms of milk production, meat production and need to revamp this sector** ***(20 words)***
2. **Discuss the government's initiatives like establishment Rashtriya Kamdhenu Aay , Rashtriya Gokul Mission etc. taken in dairy sector apart from challenges faced by this sector** ***(60 words)***
3. **Advantages to dairy sector as India opted out of RCEP** ***(50 words)***
4. **Conclude with improvement made by dairy sector in last few years and its ability to face multiple woes Indian economy is acing today.** ***(20 words)***

Hints

India is the world's largest milk producer, with 21 percent of global production, followed by the United States of America, China, Pakistan and Brazil. Apart from it India has the largest cattle and livestock population of the world. It provides an opportunity to the Indian dairy sector to contribute to Indian GDP and help in doubling the agricultural export in accordance with agriculture export policy and farmer's income by 2022. Apart from it, India is largest exporter of buffalo meat in the world which accounts for more than 58% of the total meat production. Hence, dairy sector has vast possibilities for government has taken various initiatives.

Initiatives taken by government to boost dairy sector

- Government has proposed establishment Rashtriya Kamdhenu Aayog for conservation, protection and development of cows and their progeny.
- Dairy Processing and Infrastructure Development Fund was formed with a total outlay of Rs. 10,500 crore to develop infrastructure facilities in dairy sector such as
  - To modernize the milk processing plants and machinery and to create additional infrastructure for processing more milk.
  - To create additional milk processing capacity for increased value addition by producing more dairy products.

- To bring efficiency in dairy processing plants/producer owned and controlled dairy institutions, thereby enabling optimum value of milk to milk producer farmers and supply of quality milk to consumers.
- To help the producer owned and controlled institutions to increase their share of milk, thereby providing greater opportunities of ownership, management and market access to rural milk producers in the organized milk market.
- To help the producer owned and controlled institutions to consolidate their position as dominant player in the organised liquid milk market and to make increased price realisation to milk producers.

- Government has also launched Rashtriya Gokul Mission which aims to conserve and develop indigenous bovine breeds. It has been launched 'under the National Programme for Bovine Breeding and Dairy Development (NPBBD).
- Gokul Grams have been established under this mission to help better care of bovines and make available better facilities for both productive and unproductive animals.
- These grams will also be established near cities to take care of stray bovines and produce milk to be transported to these cities.

Advantages to dairy sector as India opted out of RCEP

- India opted out of Regional Comprehensive Economic Partnership (RCEP) which included dairy giants such as Australia and New Zealand. It was a free trade agreement which would have allowed these countries to access Indian market.
- Farmers in both countries practice cattle ranching and thus has ability to distort any market.
- It would have made dairy sector in India more vulnerable which is largely supported by small dairy farmers mostly practicing mixed farming. Thus, India has helped its farmers by opting out of RCEP.
- While on the other hand, it will reduce competition and Indian consumers will get poor quality and expensive products of milk.

Conclusion:

Overcoming all these challenges Indian dairy sector has grown with 6.4 per cent annually over the last four years which is almost four times of global growth rate of 1.7%. This development has come amid success of government's initiatives to boost this sector. As Indian farmers are more inclined towards subsistence intensive agriculture along with rearing of animals, development of dairy infrastructure can supplement their income by fetching better prices for milk and milk products. Further, this sector has potential to address the agrarian distress and rural poverty coupled with seasonal unemployment

8. Our nation's inland waterways and rivers are the hidden backbone of our transport network. In the context of given statement analyze the problems and prospects for inland waterways in India.

(250 words)

Approach

1. Introduce with giving a background about India's inland waterways and rivers ***(30 words)***

2. **Highlight the opportunities linked with inland** ***(80 words)***
3. **Discuss the problems associated with development of inland waterways** ***(80 words)***
4. **Write a way forward** ***(60 words)***

Hints

India has an extensive network of inland waterways in the form of rivers, canals, backwaters and creeks. There are 111 officially notified Inland National Waterways (NWs) in India identified for the purposes of inland water transport as per The National Waterways Act, 2016. Inland Waterways Authority of India is the statutory authority in charge of the waterways in India.

Opportunities and prospects of inland waterways:

- A well-coordinated inland waterways network could bring a fundamental alteration in the logistics scenario of the country.
- The cost of transporting one tonne freight over 1 km by waterway is Rs 1.19 compared with Rs 2.28 and Rs 1.41 by road and rail, respectively. And the cost of developing an inland waterway is barely 10 per cent of a four-lane highway of similar capacity.
- Inland Water Transport (IWT) mode is widely recognized as environment friendly and cost effective mode of transport.
- The waterways are also proposed to be linked to the eastern and western Dedicated Freight Corridors (DFCs), as well as the Sagarmala Project, which aims to promote port-led direct and indirect development.
- Waterways can decongest roads, including highways by moving cargo away. Waterways do not involve challenges associated with land acquisition, which has always been a sensitive issue, causing time and cost overruns of numerous projects.
- They are expected to also "help create seamless interconnectivity connecting hinterlands along navigable river coasts and coastal routes" and "are likely to play a crucial role in connecting the north-eastern states to the mainland."

Problems of Inland waterways:

- India has nearly 14,500 km of navigable waterways, yet inland water transport (IWT) accounts for less than 1 per cent of its freight traffic, compared with ~35 per cent in Bangladesh and ~20 per cent in Germany.
- On the environment front, extensive and regular dredging of rivers will destroy their morphological integrity, flora and fauna and river-dependent livelihoods. A scientific study by Bangalore-based ATREE said that noise from large ships could adversely affect river dolphins.
- The channel draft of the national waterways is not uniform at 2 meters throughout the year, as is required. Some of these rivers are seasonal and do not offer navigability through the year. Around 20 out of the 111 identified national waterways have reportedly been found unviable.

- By 2020-21, detailed studies showed that the number of waterways found to be viable for cargo transport is only 23 out of the 106 National Waterways announced in 2016. According to the Action Plan released by Inland Waterways Authority of India in April 2020, out of the 106 newly declared waterways, 63 are found to be non-viable for cargo or passenger/ tourism.
- Further, all the identified waterways require intensive capital and maintenance dredging, which could be resisted by the local community on environmental grounds, including displacement fears, thereby posing implementation challenges.
- Out of the 37 waterways that were to be developed in three years by 2019, work has not even begun on 21 waterways. On remaining 16 waterways, development of waterway has started and is at various stages, along with two more waterways not listed in the 37, and these waterways are operational to a limited extent.

Way Forward:

- **Physical infrastructure**: The government should focus on developing navigation, channel operation and maintenance, and external connectivity infrastructure. Private players can undertake terminal development, cargo and passenger handling, and building low-draft vessels and related repair facilities.
- **External connectivity infrastructure**: For a user, availability of seamless, multimodal last-mile connectivity to and from hinterland reduces trans-shipment cost and makes IWT way cheaper. So the government will need to set up multimodal logistics parks and inland port terminals. For private developers, support infrastructure such as utilities, power, and last-mile connectivity are vital for terminals, and States need to pitch in for this.
- **Incentivising cargo transport through inland waterways**: (a) Offer incentives, including tax subsidies, for transporting a portion of industry cargo through IWT. (b) The Government can mandate/incentivise industries in the proximity of national waterways to use this mode for a portion of their shipments. (c) Higher road taxes can be levied on transportation of coal and inflammable material over longer distances because they are harmful to environment or pose a danger to those in proximity. (d) Capital dredging, along with different waterways, will also offer opportunities to reclaim land along riverbanks. In West Bengal and Assam, where land for industries is an issue, such reclamation can be an answer.
- **Promoting passenger transportation and tourism**: In many States, there are ferry services on national waterways, but these are mostly unorganised country boats. Terminal facilities are also woefully inadequate. Along with passenger terminal development, the government needs to offer financial support to ferry operators to improve safety, and facilitate insurance coverage.

Conclusion:

Inland waterway development requires a multimodal network comprising water bodies and roadways, including culverts, bridges etc, to be developed. This involves investment in a large number of activities to be carried out for infrastructure development. Only such a holistic and concerted effort can change India's transportation landscape, de-congest arterial roads, and even improve quality of life across geographies.

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NOTES

HUMAN GEOGRAPHY

SET-1: QUESTIONS

POPULATION AND MIGRATION

Q1. At 1.2 billion people, India comprises almost 18 percent of the world's population. However, there has been a huge cut year after year in gross budgetary support towards building human capital. Discuss the challenges that it will bring forth and suggest some remedies.

Q2. Population-resources balance determine, whether region is over populated or under-populated. Elucidate.

Q3. The second demographic dividend will continue in most Asian countries even after the first demographic dividend has ended. In the light of above statement, discuss the potential and challenges of reaping the benefits of second demographic dividend in India.

Q4. India's demographic achievements are far worse than those of China and the East Asian Tigers, despite the efforts long made by successive governments of independent India. Critically examine the effectiveness of family planning policy in this matter.

Q5. Child marriage and adolescent fertility, childhood malnutrition, and worsening child sex ratio are major obstacles in India to effectively utilize its "demographic window of opportunity". Substantiate this statement.

Q6. Intra-state and inter-state migration in India is compulsive in nature. Discuss.

Q7. Give the analytical overview of interstate migration in India. Also, critically analyze how far the migration has affected the women in Indian society.

Q8. Migration is a constant phenomenon throughout human history. People have shifted to find better pastures, more game, and other resources; similarly people have left home to escape religious or political persecution or even climate threat. Elaborate on some of the Socio-political push and pull factors, which force migration in 21st century?

Q9. Analyze the impact of migration on urban demography?

Q10. Discuss a two way linkage between Migration and Climate Change with example.

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SET-1: ANSWERS

1. At 1.2 billion people, India comprises almost 18 percent of the world's population. However, there has been a huge cut year after year in gross budgetary support towards building human capital. Discuss the challenges that it will bring forth and suggest some remedies.

(200 words)

Approach

1. **Discuss the factors which limit effective utilization of social welfare programs.** ***(40 words)***
2. **Bring out details of government support in the form of gross budgetary support towards building of human capital** ***(60 words)***
3. **Analyze reasons why there has been cuts in the budget support** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Social welfare programs:

- In India, there are a number of social welfare schemes that aims at uplifting the underprivileged and providing necessary assistance to ensure basic facilities of livelihood are made available to all. From housing to education and from employment to subsidized nutritious food there are social schemes for everything in the country.
- However, according to the report by the Ministry of Statistics and Programme Implementation 12 pro-poor schemes in which the central government invested a good amount of money failed to achieve their set targets last financial year.
- For example, Pradhan Mantri Gram SadakYojana failed to meet its target in 14 states, Pradhan MantriAwasYojana – Gramin could not reach its target in 27 states, the skills development programme National Rural Livelihood Mission met its goal only in Kerala and Tamil Nadu.

Why these social schemes failed:

- Generally, people blame the central as well as state government for mismanagement, lack of political will, and of course, gross corruption for the failure of implementing the social welfare schemes.

- What is mostly overlooked is the fact that non-cooperation of the people for whom these projects are created or in many cases, misappropriation of facilities provided under these schemes. Case in point, the recent incident of tribals of Biligiriranga Hills who are selling government provided ghee in open markets to buy alcohol and meet their additional expenses.
- One of the primary reasons for the failure of social welfare scheme in India is the apathy of the people for whom the programmes, schemes and plans are being made.

Analysis of factors which limit effective utilization of social welfare programs:

- For social policy to be effective, decision makers must consider the ismpact their policies will make on the community. This provision is mostly overlooked, thus limiting the scope of its effectiveness.
- Erroneous attempt at the level of decision makers when they don't consider the will of the people while developing and implementing social policy.
- People advocating for change have perceptions and biases that inevitably shape social policies. These attitudes are also not factored in, at times.

Government support in the form of gross budgetary support towards building of human capital:

- In the three important areas of health, education and social protection, the increase in allocation is only about 13%.
- This is negligible in real terms after taking into account the impact of inflation, and even this negligible increase is at least partly provided for by extra-budgetary resources.
- **Planned expenditure not matching the talk:** infrastructure in rural areas the total amount to be spent by the involved ministries will be Rs 14.34 lakh crore, including extra-budgetary and non-budgetary resources of Rs 11.98 lakh crore. The amount mentioned is huge (and many times more than the total budget of the rural development ministry) – and the shock of hearing only increases on learning that around 80% of this is from extra-budgetary and non-budgetary resources.

Why there have been cuts in the budget support:

- Its efforts to keep **fiscal prudence** robust, the Centre trimmed the annual budgetary expenditure for the current financial year by Rs 50,000 crore, or 2% from the estimated level, and the axe could fell primarily on social-sector spending.
- Non-tax revenue collection was significantly below budget target.
- To **meet the tough fiscal deficit** target of 3.3% of the GDP for FY19.
- **Non – achievement of stated outcome** by certain social sector schemes.
- Better "**economies**" implemented by ministries.
- Shift towards **"outcome budgeting"**
- Ministries lagged behind in spending.

Conclusion:

The focus of the project is to create an enabling environment to ensure equal opportunities, equity, Social Justice and empowerment of common citizen. The schemes intend to create a sense of discretion among them and hence the government support can help only till a certain level. Within these factors, it gets important to acknowledge importance as well as implications of continuous operations of social welfare schemes.

2. Population-resources balance determine, whether region is over populated or under-populated. Elucidate.

(200 words)

Approach

1. **Briefly introduce the relation between population and resources** ***(60 words)***
2. **Discuss how can we define whether the region is overpopulated or under-populated** ***(100 words)***
3. **Conclusion** ***(40 words)***

Hints

Fulfilment of any of need, development and aspiration depends upon exploitation of resources which is unevenly distributed around the world. The Size, distribution and population structure within a country must be viewed in relation to its natural resources and the technology available to exploit these resources. The concept of optimum population, overpopulation, and under population is intimately related with the resource base and its exploitation pattern.

In population-resource relation, we need to consider the complex as well as dynamic linkages of capability opportunity-propensity matrix of different human groups and their individual members separately, inhabiting presently and also will inhabit in future in different regions of the world.

- A stage of development in population resource relationship when technology and resources are there but due to lack of adequate hands they are not being efficiently exploited for the betterment of the society. In this stage of population development, the living standard of the population will be lower than the maximum potential. This is the stage of under population.
- If population continued to expand slowly a time will reach when total output keeps increasing but per capita output started diminishing or law of diminishing return started working in the region. The stage of population expansion beyond which the law of diminishing return started working or marginal output started decreasing is the stage of optimum population
- Beyond optimum population, if population further expand then total output may increase but it will have negative impact on their living standard as less and less per head resource are available. This is the condition or stage of overpopulation with respect to the resource base of the region. Depletion of resources also leads to case of over population.

- Due to variation in distribution of population, their composition, technological attainments and resource base and also a very complex pattern of globalization, optimum population in relation to resource base are rarely found. Thus, most of regions either suffer from under population, like Brazil, Columbia, Peru, Zaire, Asiatic Russia, etc. or overpopulation, like India, China, Pakistan, Bangladesh, Malaysia, etc.

Conclusion:

Population escalation is a major issue around the world which has adverse impact on numerous environmental and human health problems. Population growth continue to increase in the world at a fast pace. The effectual way to stop population growth is to implement family planning policies but the exact way to achieve that has created a great deal of disagreement. Several feasible solutions have been proposed by the government to curb population.

3. The second demographic dividend will continue in most Asian countries even after the first demographic dividend has ended. In the light of above statement, discuss the potential and challenges of reaping the benefits of second demographic dividend in India.

(250 words)

Approach

1. **Briefly introduce the demographic dividend** ***(40 words)***
2. **What is first and second demographic dividend** ***(50 words)***
3. **Discuss the potential of second demographic dividend for India** ***(60 words)***
4. **Mention some challenges for second demographic dividend for India** ***(60 words)***
5. **Conclusion** ***(40 words)***

Hints

The demographic profile of a country plays a very important role in the economic development of a country and every country possesses two demographic dividends, though at different point of time. As most of Asian countries make them ready for the passing of the first demographic dividend they must plan to seize the second one and especially India.

What is first and second demographic dividend?

The first dividend occurs during the demographic transition process, when the working-age population increases as a share of the total population, and the percentage of both young and old dependents decreases. The second demographic dividend results from an increase in adult longevity, which causes individuals to save more in preparation for old age. This increase in savings can thus contribute to capital accumulation and economic growth

Potential of SDD for India:

- According to World Population statistics the ratio of old age person (<60years) is expected to increase from 10% at present to 22% by 2050 and correspondingly the working age population is going to decline.
- Indians have a natural tendency to save for their future and especially for old age and therefore these savings can be utilized.
- Government has focused on increasing employment levels through various efforts like Make in India, Start-Up India which will raise the level of income in India so that people can save.
- The indirect taxes have been rationalized post liberalization and further talk of New Direct Tax code will aims at reducing the tax burden and therefore leaving sufficient to save.
- Post liberalization a vibrant financial sector is active to provide saving instruments to people. Government has come out with number of schemes like Atal Pension Yojana.

Challenges for SDD for India:

- Present level of per capita income in India are very low to benefit from SDD. Therefore, there is a need to tap the first demographic dividend through skill India and Make in India in order to tap the SDD.
- The formal employment rates in India are low. Most of the employment is in informal sector where the wage rates are low and savings for future are low.
- Low literacy levels, low penetration of financial institutions makes Indian to look for assets like real estate and gold as viable saving instruments.
- Most of the savings are in the form of gold or other assets therefore suitable means for channelizing these resources to the market must be found out.
- Inflation levels in India tend to be variable and especially towards higher side, which negatively impacts savings.

Conclusion:

Therefore, it can be said that government must come out with suitable policies to tap the SDD in form of greater employment levels, greater financial inclusion, low and sustainable levels of inflation and sound tapping of first demographic dividend if it wants to cash on the SDD.

4. India's demographic achievements are far worse than those of China and the East Asian Tigers, despite the efforts long made by successive governments of independent India. Critically examine the effectiveness of family planning policy in this matter.

(200 words)

Approach

1. **Discuss the factor which led to slow down in the human capital building in India.** ***(40 words)***
2. **Bring out distinctness in the human capital building programme of China and East Asian Tigers** ***(60 words)***

3. Attempt a critique of the family planning policy of India. ***(60 words)***

4. Conclusion ***(40 words)***

Hints

India's demographic achievements

- The life expectancy in India has increased from a low of 20 years during 1911-20 to over 30 during 1931-40, crossed 40 years during 1951 -60, 50 years in the mid-60, 50 years in the mid - 1970s, and 1970s, and 60 in the early 1990s.
- The Infant Mortality Rate (IMR) was well over 100 per thousand through the 1970s but the latest figure, for 2011, is 44.
- Under-five Mortality Rate (U5MR) has declined from over 200 per thousand (one fifth of newborn not surviving to the sixth year) to 55 in 2011.
- A steady fall is seen since the 1970s, with the CBR reaching 22.1 and the TFR 2.4 by 2011.
- India is in the process of demographic transition and has now entered the phase of falling fertility thereby reducing natural growth and is predicted to reach low fertility-mortality replacement level in the foreseeable future.
- Though uncontrolled population growth is no longer an issue, population will be much higher than the present level; India will overtake China and will become the most populated country before 2030.

Despite certain level of achievements, there are factors which have led to the slowdown in the human capital building in India:

- Talent, not capital, will be a key factor linking innovation, competitiveness and growth in the 21st century.
- One factor that accounts for India's low human capital performance is education. Nearly half of India's 28 million tertiary students are pursuing degrees in the social sciences, business, and law. Nearly 20 percent are in engineering, manufacturing, and construction, and roughly 15 percent are in sciences. Humanities, education, agriculture, services, and health and welfare each account for 5 percent or less.
- As these graduates move into the workforce, the concern is whether India's education system is supplying the right mix of workers to meet its economic structure and support its global competitiveness.
- Socioeconomic mobility is a second factor that constrains human capital development. Typically, the relationship between the two is viewed in reverse: Underdeveloped human capital leads to a lack of mobility. However, lack of mobility can entrench counterproductive patterns of thinking handed down over generations.
- Many people believe that their social and economic fate is defined by their social status at birth. These deeply rooted identities lead to a self-determinism that can lower the ambitions of otherwise intelligent people. Rooting out toxic attitudes towards human equality – among both victims and the privileged – is fundamental to improving human capital.

Human capital building programme of China:

- The true success factor for Chinese growth is the huge investments made in human capital development and much of that was made in the 1950s, 1960s and 1970s.

Human capital building programme of East Asian Tigers:

- The growth of the so-called East Asian Tigers — Hong Kong SAR (China), Singapore, South Korea and Taiwan (China) — was built on astute investments in schooling and training and enhanced by a demographic dividend made possible through falling fertility rates. The demographic dividend meant that when young people became workers they not only had more schooling but they also had fewer dependents to support.

Family planning policy:

- Though it covers only 2.4 per cent of world land area, India has 16 per cent of world's population.
- Without the implementation of stringent, effective population management policies, the country's population will rise above 2 billion within the next 20 years.
- The National Population Policy 1976 called for a "frontal attack on the problems of population" and inspired state governments to "pass suitable legislation to make family planning compulsory for citizens" and to stop childbearing after three children, if the "state so desires". The Population Policy 1977 clearly underscored that "compulsion in the area of family welfare must be ruled out for all times to come," and emphasized the need for an educational and motivational approach to make acceptance of family planning completely voluntary. However, in the 1980s, the time-bound, target-oriented approach was revived and efforts to encourage the use of reversible methods were initiated.
- **National Population Policy 2000:** To address the unmet needs for contraception, health care infrastructure, and health personnel, and to integrate service delivery for basic reproductive and child health care; to bring the TFR to replacement levels of2.1 by 2010; to achieve a stable population by 2045.

Thrust areas under family planning programme:

- **Mission ParivarVikas**: to unsure availability of contraceptive products to the clients at all the levels of Health Systems
- Emphasis on Spacing methods like IUCD
- Strengthening community based distribution of contraceptives by involving ASHAs
- Ensuring quality care in Family Planning services by establishing Quality Assurance Committees at state and district levels Plan for accreditation of more private/ NGO facilities to increase the provider base for family planning services under PPP.
- Increasing male participation and promoting Non scalpel vasectomy.
- Strong Political Will and Advocacy at the highest level, especially in states with high fertility rates.

Critique of family planning programme:

- The Government has been experimenting with a variety of approaches to provide family planning services to the people. It started with a clinical approach, switched over to the extension approach, to target-oriented approach, to selective approach, to method specific targets approach, and to decentralized area specific planning approach since 1996. Such policy changes have created confusion and indecisiveness in the minds of the field staff connected with the family welfare programme.
- Untrained Health Workers

- The family welfare programme in India is formulated, sponsored and financed by the Central Government uniformly throughout the country. But it is implemented by the States at their district, block and village level bureaucrats. Such an indiscriminate and macro programme is counterproductive in India where there are diversities of castes, creeds, religions, customs, etc. Thus it is not keeping with local needs and circumstances of different types of people and is counter-productive.
- As a corollary to the above, one of the main weaknesses of this state-sponsored programme has been to achieve quantitative method-specific targets of acceptors of family planning.
- The family welfare programme has failed to check inter-state disparities in respect of population growth. Rather, it has widened them, as revealed by the 2001 Census. For instance, Bihar recorded a much higher growth rate of population at 28.43 per cent during 1991-2001 as against 23.28 per cent in the previous decade

Conclusion:

To stay relevant in a global economy defined by "talent, innovation, and competitiveness," India should take a more comprehensive view of development that incorporates all elements of human capital. Deeper educational reforms, an emphasis on creating a level socio-economic playing field, and improvement in basic urban living conditions would represent a good start.

5. Child marriage and adolescent fertility, childhood malnutrition, and worsening child sex ratio are major obstacles in India to effectively utilize its "demographic window of opportunity". Substantiate this statement.

(200 words)

Approach

1. **Discuss meaning and importance of the term "demographic window of opportunity".** ***(50 words)***
2. **Analyze how Child marriage and adolescent fertility, childhood malnutrition, and worsening child sex ratio are defeating effective utilization of this window.** ***(60 words)***
3. **Attempt suggestive way outs and challenges faced** ***(50 words)***
4. **Conclusion** ***(40 words)***

Hints

Meaning and importance of "demographic window of opportunity**":**

A demographic window of opportunity is created by the process of the demographic transition. This demographic window is the period in which the working-age population is growing and the young cohort is decreasing, while the old cohort is still small.

China will have nearly 210 million fewer workers by 2050. India will add 285 million to its working age population over the same period.

Taking advantage of this demographic window of opportunity will need economic reforms to encourage creating jobs, providing skills training to the growing labour force and improving the quality of human capital by addressing issues such as malnutrition.

Challenges to the demographic window of opportunity: Child marriage and adolescent fertility, childhood malnutrition, and worsening child sex ratio.

For our demographic dividend to indeed become our strength, a minimum of seven pre-requisites are:

- **Large-scale and sustained long-term investment in infrastructure and energy.** Infrastructure creation being relatively labour intensive, it will help absorb the capital and labour surplus
- **Large and sustained capital flows into India,** creating large capital surplus for deployment into infrastructure, energy and water management**.**
- **India becoming a global-scale manufacturing hub,** earning large and sustained surplus that will aid capital build-up for deployment in manufacturing and infrastructure.
- **Large-scale re-generation of arable land**, world-class water harvesting and irrigation, and land and crop productivity to sustain and create jobs in agriculture.
- **Strong logistics and cold chain infrastructure** that will eliminate wastage of agricultural produce and develop a global-scale agriculture and food industry.
- **Science- and technology-driven inventions** and innovations to reach global markets with pricing power.
- **Long periods of relative internal and external peace**, so that we do not waste the already scarce resources of capital and time.

But, **these pre-requisites are heavily dependent on "Labour" factor. If the labour is not educated, healthy and free from vices, the same demographic window of opportunity will turn into demographic burden.**

- India's **literacy rate**, according to Census 2011, is around 74 per cent; the level is well below the world average literacy rate of 84%. Further, the 2011 census indicated a 2001–2011 decadal literacy growth of 9.2%, which is slower than the growth seen during the previous decade. There is a wide gender disparity in the literacy rate in India: effective literacy rates (age 7 and above) in 2011 were 82.14% for men and 65.46% for women
- **Childhood malnutrition:** Government is implementing several schemes and programs like Anganwadi Services, Scheme for Adolescent Girls and PradhanMantriMatruVandanaYojana under the umbrella Integrated Child Development Services Scheme as direct targeted interventions to address the problem of malnutrition in the country. All these schemes address one or other aspects related to nutrition and have the potential to improve nutritional outcomes in the country. Malnutrition is not a direct cause of death but contributes to mortality and morbidity by reducing resistance to infections.
- **Worsening child sex ratio:** Some of the reasons for neglect of girl child and low child sex ratio are son preference and the belief that it is only the son who can perform the last rites, that lineage and inheritance runs through the male line, sons will look after parents in old age, men are the bread winners etc. Exorbitant dowry demand is another reason for female foeticide/infanticide. Small family norm coupled with easy availability of sex determination tests may be a catalyst in the declining child sex ratio, further facilitated by easy availability of Pre-conception sex selection facilities.

Suggestive way outs:

- National level mechanism for tracking the children in migration, planning of vertical development of school space with proper security and, in view of the highly mobile nature of urban poor population, the need for a policy to ensure that identity of children and subsequent entitlement in term of educational right is protected.

- Establish public funded pre-schools in urban areas with a carefully designed age-appropriate learning curriculum and adequate trained teachers.
- Building a system to reach newly-weds to counsel them and improve their nutritional status prior to conception, monetary compensation to pregnant mothers during maternity leave, establishment of crèches attached to the ICDS centres must be considered.

Conclusion:

A growing workforce is an advantage for both the manufacturing and services sectors in India. Not only do businesses have access to people that are young and physically fit, it means less cost pressures, particularly on the wage front, because of the availability of labour. Hence, it is quintessential for India to work on a war footing on Child marriage and adolescent fertility, childhood malnutrition, and worsening child sex ratio fronts to ensure effective utilization of its "demographic window of opportunity.

6. Intra-state and inter-state migration in India is compulsive in nature. Discuss.

(200 words)

Approach

1. **Briefly introduce the term human migration** ***(50 words)***
2. **Discuss the factors by which people migrate from one place to another place (Intra-state and inter-state migration) and why it is compulsive in nature** ***(100 words)***
3. **Way Forward** ***(50 words)***

Hints

Migration (human) is the movement of people from one place to another.

- Migration is a response to the uneven distribution of opportunities over space. People tend to move from place of low opportunity and low safety to the place of higher opportunity and better safety. This, in turn, creates both benefits and problems for the areas; people migrate from and migrate to.

Factors by which people migrate

- Intra State migration takes place between two parts of the same state. A very high proportion (about 70%) of the intra-state migrants is classed as rural to rural migrants while 9-10 per cent of the migrants were classed as urban to urban, about 15 per cent rural to urban and about 5 per cent urban to rural. Nearly three fourth of the total intra-state migrants were females, mainly caused by marriage. As much as 75 per cent of the female migrants belonged to the rural to rural.
- Volume of inter-state migration, i.e., migration between two states is much smaller than the intra- state migration simply because of increase in distance. Most of the inter-state migration takes place along border between two neighbouring states. But nowadays due to better transport facilities and greater opportunities in metro cities, this type of migration is also increasing.

- In India people migrate from rural to urban areas mainly due to poverty, high population pressure on the land, lack of basic infrastructural facilities like health care, education, etc. Apart from these factors, natural disasters such as, flood, drought, cyclonic storms, earthquake, tsunami, wars and local conflicts also give extra push to migrate.
- On the other hand, there are pull factors which attract people from rural areas to cities. The most important pull factor for majority of the rural migrants to urban areas is the better opportunities, availability of regular work and relatively higher wages. Better opportunities for education, better health facilities and sources of entertainment, etc., are also quite important pull factors.

Intra-state and inter-state migration in India is compulsive in nature due to its certain positive impacts.

- **Labour Demand and Supply:** Migration fills gaps in demand for and supply of labor, efficiently allocates skilled labor, unskilled labor, and cheap labor.
- **Economic Remittances:** Economic well being of migrants provides insurance against risks to households in the areas of origin, increases consumer expenditure and investment in health, education and assets formation.
- **Skill Development:** Migration enhances the knowledge and skills of migrants through exposure and interaction with the outside world.
- **Quality of Life:** Migration, enhances chances of employment and economic prosperity which in turn improves quality of life. The migrants also send extra income and remittance back home, thereby positively impacting their native place.
- **Social Remittances:** Migration helps to improve the social life of migrants, as they learn about new cultures, customs, and languages which helps to improve brotherhood among people and ensures greater equality and tolerance.
- **Food and Nutrition Security:** According to the 2018 State of Food and Agriculture report by Food and Agriculture Organisation (FAO), outmigration often leads to improved food and nutrition security for migrants.
- **Demographic Advantage:** As a result of outmigration, the population density of the place of origin is reduced and the birth rate decreases.
- **Climate Change Adaptive Mechanism:** Migration has also emerged as a possible adaptive mechanism in the context of climate change and the occurrence of extreme weather events like floods, droughts, and cyclones.

Way Forward

- India needs to formulate migration centric **policies, strategies, and institutional mechanisms** in order to ensure inclusive growth and development and reduce **distress induced migration,** thereby increasing India's prospects for poverty reduction and achieving Sustainable Development Goals.
- The government at Centre needs to provide amenities and social security's for the migrant population which is riddled with the issues of inadequate housing; low-paid, insecure or hazardous work; extreme vulnerability of women and children to trafficking and sex exploitation etc. For instance, schemes like **Kerala government's** Aawaz health insurance scheme, **Apna Ghar project** -accommodation for migrant workers, Portable Rights- ensures the basic rights to workers in their respective home state, even as they labour in other states.

7. Give the analytical overview of interstate migration in India. Also, critically analyze how far the migration has affected the women in Indian society.

(250 words)

Approach

1. **Give a brief description of interstate migration in India** ***(40 words)***
2. **Discuss the migration pattern in India** ***(90 words)***
3. **Discuss positive and negative effects on women in Indian society.** ***(80 words)***
4. **Way Forward** ***(40 words)***

Hints

Migration and urbanization are direct manifestations of the process of economic development, particularly in the contemporary phase of globalization. According to a recent estimate, inter-state labour migration has increased in India constituting 8.1% of the total workforce of the country.

Migration pattern in India:

- **High-levels of migration:** This is evident from Census data which says about 5-6.5 million people migrated annually between states during 2001-2011. Railway passenger data put this figure at nearly 9 million. This can be attributed for getting better economic opportunities due to falling agriculture incomes, urbanization and globalization.
- **Language is not a barrier:** In labour migration geographic distance appears to be an obstacle than the linguistic and cultural variability. The relatively developed states like Tamil Nadu, Karnataka, Delhi etc. attract the most number of migrants.
- **Migration is accelerating:** Rising to 4.5 per cent per annum in 2001-11 from 2.4 per cent in 1991- 2001. This can be attributed to falling agricultural incomes due to climate change or monsoon failures. According to Census 2001, 8.1% of Indian workforce migrated for economic reasons. The economic boom started in 2000s which opened up many high paying jobs made it financially prudent for people to move for jobs.
- **Male dominant migration:** It is also observed that 80% of migrants are males and the share of women in migrant force is also increasing which was hither negligible. This is evident from the feminization of agriculture and falling women contribution to GDP and workforce participation.
- **Intra-state:** Migrant flow between the states are lower than flows within states to an estimate that flow within the state is four times than between states.
- Gender disparity is coming down with female mobility increasing from almost zero to almost the same as male mobility. Though part of the trend can be attributed to women migrating with their husbands for their jobs, there is a growing number of females migrating for their own jobs.

Negative effect of migration on Women:

- **Negotiated Identities:** Destruction of social and family life and Women not residing in extended families are faced with a loss of their identity when their male counterparts migrate to other places. Younger wives are more likely to be living away from their husbands than older wives. This is reflective of labour migration being highly selective of younger men.

- **Financial hardships and increased responsibilities for women:** responsibilities outside the home may in some instances increase the work burden of women. Domestic responsibilities may be shared by the older daughter who acts as a little surrogate mother to her brothers and sisters.
- **Child-Women Ratio:** A study carried out in Ludhiana district of Punjab, addressing the effect of rural-to urban migration on fertility finds generally higher fertility among migrants than non-migrants. There are economic factors relating higher fertility to higher rates of migration.
- **Feminizations of agriculture:** Migration of young male population from villages has resulted in feminization of agriculture. But women face many challenges in this patriarchal society including that of availing of credit from banks as they generally don't have properties registered in their names.
- **Vulnerable to violence:** In case of male members away, women are at greater risk to gender crimes. Women migrants to other cities after their marriage or for employment also face these hurdles.
- Lack of man-power also hinders availing quality services in villages, because of whose absence they migrated at first place.

Positive effect of migration on Women:

- **Autonomy and control:** to cope with the low level of remittances women often take up employment in the informal sector and learn to administer household budgets.
- **Self-esteem and role expansion:** acquisition of skills in tasks not traditionally undertaken by women. In the absence of husband's women are de facto household heads and execute various responsibilities such as hiring and supervision of agricultural labour
- **Dismantling in gender-segregated roles:** For men, separation from their wives necessitates undertaking domestic tasks that they would not have otherwise done.
- It can be seen that women are largely facing the brunt of distress caused by the migration. There is an urgent need to tackle this un-sustainable pace of migration and ameliorate the condition of women. The success of social welfare programmes like MGNREGA in checking migration must be replicated in affected areas. There is an urgent need to give impetus to programmes like "Gram Uday Se Bharat Uday" along availing services and employment at village level.

Way Forward:

Specific recommendations to prevent subsistence or forced migration

- Sustained availability of work at the grass root level.
- Community works, Conservation of forest resources, revival of traditional water supply system should be taken up to increase the productivity.
- Irrigation facilities should be provided so that the production of more than one crop a year can be done.
- Minor and Micro Irrigation facilities along with renovation of traditional water harvesting systems should be taken up.
- Distress paddy selling should be avoided by giving correct price.
- Employment opportunities, particularly self-employment opportunities should be created at village level to check migration.

- SHGs should be made sustainable and the members should be given intensive capacity building, marketing linkage facilities etc.

Along with this migration is also a progressive force. Bringing transformation into the lives of those migrated. However, they should be provided the health, PDS, education benefits in the new places through transferable state benefit system.

8. Migration is a constant phenomenon throughout human history. People have shifted to find better pastures, more game, and other resources; similarly people have left home to escape religious or political persecution or even climate threat. Elaborate on some of the Socio-political push and pull factors, which force migration in 21st century?

(250 words)

Approach

1. **Briefly introduce migration** ***(50 words)***
2. **Discus social and political factors behind migration** ***(150 words)***
3. **Conclusion** ***(50 words)***

Hints

Migration is a way to move from one place to another in order to live and work. Movement of people from their home to another city, state or country for a job, shelter or some other reasons is called migration. Migration from rural areas to urban areas has increased in past few years in India.

Social Factors

- **Education and literacy:** the need for higher education necessitates intra city, rural to urban and international migration. Increased migration to USA, Australia, and Germany is largely due to higher education opportunities.
- **Marriage:** rural-rural, rural-urban female migration is mostly because of marriage. In the present times females are seen migrating to western countries like USA, UK, Canada etc and also to gulf regions due to marriages.
- **Health care:** migration from rural to urban areas for tertiary health care services and sometimes even for better climate, such as older people shifting from colder climate to warmer climate.
- **Religious:** increase in spiritualism, maintenance of culture, etc, pulls people to religious places like Vatican City, Mecca, Varanasi etc

Political Factor:

- **UNHCR's annual Global Trends Report:** World at War, released in 2015 said that worldwide displacement was at the highest level ever recorded. It said the number of people forcibly displaced at the end of 2014 had risen to a staggering 59.5 million compared to 51.2 million a year earlier.

- The number of refugees and internally displaced people is on the rise. In the past five years, there have been more than 15 conflicts have erupted or reignited: eight in Africa (Côte d'Ivoire, Central African Republic, Libya, Mali, north-eastern Nigeria, Democratic Republic of Congo, South Sudan and this year in Burundi); three in the Middle East (Syria, Iraq, and Yemen); one in Europe (Ukraine) and three in Asia (Kyrgyzstan, and in several areas of Myanmar and Pakistan).
- **Persecution:** Myanmar Rohingya, Tamils in Sri Lanka, Hindus from Bangladesh to India. These state led political persecutions have displaced people of their roots. In 2015 Rohingya were seen migrating from Myanmar to Bangladesh, Indonesia, Malaysia, Australia etc.
- **Civil war and strife:** The civil war in Syria has displaced millions of people who are migrating to Europe.
- **Political instability:** Politically unstable regimes like North Korea, Pakistan and Afghanistan have seen wave of migration to neighbouring countries.
- At the same time stable and secular states act as pull factors of migration. India receives people from Pakistan, Bangladesh, and Myanmar etc. USA attracts world population because of its secular and democratic principles.

Conclusion:

Article 19 of Constitution guarantees citizens with Freedom of Movement within State. The main reason of migration was to upgrade living standard and to gain better public service. It shows that it is needed to upgrade the living standard of people in rural areas and to provide for a better public need. However, the Internal Migration has set of Advantages and Disadvantages. The need of Hour is Government should address the Problems of Migrants to provide better Living and Working Conditions.

9. Analyze the impact of migration on urban demography?

(200 words)

Approach

1. **Give a brief description of migration and rural urban migration** ***(50 words)***
2. **Its social consequences on the urbanisation process** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Migration is one of the important factors after fertility and mortality that affect the demographic changes in a country. But whereas both fertility and mortality operate within the biological framework, migration does not. More importantly, migration influences the social, political and economic life of the people. In India, one of the most significant migration patterns has been rural to urban migration, the movement of people from the countryside to cities in search of various opportunities.

Rural-to-urban migration, in particular, affects migrants' economic burdens and opportunities, presents new environmental risks and benefits, leads to changes in the cultural and social context in which migrants function, and provides access to resources that were unavailable at their place of origin. Clearly, the migration process and its consequences can impact migrants' well-being both positively and negatively.

Consequences

- It has effects on both population of the places that people leave & on the population of those in which they settle. These effects vary with different types of migration & length of migrants stay in places.
- Generally the proportion of the old, children and females increases in the source areas due to migration. On the other hand the proportion of these persons in the population of the receiving areas is generally lowered. So this is one of the reasons for high sex ratio in source areas and low sex ratio in the receiving areas. This happens because it is the youthful male population which is mostly involved in migration.
- Thus not only the number of people but also the structure of population in both regions involved in migration is changed. It results in changes in rates of fertility, mortality and consequently in the growth of population. The source regions are depleted of the youthful population and this result in lowered rates of births and comparatively lower rates of growth. An inverse impact is observed in the case of population structure of the receiving areas.
- Further in the case of male rural-to-urban migration, young men seek employment in the cities, leaving behind female relatives to manage on their own and to provide for both the elderly and the young. This not only changes family structure, but usually leads to adjustments in family roles, and more importantly, in the division of labour as well as in the way labour is utilised in the community of origin and destination.
- In the long term, it also leads to aging of the labour force. As a result of these adjustments, women often assume major responsibilities for, and in some countries become the backbone of, subsistence food production (a phenomenon which has been termed the 'feminization of agriculture') and in the management of their families' livelihoods.
- However, high out migration from Uttarakhand, Rajasthan, Madhya Pradesh and Eastern Maharashtra have brought serious imbalances in age and sex composition in these states. Similar imbalances are also brought in the recipient states.
- Further Rural-urban adult migration makes heavy demand on children who are left behind in rural areas to shoulder the responsibility of agriculture production and food security. Labour shortage due to rural-urban adult migration may mean that children in rural areas often have to face tighter time schedules and patterns of time use and human energy inputs required in agriculture production.
- It would be important to look at migration not always as a negative phenomenon - reflecting misery and lack of livelihood opportunities in the out migrating regions and absence of basic amenities and health hazards in immigrating regions. It needs to be seen also as an opportunity being taken up by people to improve their socio-economic conditions.
- There are evidences that this is currently being taken up by skilled and better off sections. A large number of science and technology personnel in backward regions are locating themselves in a handful of cities and developed regions, analogous to the trends and pattern in international migration. While a section of the elite and highly skilled persons are increasingly enjoying benefits of migration.

- It should be possible to "use urban dynamics to help reduce poverty" and make migration an instrument in the strategy of poverty alleviation and hence be incorporated into a programme for meeting the first and the most important target under MDG.

Conclusion:

It is important to harness the potential of migration in the context of development and poverty alleviation.

10. Discuss a two way linkage between Migration and Climate Change with example.

(200 words)

Approach

1. **Give a brief description of Migration and Climate Change** ***(40 words)***
2. **How climate change results into migration** ***(60 words)***
3. **How migration effects climate change** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

The United Nations Framework Convention on Climate Change (UNFCCC) defines 'climate change' as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Climate change is the increasing the instances of extreme climatic events likes floods, cyclones, draughts, etc., which effect human beings in various ways like loss of property, livelihood and many a times life. Migration has been one of the most visible negative impacts of climate change which further effects climate change.

Two way linkage between climate change and migration:

Climate change, environment variability and migration are interlinked. Climate change results into environmental degradation, disasters which results into migration and that in turn can further feed climate change.

How climate change results into migration:

Climate-related migration not only involves people fleeing from the imminent threat or aftermath of a climate disaster – the most commonly referenced type – but also entails planned relocation by households and communities as an adaptation strategy to search for alternative livelihoods and sources of income.

Climate change results into changes in rainfall patterns and hydrological cycles, soil degradation, desertification etc. which effects crop yields and agriculture overall. This makes livelihood and survival difficult and creates food security problem.

Climate change also exacerbates health problems especially in equatorial and tropical areas. With increases incidences of viral and other diseases and poor health infrastructure in some backward areas people start migration.

Extreme events like floods, cyclones, coastal erosion and coastal floods creates threats to life and property, so people generally try to avoid such areas.

As a response to these effects people use migration as an adaptive strategy. Extreme climatic events in recent periods like two consecutive draughts in Maharashtra, force people to migrate to new areas or urban towns.

The migration can be to urban areas, new virgin areas in forests, within same country and foreign country also.

How migration effects climate change:

As people migrate to new areas like urban areas where they change their life style, habits, etc. More use of fossil fuels, power etc is attached to urban areas. This causes climate change. In a report by IPCC, CO2 emission from use of fossil fuels, industries and transportation is major contributor to green house gases.

Many times communities migrate to new areas and clear forests or grasslands which otherwise were storehouse of carbon. This further lead to climate change.

Therefore it is clear that climate change and migration has two way linkages with each feeding other. As a result of each negatively affecting the sustainability of human beings there is a need to manage both efficiently.

Conclusion:

Adaptation and mitigation strategies like drought proofing of agriculture, building infrastructure which can withstand floods and cyclones etc. must be developed to tackle extreme climatic events so that migration is avoided.

There should be a migration policy so that negative effects such as cleansing of forests can be avoided by properly managing migration.

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NOTES

SET-1.1: QUESTIONS

POPULATION AND MIGRATION

Q1. Elaborate the link between a country's landscape and occupational structure; also illustrate the relationship between this link and economic development, with suitable example.

Q2. India lags behind China in literacy and education rates for both its rural and urban population, which could impact future development. Discuss

Q3. India's rising population has brought in certain social challenges like son Meta preference, as indicated by the Economic Survey. Critically link these social challenges with the obstacles faced by the "developmental vehicle" of the country.

Q4. The geography of Central India tribal belt is one of the major factors behind rise of left wing extremism. Examine.

Q5. Unsustainable Over development rather than poverty is the cause of environmental problems in the emerging India. Critically evaluate.

Q6. Open defecation in India has a direct correlation with the geography of the region. Analyze the reasons for it.

Q7. Examine the role of digital technology in transforming the rural India with suitable examples.

Q8. "Inclusive growth in India requires collective efforts". Explain the private sector's participation in driving growth particularly in the laggard states.

Q9. Critically examine the idea of sustainable development.

Q10. Development of satellite town is the important remedy for tackling the issue of haphazard urban development. How far do you agree with this statement? Illustrate.

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SET-1.1: ANSWERS

1. Elaborate the link between a country's landscape and occupational structure; also illustrate the relationship between this link and economic development, with suitable example.

(200 words)

Approach

1. **Discuss, How geography of the region is linked to economic development** ***(100 words)***
2. **Elaborate the link between a country's landscape and occupational structure** ***(100 words)***

Hints

The landscape and other geographical aspects of a region severely affect its society and people, particularly the manner in which they earn livelihood. Localized nature of development processes and innovative activities is linked to the emergence of spatial inequalities in development levels. Such disparities at the geographical level appear to be even more relevant in the case of developing and emerging countries, where only a limited set of locations shows the capability to spur economic growth through industrialization, while the rest seems to stagnate or decline.

As a Result while,

- Tropical regions are hindered in development relative to temperate regions, probably because of higher disease burdens and limitations on agricultural productivity; the Coastal regions, and regions linked to coasts by ocean-navigable waterways, are strongly favoured in development relative to the hinterlands. It is a major cause of Mumbai, Chennai, Kolkata, and Vishakhapatnam being highly industrialized.
- Natural disasters are also one of the determinants of industrial development of a region. That's why cyclone affected Orissa, landslides affected Uttarakhand and Himachal Pradesh and flood affected northern Bihar have remained relatively poorly developed. Difficult terrain can hamper the industrial growth in an area. This is one of the main causes of underdevelopment of the north eastern India besides lack of peace.
- Furthermore, geography seems to be a factor in the choice of economic policy itself. When we identify geographical regions that are not conducive to modern industrial growth, we find that many of these regions have high population density and rapid population rise, e.g., eastern UP and Bihar, thus showing high interdependence of economy and geography of a region.

- For example, the people in Rajasthan and Ladakh were forced to be nomadic tribesman due to the barren land there, while people in the region between these two (Haryana and Punjab), practiced settled agriculture not long ago. However, in modern time, while the extreme climate of these two regions has brought a large number of tourists and the people have shifted from grazing cattle to hospitality industry; the people in Punjab and Haryana are still mostly engaged in agriculture. While both the regions have experienced development; in one place the development has affected occupational structure (from shepherds to hospitality) and in other the occupation structure (agriculture) has brought development.
- Thus, the economic development and occupational structure affects each other and landscape also plays a big role in it. However, over the course of time, the role of landscape is going down, as local economies are getting more intertwined with national and international demand – supply chain. The region which was good for production of a particular commodity could not produce it in abundance due to lack of local demand, are now able to specialize in it, due to global demand.
- For example, many regions of USA have resorted to corn and maize production from wheat and other products, due to increased global demand for them for production of bio-fuels. Thus, globalization and economic development has affected the domestic production pattern in USA. Similarly, a global resurgence in consumption of oats has brought good incomes to the oats growing regions in Europe and has resulted in employment generation, in some cases people have joined from other sectors such as manufacturing job to oats production.

2. India lags behind China in literacy and education rates for both its rural and urban population, which could impact future development. Discuss

(200 words)

Approach

1. **Bring out Literacy parameters and current situation of India and China.** ***(40 words)***
2. **Analyze how and why India lags behind China in literacy and education.** ***(60 words)***
3. **Challenges and opportunities foreseen in this course –correction path.** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Literacy achievements in China:

- China is close to the elimination of illiteracy in the younger age groups, while India is nowhere near achieving that goal.
- Education in China is a state-run system of public education run by the Ministry of Education. All citizens must attend school for at least nine years, known as the nine-year compulsory education, which is funded by the government. Compulsory education includes six years of primary education, starting at age six or seven, and three years of junior secondary education (junior middle school) for ages 12 to 15.

- The Ministry of Education reported a 99 percent attendance rate for primary school and an 80 percent rate for both primary and middle schools.

Literacy achievements in India

- According to the Census Data 2011, India is overpopulated with a population of 121,01,93,422 which means India today is a powerhouse of talent of 121,01,93,422 plus. In order to convert the population from a challenge to an opportunity, the area that requires immediate attention is education and training.
- 25% of Indian population is still illiterate and out of the total population of 1.21 billion in India, 220 million children go to school.
- India's GER (Gross Enrolment Ratio) is 12.4 percent. The GER in developed countries is between 50 percent to 70 percent.
- Our current education system selectively discards talented students with inquisitiveness, ability to ask questions and dream to do something challenging, something better for the society.

Why India lags behind China in literacy and education

- India scores much lower than China in female literacy and labour participation, which is affecting the country's growth potential. In 2011, the Indian female adult literacy rate stood at 55.0% of the female population aged 15+, compared to 91.4% in China. In the same year, India's female employment rate was 25.0% of the working age female population (aged 15-64), compared to 71.5% in China.
- The true meaning of economic development is to be found only when people from all sections of society benefit and also when economic growth is able to achieve the UN Sustainable Development Goals by eliminating hunger, diseases, malnutrition, and illiteracy.
- Assessing the performance of a country solely based on a single metric like GDP does not give a true and accurate picture of a country's progress. In this context, when one compares India's progress with China's on critical social indices, India is a laggard.
- The Global Burden of Disease 2015 report, 2016 Social Progress Index and the 2016 Global Hunger Index show that India lags far behind China in terms of human capital development.
- The lower rates in India have been due to gender inequalities and a preference among many Indian families of educating males instead of females. According to the World Economic Forum's Gender Gap Report 2011, India ranked 113th out of 135 countries, compared to China (61st). The index measures countries' gender disparity in terms of education, health, economic clout and political empowerment.
- India's large rural population, where women typically work informally in households and in agriculture has also been a factor in its lower rates of female literacy and employment. In 2011, 68.8% of India's population still lived in rural areas, higher than 50.1% in China.

Course –correction path:

- There is a need for the Indian government to invest heavily in education and public health care, as well as take effective steps to improve gender equality and address malnutrition and stunting, especially among young children. These are all necessary efforts if India aspires to outpace China in social development by the end of the next decade.

- The Central Government has launched an Integrated Scheme for school education- Samagra Shiksha, which subsumes the three erstwhile Centrally Sponsored Schemes of Sarva Shiksha Abhiyan (SSA), Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and Teacher Education, from the year 2018-19. Under the Centrally Sponsored Scheme of Samagra Shiksha, Information & Communication Technology (ICT) component envisages covering all Government and Government Aided schools from classes VI to XII.
- In higher education also, various schemes, namely, Rashtriya Uchchatar Shiksha Abhiyan (RUSA), Global Initiative for Academics Network (GIAN), Impacting Research, Innovation & Technology (IMPRINT), Technical Education Quality Improvement Programme (TEQIP), Pandit Madan Mohan Malaviya National Mission on Teachers and Teaching (PMMMNMTT), Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM), National Digital Library, campus connect programme, Uchhatar Avishkar Abhiyan, Unnat Bharat Abhiyan are being implemented to improve the quality of higher education. A number of initiatives are also undertaken by UGC and AICTE for quality improvement in higher and technical education.
- Currently, the Government is in the process of framing a New Education Policy (NEP) for meeting the changing dynamics of the population's requirement with regard to quality education, innovation and research, aiming to make India a knowledge superpower by equipping its students with the necessary skills and knowledge.

Challenges and opportunities foreseen

- Little oversight mechanism in education sector
- Since Education is a public good, private sectors are least hopeful in providing services at affordable rates
- Weak governance and regulatory system at higher education.

Conclusion:

For India, educational quality reform (devoid of Learning poverty gap and count) continues to be high on its list of development priorities because the country's relatively high rates of economic growth have not led to a reduction in hunger and under nutrition.

3. India's rising population has brought in certain social challenges like son Meta preference, as indicated by the Economic Survey. Critically link these social challenges with the obstacles faced by the "developmental vehicle" of the country.

(250 words)

Approach

1. **Discuss approaches which India seeks to utilize to upgrade its social "developmental vehicle".** ***(60 words)***
2. **Analyze social evils like son Meta preference and their impact on inclusive growth.** ***(80 words)***
3. **What actions have the government taken to facilitate inclusive development (bias free Growth).** ***(70 words)***
4. **Conclusion** ***(40 words)***

Hints

India's Developmental Model:

For a developing country to achieve modernization and economic growth, it has to follow a linear developmental model that divides up progress into stages.

According to linear conceptions of development, India—and other developing countries like it—ought to focus first on delivering, in both quantity and quality, basic necessities: health care, education, water and sanitation facilities, and food. Only then should the country turn to investing more aggressively in flashy projects that promote higher levels of modernization.

The essence of modernization and economic growth should favor "human capital building", something which is and should be included in the developmental model, to be used by India.

Social problems which create hurdles in the path of developmental vehicle:

- Illiteracy, Poverty, Unemployment and Population Growth
- Child Abuse, Child Labour and Violence against Women
- Casteism, Communalism, Regionalism and Language Conflicts
- Crime, Criminal, Criminology and Juvenile Delinquency
- Alcoholism, Drug Abuse and Corruption
- Phenomenon of son meta-preference which involves parents adopting fertility "stopping rules"

Illiteracy, Poverty, Unemployment and Population Growth and their effect on developmental vehicle

- **Effects of the rapid population growth in India:** The burden of school age population has already shown signs of becoming unbearable. The proportion of children in schools is increasing fast and, vast numbers are still not covered. The absolute number or illiterate persons increases every year. This is only an indication of the wastage of human resources for want of appropriate development opportunities.
- **Child Abuse - effects**: The first is loss of self-esteem; the second effect is on self-dependency, third on deviant behaviour. The fourth effect is on social and interpersonal problems and last effect is victimization. Abused children develop a negative view of both; themselves and society.
- **Child Labour – effects:** Child workers who are made to toil for long hours under hazardous conditions hardly maintain good health. Many of them suffer from lung diseases, tuberculosis, chronic stomach pain, eye diseases, asthma, bronchitis, back pain, skin diseases, typhoid etc. working conditions of these children are so horrible that some get injured and even disabled in fire accidents.
- **Violence against Women:** It is the result of unequal distribution of power between men and women, unequal access to resources, gendered division of Labour, and gendered notions of sexuality that stems from traditional ideologies. Consequently, violence against women results in further subordination of women and reinforces women's economic, political and social inequalities
- **Communalism – effects:** It is a social phenomenon characterized by the religion of two communities, often leading to tension and even riots between them. In its latest manifestation, communalism amounts to discrimination against a religious group in matters of employment, education, commerce, politics, etc.

Phenomenon of son meta-preference:

- The biologically determined natural sex ratio at birth is 1050 males per 1000 females. After sex selection was declared illegal in India in 1994, the sex ratio at birth (SRB) began to stabilize. In 1970, the SRB was 1060 males per 1000 females. In 2014, this rose to 1108, contrary to the belief that development would mend the skewed sex ratio.
- **Reasons behind preferring a male child:** compulsion of a woman to move to her husband's house post marriage, inheritance of property, rituals performed by sons, and dowry.

Actions taken by the government to facilitate inclusive development

- The challenge of gender is long-standing. India must confront the societal preference, even meta-preference for a son, which appears inoculated to development. The skewed sex ratio in favor of males led to the identification of "missing" women. But there may be a meta-preference manifesting itself in fertility stopping rules contingent on the sex of the last child, which notionally creates "unwanted" girls, estimated at about 21 million. Consigning these odious categories to history soon should be society's objective. The **government's Beti Bachao, Beti Padhao and Sukanya Samridhi Yojana schemes**, and mandatory maternity leave rules are all steps in the right direction.

Conclusion:

Just as India has committed to moving up the ranks in the ease of doing business indicator, it should perhaps do so on gender outcomes as well. Here, the aim should be broader. Many of the gender outcomes are manifestations of a deeper societal preference, even meta-preference for boys, leading to many "missing" women and "unwanted" girls. So, Indian society as a whole should perhaps resolve—the miles to go before society can sleep in good conscience.

4. The geography of Central India tribal belt is one of the major factors behind rise of left wing extremism. Examine.

(200 words)

Approach

5. **Briefly introduce the Naxalism or Left wing extremism** ***(50 words)***
6. **Discuss the reasons behind the spread of Naxalism** ***(100 words)***
7. **Conclusion** ***(50 words)***

Hints

The Naxalite movement is also the biggest threat to India, in terms of the effects on its citizens and what it means for democracy and rule of law. Not only has there been a great loss of life since the conflict between the guerrillas and the military, but addressing the problem through violence risks polarising people further and driving them to subservience.

The reason for rise of Left wing extremism in India is manifold. These include Socio-economic causes, Governance Failure etc however Geography of central India tribal belt also plays a major role in spread of Naxalism in this region.

The geographical reasons are:

- The tribal belt of central India is very rich in Minerals. Most of Bauxite, iron-ore, coal and mica are found in this region. Post Independence Industrialization required Minerals as raw materials and since these areas were rich in Minerals they attracted Government PSUs and private Players. The exploration of these Minerals led to acquisition of lands of tribal's however they were not either adequately compensated for it or not compensated at all. This has led to the conflict between economic progress and aboriginal land rights that fuel the Naxalite's activities.
- Most of the tribal belt of central India is covered with Forests Naxalism thrives in these areas. It helps them fight against the police and the army by waging Guerrilla warfare. Also due to difficult and hostile terrain it is difficult for Security forces to fight.
- The slow implementation of land reforms is also one of the reasons for the growth of Naxalism. Landlords frequently moved the court to delay implementation of these reforms. This has impacted the agricultural development and led to spread of poverty and unemployment.
- Governance failure is also one reason for the rise of Naxalism and Geography paid major role in the Governance failure since difficult and hostile terrain made it difficult for the schemes and the policies of the Government to reach the people in this area due to lack of physical connectivity as roads are difficult to build in this terrain. It also made it difficult for the people to complain to the higher authorities about the oppression and exploitation of the local bureaucracy and since local bureaucracy was shielded from any complaints they continued with their oppressive ways. The impact of the all this was backwardness of this region, which increased tribal alienation and forced them to join naxal movement.
- Hence Geography has played a major role in the rise of Naxalism in tribal areas of central India along with socio-economic causes.

5. Unsustainable Over development rather than poverty is the cause of environmental problems in the emerging India. Critically evaluate.

(200 words)

Approach

1. **Give a brief description of Unsustainable Over development** ***(50 words)***
2. **Discuss the environmental problems in the emerging India due to poverty and Unsustainable Over development** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

The rapid increase in population and economic development has led to severe environmental degradation that undermines the environmental resource base upon which sustainable development depends. The economics of environmental pollution, depletion and degradation of resources has in fact been neglected as compared to the issues of growth and expansion.

- India is facing various kinds of environmental problems like air pollution, pollution of water bodies, loss of biodiversity and green spaces to name a few.
- **Many a times in orthodox view, poverty is identified as the cause of environmental problems because of the following reasons:**

- Poor people are unaware of the environmental impacts of their actions and carry on their activities indiscriminately.
- It is said that poor people degrade environment in response to population growth and economic marginalization. Poor people are forced to overuse their environment for their survival and this lead to impoverishment of environment which further impoverish them as the benefits they draw from it decreases.
- Their actions like open defecation in absence of toilet facilities, unsustainable use of fertilizers in agriculture field lead to contamination of water bodies.
- They use forest wood or other traditional means of energy which are responsible for release of large amount of soot and CO_2 in environment.
- In tribal areas the practise of Jhum cultivation leads to cleansing of vast amounts of forest areas and loss of green cover. These people also violate the inviolable spaces of wildlife.
- All these have resulted into faulty policies like alienating forest people from their resources, assigning the responsibility of environment management solely to governments and sidelining people.
- But if we look in reality it is the unsustainable over development, with its various negative externalities like inequalities in the society, is the real reason for environmental problems being faced by India because of the following reasons.
- With too much focus on economic aspects only and overlooking environmental aspects has resulted into environmental problems. For example the European countries score high in digital governance aspects but are also the highest contributors to per capita e-waste, USA with highest GDP is highest contributor of green house gases.
- Unrestrained focus on development has led to the problem in Latur in recent and in Punjab and Haryana where ecological unsustainable crops were sown through government policy support.
- Similarly unrestrained consumerism has led to over-exploitation of resources, encroachment of water bodies as was evident during Chennai and Uttarakhand floods.
- Even the problems of poor can be attributed to unsustainable development which have resulted into emasculation of economic resources by few and leaving others struggle for survival, for whom it is difficult to consider environment as a factor in struggle for survival.
- Overall it can be said that though both poverty and unsustainable over development both are responsible for the present environmental problems but these effects are a by-product of livelihood earning by poor and luxurious life by rich.
- In view of this there is a need to engrain environment into every aspect of policy making, involvement of people into management of environment and creating awareness among them so that development effort is sustainable and environmentally sensitive.

6. Open defecation in India has a direct correlation with the geography of the region. Analyze the reasons for it.

(200 words)

Approach

1. Briefly introduce Open defecation ***(50 words)***

2. **Discuss why open defecation in India has a direct correlation with the geography of the region** ***(60 words)***
3. **Steps taken by the Government** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

Open defecation refers to the practice whereby people go out in fields, bushes, forests, open bodies of water, or other open spaces rather than using the toilet to defecate.

Around 595 million people, which is nearly half the population of India, defecate in the open. India accounts for 90 per cent of the people in South Asia and 59 per cent of the 1.1 billion people in the world who practise open defecation (UNICEF report).

Though several socio economic, infrastructural and attitudinal factors lies at the root of this problem, a distinct correlation with the geography of the region can be marked.

Indo-Gangetic plain: High population pressure, poverty, illiteracy and infrastructural inadequacy has led to this area facing the highest incidence of open defecation.(Uttar Pradesh, Bihar, West Bengal etc)

More in village than in Urban areas: Availability of open fields, wilderness and running water sources, makes it easy for village people to defecate in open(attitude plays a major role).

Dry regions: 60% of India's land area is classified as semi arid and arid, where people face severe crunch of drinking water and other domestic use. Sanitation assumes a less priority here. A study conducted by SULABH points out that despite having toilet at home people in Jaisalmer prefer to defecate in open due to water crunch.

Hilly and forested area: Difficult terrain and isolated location of central India forest belt (MP, Chhattisgarh), makes construction of toilet and disposal of human waste, difficult.

City Slum: Lack of basic sanitation and water facility forces slum dwellers to defecate in open. E.g. Dharavi , Mumbai.

However Geographical pattern of open defecation in India must be juxtaposed with other fundamental factors (attitude, cultural norms, technology, etc) to chart out a holistic strategy to handle the issue of open defecation in India.

Steps taken by the Government:

In order to ensure sanitation facilities in rural areas with the broader goal to eradicate the practice of open defecation. E.g. **Swachh Bharat Mission:** The government is taking various steps under the Swachh Bharat Mission to make all states in the country ODF

The change in Mindset is most important. Many of them already have a toilet but prefer to defecate in the open. The biggest challenge therefore is triggering behaviour change in vast section of rural population regarding need to use toilets. Further there is need for availability of water for use of toilets.

Thus community-led public-private partnerships needed to improve access to toilets and awareness campaigns in schools and slums in both urban and rural sectors for maintenance of sanitation.

7. Examine the role of digital technology in transforming the rural India with suitable examples.

(200 words)

Approach

1. **Briefly introduce the digital technology** ***(50 words)***
2. **Discuss how digital technology helps in transforming rural India** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Digital technologies are becoming the facilitator of socio-economic development in rural India with its obvious facilities by way of health, education, financial services and employment avenues and improving agriculture productivity, etc.

Transforming rural India with the help of digital technologies:

- These can help the bridge gaps by providing 'e' and 'm' services. Digital technologies meant for rural sector can be classified into three categories: Those solutions which aim are aimed at empowerment, those which would do enablement, those for market expansion.
- In rain-fed areas, the construction of bunds and check-dams is vital. Choosing the right location for such water-harvesting structures can be greatly facilitated by using satellite remote sensing data, as pilot projects have already demonstrated
- With respect to empowerment- e-choupal comes up as fine example. This is example of efficient supply chain system empowering the farmers with timely and relevant information enabling them to get better returns for their produce. It gives other offerings also to the farmers' like- insurance and farm management practice, etc.
- The practice of e-governance, which creates transparency and governance through IT has enabled the citizens. Successful implementation of e-governance in the areas like- maintain land records is a great step in removing the malpractices and creating assurance of rightful ownership
- Aadhar is another such tool, which has empowered the masses by confirming their identities and is good example of ICT solution attempting to provide access to monetary benefits by establishing the correct identity and this way rural economy is also expanding. Examples include DBT for LPG cylinders, Aadhar based ration distribution.
- Information related to commodity prices, transportation, agricultural practices, weather, etc., are crucial for the farmer. Digital technology can now provide this easily and instantaneously either at a village computer kiosk or on a mobile handset. Transactions, including purchase of agricultural inputs, but also other goods and services, can also be handled on such kiosks or on a mobile phone.
- IT supports new methods for precision agriculture like computerized farm machinery that applies for fertilizers and pesticides. Farm animals are fed and monitored by electronic sensors and identification systems.

- Soil Management, Water Management, Seed Management, Fertilizer Management, Pest Management, Harvest Management and Post-Harvest Management are the important components of e-Agriculture where technology aids farmers with better information and alternatives. It uses a host of technologies like Remote Sensing, Computer Simulation, Assessment of speed and direction of Wind, Soil quality assays, Crop Yield predictions and Marketing using IT.
- Direct connect through e-commerce has facilitated large number of artisans agro-based small enterprises in rural areas. Women's livelihood is being facilitated amongst the weavers' community in the north-eastern states by marketing their product through the internet medium.
- Central, state governments and private organizations have taken ICT measures for agriculture extension which include ITC- e-choupal, Kisan Kerala, Aaqua, Rice knowledge management portal, e-Krishi, Mahindra KisanMitra, IFFCO Agri-portal, Village knowledge centers etc.

Though lots of problems like feasibility of connectivity in rural areas, cost involved in ensuring services, need for basic computer literacy and literacy hinders the fast development of e-Agriculture, it will definitely be an engine of growth in Rural India once the initial hiccups are overcome. With the new extension of ITC initiatives like Krishivihar, i-Kisan, e-kutir, e-Sagoo, ICT models- AGROWEB, Agropedia, Agr-Innovate, etc. Indian agriculture has come to a long way and established several records in terms of production and productivity. IT had the potential to transform agriculture into a better prospect in the wake of climate change and decrease in the cultivable land.

8. "Inclusive growth in India requires collective efforts". Explain the private sector's participation in driving growth particularly in the laggard states.

(200 words)

Approach

1. **Briefly introduce why inclusive growth is the biggest challenge for India** ***(50 words)***
2. **Discuss the public-private sector partnership in driving growth particularly in the laggard states** ***(60 words)***
3. **Role of private sector in the growth** ***(60 words)***
4. **Conclusion** ***(30 words)***

Hints

Inclusive growth is necessary for sustainable development and equitable distribution of wealth and prosperity. Achieving inclusive growth is the biggest challenge in a country like India. The best way to achieve inclusive growth is through developing people's skills.

India has the potential of becoming a leading economy and has the unique opportunity to make that growth inclusive, provided there is willingness on the part of all sections of society to put in hard and disciplined work, together with serious, sustained and purposeful planning.

There is a need for more public-private partnerships. The private sector should take more social responsibility and contribute towards making growth more inclusive.

The private sector as non-state players includes NGOs, INGOs, civil society groups, corporate foundations and resource agencies. It is believe to be possible for like- minded stakeholders to come together and supplement each other's' efforts. Each stakeholder brings a different set of skills, which can collectively help in effective implementation.

Over the past few years, policymakers and development finance institutions (DFIs) have increasingly looked to the private sector to help meet these financing needs. In the right investment climate, the private sector can support the inclusive and environmentally sustainable growth that is at the heart of the global development agenda.

A key contribution of the private sector is in promoting economic growth, which it does through **investments, knowledge transfer, and enhanced productivity**. By creating **new markets, fostering competition**, and making investments, the private sector helps **allocate resources productively and efficiently, improving prospects for economic growth**. Economic growth generates resources that can be used for future investment as well as social development.

According to the World Bank, the private sector is the source of nearly 90% of the world's jobs. So by **providing direct employment**, as well as finance to the sectors and geographic regions where it is most needed, the private sector promotes not just growth — it promotes inclusive growth.

The private sector also helps to **boost living standards**. This extends beyond extreme poverty as captured in the MDGs to areas such as the availability and quality of goods and services such as housing, infrastructure, health, and education. In this context, the private sector also plays a critical role in improving service delivery through public-private partnerships. These are particularly relevant in the case of infrastructure, as they allow for risk sharing, and are benefitting from improved institutional capacity and clearer legal and regulatory frameworks.

The private sector can also promote the adoption and/or retrofitting of **environment-friendly technologies**. This is valuable in the face of climate change, which can adversely impact many critical development goals such as food security, health, and water. The largest mitigation opportunities, especially for energy efficiency, remain in middle income countries.

Lastly, the private sector is a **reliable source of revenue** for government operations through its contributions to taxes and duties.

Education forms the foundation for all levels of learning and development. It empowers and equips individuals with analytical capabilities, instils confidence and fortifies them with determination to achieve goal-setting competencies. It, therefore, plays a pivotal role in improving the socio-economic condition of the nation.

9. Critically examine the idea of sustainable development.

(200 words)

Approach

1. **Briefly introduce the term "sustainable development"** ***(30 words)***
2. **Explain the concept of sustainable development** ***(60 words)***

3. **How it helps to achieve environmental, social, and economic needs** ***(60 words)***

4. **Critically examine the ideas of sustainable development.** ***(50 words)***

Hints

'Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.'

The concept of sustainable development can be interpreted in many different ways, but at its core is an approach to development that looks to balance different and often competing, needs against an awareness of the environmental, social and economic limitations we face as a society.

All too often, development is driven by one particular need, without fully considering the wider or future impacts. We are already seeing the damage this kind of approach can cause, from large-scale financial crises caused by irresponsible banking, to changes in global climate resulting from our dependence on fossil fuel-based energy sources. The longer we pursue unsustainable development, the more frequent and severe its consequences are likely to become, which is why we need to take action now.

So is it all just about the environment? Living within our environmental limits is one of the central principles of sustainable development. One implication of not doing so is climate change.

But the focus of sustainable development is far broader than just the environment. It's also about ensuring a strong, healthy and just society. This means meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity.

- The Rio Conference gave a boost to both national and local action to implement the idea of Sustainable development.
- National committees for sustainable development were established on a high political level in many countries.
- Local Agenda 21 documents and action plans were drawn up in a great number of municipalities.
- Many corporations jumped on the bandwagon.
- The newly established United Nations Commission for Sustainable Development started to scrutinize the implementation of the Rio decisions at its annual meetings.

At the same time a sceptical debate about the concept continued. One of the most striking characteristics of the term "sustainable development" is that it can mean all things to all people. In the environmental community many accused government and business of "cosmetic environmentalism" under the umbrella of the concept. Some felt that the term "sustainable development" was used as an alibi rather than as guidance for strong action.

Another critical argument was related to the de facto dominance of environmentally centred actors in the work. These critical voices demanded more emphasis on the economic and social 'pillars' of the concept. More recently it has been argued that the political acceptability of sustainable development depends on its capacity to respond to a country's persistent social problems. It has also been noted that the economic 'pillar' has to be integrated in the concept as a whole and not be seen as an independent part of it. However, the term does not give any guidance on how to arbitrate between the unavoidably conflicting objectives of economic rationality/profitability, social justice and ecological equilibrium.

Climate change is a reminder of the fact that poor people are most likely to be the first victims and the greatest sufferers of environmental degradation. The poor are more vulnerable than others to environmental hazards and environment-related conflicts and least able to cope with them when they occur. They also tend to be most dependent on the environment and direct use of natural resources, and are therefore most severely affected by environmental degradation and lack of access to natural resources.

1.2 billion people are still living on less than a dollar a day and half the developing world lacks access to sanitation. Every week in the developing world 200,000 children under five die of disease and 10,000 women die giving birth. In addition we need to adjust ourselves to the new geography of poverty. Some regions score highly on most of the goals, whereas sub-Saharan Africa is lagging behind. In a few years' time, for the first time in history, there will be more people, in absolute figures, living in extreme poverty in Africa than in Asia.

10. Development of satellite town is the important remedy for tackling the issue of haphazard urban development. How far do you agree with this statement? Illustrate.

(250 words)

Approach

1. **Define satellite town** ***(40 words)***
2. **Discuss the advantages and need of satellite towns** ***(90 words)***
3. **Mention ways of making satellite towns sustainable and smart** ***(80 words)***
4. **Conclusion** ***(40 words)***

Hints

A town designed to house the overspill population of a major city, but located well beyond the limits of that city, and operating as a discrete, self-contained entity is called "satellite town". These towns develop when a town or a city reach a certain limit of congestion and exhaustion. These have their own identity but are under the influence and power of the major city. The idea behind satellite townships is to bring up planned habitations to ease the population growth in towns.

There are many renowned Satellite cities in India which have gained prominence due to their infrastructure development and the potential to attract realty growth. Prominent satellite cities near Delhi are Gurgaon, Noida, Ghaziabad and Faridabad. Mumbai also some renowned satellite cities like Navi Mumbai and Thane.

Significance and need of satellite towns:

- As city limits become overcrowded and land prices hit the roof, satellite townships have come up as a solution to the haphazard development of suburban areas.
- Satellite cities offer the atmosphere of the smaller city — downtown, work, school and entertainment and culture places are all in close proximity.

- Some satellite cities have significant universities and may even be the university town of 50-100 years ago, now all grown up with a diversified industrial and employment base, such as Navi Mumbai which is now an education hub.
- The purpose of these satellite towns are to accommodate the impending economic and population growth expected in the major cities of the region.
- Satellite towns tend to decongest the overcrowding of the main city by providing habitation to the over spilled population of the main city.
- In general, there is a daily commutation of a major portion of the population of satellite towns to the main cities mainly for work. Transport infrastructure developed in Satellite cities not only provides its residents easy accessibility but also enables to decongest traffic in the main city.
- Besides providing its residents with superior quality of living in the form of road connectivity, electricity, water, drainage and other important amenities, it also enables to propel the local economy.
- Lastly, satellite cities provide a scientific balance between the population and the resources needed by them leading to environment-friendly and sustainable development.

Making satellite towns sustainable:

- Satellite towns need to be well-connected and self-sufficient. In simple terms, they should be smart cities in themselves.
- Urban government agencies should be innovative and use market dynamics to raise and deploy funds for infrastructure.
- State governments can provide mini buses between these towns, and improve the quality of commuting. In addition to road transport, connectivity via metro rail must also be extended. High quality roads must be put in place, while facilities for water supply, electricity, and sewage systems must also be established.
- While the developers are upbeat about integrated townships, the governments, both central and state, have to do more to promote these satellite townships.

Conclusion:

The success of satellite cities can be largely attributed to the efficient integration of economic activities and infrastructure. The satellite cities with a head start are now poised for the next stage of transition, which is likely to be by way of expansion of the services sector. These cities already have most key ingredients like human capital, infrastructure and land availability to become strong service sector hubs.

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NOTES

SET-1.2: QUESTIONS

POPULATION AND MIGRATION

Q1. Elaborate the concept of mental map.

Q2. Discuss the role of fertility as a component of population dynamics and elaborate on its various measures.

Q3. Although, India is blessed with an increasing demographic dividend, however, this blessing could quickly turn into a burden, if not engaged properly. Discuss.

Q4. Population-resources balance determines whether region is over populated or under-populated. Elucidate.

Q5. Critically examine Malthus theory of population growth and discuss its relevance in context of India.

Q6. India needs to start addressing issues concerning its growing elderly population. Discuss. Also, discuss the steps taken by the government to tackle these issues.

Q7. Does religion plays a significant role in the growth of the population in India? Explain with examples. Also, discuss the spatial variation in the population growth of India.

Q8. In the post-independence period, Indian cities had remained auxiliary to the concerns of balanced regional development. In this regard, discuss the need for inclusion of city issues and town planning in regional planning and development.

Q9. India is slowly cleaving into two countries- a richer, older South and a poorer, younger North. Critically analyze.

Q10. Migration is a physical and social transformation and is also an instrument of cultural diffusion and social integration. Elaborate. Also, explain the nature of gendered mobility in India.

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SET-1.2: ANSWERS

1. Elaborate the concept of mental map.

(150 words)

Approach

1. **Briefly Introduce concept of Mental map** ***(50 words)***
2. **Describe its fundamental features** ***(70 words)***
3. **Conclusion** ***(30 words)***

Hints

Mental maps refers to the images of places mentally stored by individuals and drawn upon as resources in their interpretation of spatial desirability, their organisation of spatial routines and their decision-making transaction as satisfying agents.

They have grown as a part of the behavioural criticism to the quantitative revolution. They have also been termed as cognitive or subjective environments.

The fundamental characteristics of mental maps are:

- People have a particular image of the environment.
- The image is unique for each individual.
- There is a correlation between this image and the behaviour.

For example, a herder and a farmer living in the same location will have very different images of the location based on their perception of its value to their economic activity.

Gould has stated that if spatial behaviour is the concern then mental images that men hold of the space around them provide the key to some of the structures, patterns and processes of man's work on the face of the earth. They also help in planning of the social investment.

2. Discuss the role of fertility as a component of population dynamics and elaborate on its various measures.

(200 words)

Approach

1. **Discuss the role of fertility as a component of population dynamics and elaborate on its various measures.** ***(50 words)***

2. **Brief introduction on fertility as component of population dynamics.** ***(30 words)***
3. **Elaborate on role of fertility.** ***(60 words)***
4. **Various measure of fertility rate.** ***(60 words)***

Hints

Fertility is the natural capability to produce offspring. Fertility rate is vital component to determine the current and future population.

Role of fertility as a component of population dynamics:

- Fertility is usually expressed using the proxy measure of birth rate, either crude or standardized for age and sex.
- A parent's number of children strongly correlates with the number of children that each person in the next generation will eventually have.
- Factors generally associated with increased fertility include intention to have children, and maternal support.
- Fertility is one of the three principal components of population dynamics that determine the size and structure of the population of a country

Various measures of fertility rate:

- **Crude birth rate**: the annual number of live births per thousand people
- **General fertility rate**: the annual number of live births per 1000 women of childbearing age (often taken to be from 15 to 49 years old, but sometimes from 15 to 44).
- **Age-specific fertility rate:** the annual number of live births per 1000 women in particular age groups, usually in the age group of 15-24 and likewise.
- **Total fertility rate**: the number of live births per woman completing her reproductive life if her childbearing at each age reflected current age-specific fertility rates
- **Gross reproduction rate**: the number of daughters who would be born to a woman completing her reproductive life at current age-specific fertility rates
- **Net reproduction rate**: the number of daughters who would be born to a woman according to current age-specific fertility and mortality rate.

3. Although, India is blessed with an increasing demographic dividend, however, this blessing could quickly turn into a burden, if not engaged properly. Discuss.

(150 words)

Approach

1. **Introduce concept of demographic dividend** ***(20 words)***
2. **Highlight India's demographic potential and dividend thereof** ***(20 words)***

3. **Discuss challenges in harnessing demographic dividend in India** ***(50 words)***
4. **Ways Forward** ***(40 words)***
5. **Conclusion** ***(20 words)***

Hints

A demographic dividend occurs when the rate of economic growth is increased due to a change in the age structure of a population that favours the presence of more working age people than that of a dependent population. A higher percentage of the working-age population can raise the economic output in a country as well as increase its per capita income.

India's potential demographic dividend:

According to the UN, India will overtake China to become the world's most populous nation by 2024. India is undergoing a major demographic transition. The working-age ratio in India's population is projected to increase from 64 per cent in 2013 to 69 per cent in 2040 – an addition of more than 300 million adults of working-age population. In terms of pure numbers, India would thus become the largest contributor to the addition in the global workforce.

Challenges in harnessing demographic dividend:

- The participation of women in the workforce is quite low. According to the World Bank's study between 2004-05 and 2011-12, the Female Labour Force Participation (FLFP) rate in India was 27 per cent as compared to China's 63.9 per cent.
- Even if there is a cumulative and substantial increase in the workforce, workers are also required to be more productive. This would require corresponding increases in educational and training facilities. However, the World Bank reported in 2017 that at present only 2.3 per cent of the workforce in India has formal skills training.
- Limited employment opportunities in terms of productive jobs. According to the India Skills Report 2018, a growth of 10-15 per cent is expected in hiring in 2018. Although, this is a significant growth, but such growth rate needs to be sustained if India has to keep pace with its demographic dividend on a continuous basis.

Ways Forward:

- The demographic dividend itself might be affected by many macro processes. For example, a substantial decline in fertility for a population might act to increase the demographic dividend.
- Also, improved healthcare conditions along with declining mortality rates for adults might also preserve the pool of working-age population. Greater gender equity in terms of women in the workplace might also act to increase the participation of women in the workplace, thus increasing the overall contribution to labour market.
- Economic investments that create additional jobs can also act to upsurge production in the economy as well as increase the number of working people.

Conclusion:

- However, India's demographic dividend needs to be supported by other supportive steps that can allow India's demographic dividend to be optimally used. India must look to upgrade educational and training facilities to bridge the gap in India's skill deficit. The productivity of its working-age population can be tapped early on such that education and training can be supplemented early on for progressive change. India must also develop its healthcare facilities and make them more accessible.

4. Population-resources balance determines whether region is over populated or under-populated. Elucidate.

(150 words)

Approach

1. **Introduce population resource balance concept** ***(40 words)***
2. **Elaborate on how a region is under, optimum and over populated using population and resource relation** ***(90 words)***
3. **Conclusion** ***(20 words)***

Hints

Fulfillment of needs, development and aspiration depends upon exploitation of resources which is unevenly distributed around the world. The size, distribution and population structure within a country must be viewed in relation to its natural resources and the technology available to exploit these resources. The concepts of optimum population, overpopulation, and under population are intimately related with the resource base and its exploitation pattern.

In population-resource relation, we need to consider the complex as well as dynamic linkages of capability opportunity-propensity matrix of different human groups and their individual members separately, inhabiting presently and also will inhabit in future in different regions of the world.

- A stage of development in population resource relationship when technology and resources are there but due to lack of adequate hands they are not being efficiently exploited for the betterment of the society. In this stage of population development the living standard of the population will be lower than the maximum potential. This is the stage of under population.
- If population continued to expand slowly a time will reach when total output keep increasing but per capita output started diminishing or law of diminishing return started working in the region. The stage of population expansion beyond which the law of diminishing return started working or marginal output started decreasing is the stage of optimum population
- Beyond optimum population, if population further expand then total output may increase but it will have negative impact on their living standard as less and less per head resource are available. This is the condition or stage of overpopulation with respect to the resource base of the region. Depletion of resources also leads to case of over population.

- Due to variation in distribution of population, their composition, technological attainments and resource base and also a very complex pattern of globalization, optimum population in relation to resource base are rarely found. Thus most of regions either suffer from under population, like Brazil, Columbia, Peru, Zaire, Asiatic Russia, etc. or overpopulation, like India, China, Pakistan, Bangladesh, Malaysia, and more.

5. Critically examine Malthus theory of population growth and discuss its relevance in context of India.

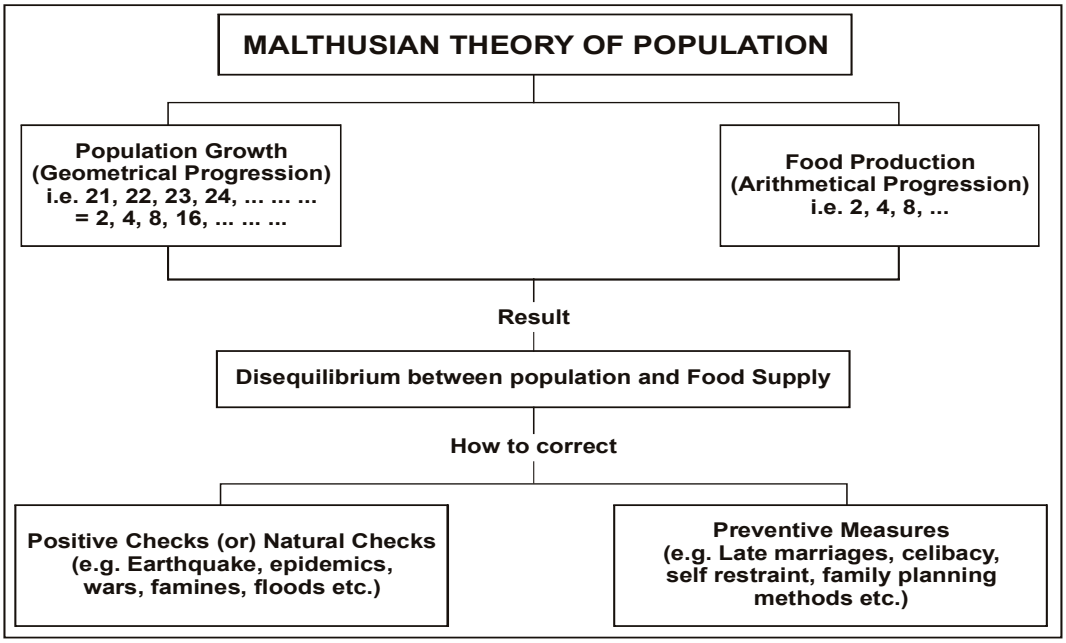
(200 words)

Approach

1. **Briefly introduce Malthus theory of population growth** ***(90 words)***
2. **Elaborate on its criticism** ***(50 words)***
3. **Discuss its relevance in Indian context.** ***(60 words)***

Hints

Thomas Robert Malthus wrote his essay on "Principle of Population". This Theory of Population is a theory of exponential population growth and arithmetic food supply growth.



Major Elements of the Malthusian Theory:

Population and Food Supply:

- Malthus theorized that populations grew in geometric progression, sequence of numbers where each term after the first is found by multiplying the previous one

- He stated that food production increases in arithmetic progression, a sequence of numbers such that the difference between the consecutive terms is constant.

Population Control:

- Malthus then argued that because there will be higher population than the availability of food, many people will die from the shortage of food.
- He theorized that this correction will take place in the form of Positive Checks (or Natural Checks) and Preventative Checks.
- He believed that natural forces will correct the imbalance between food supply and population growth in the form of natural disasters such as floods and earthquakes and man-made actions such as wars and famines.
- To correct the imbalance, Malthus also suggested using preventative measures to control the growth of the population. These measures include family planning, late marriages, and celibacy.

Criticism of Malthusian Theory:

- Prediction made by Malthus is not practical. For example, in Western Europe, populations have grown (not at the rate Malthus predicted) and food production has also risen
- Technological advancements, food production has dramatically increased over the past century. Often, the food production rate has grown higher than the population growth rate.
- Malthus' theory on food production constraints was largely based on the limited availability of land. But due to globalization we can trade well and services for food, which increases the amount of food a country can consume.
- Malthus did not provide calculations for the geometric growth of populations and the arithmetic growth of food.

Its relevance in Indian context:

- Since India is an over populated country and most of the features hinted at by Malthus are found here therefore its applicability is almost at true factor.
- India's population is rapidly increasing at a rate of 2.3% per annum
- India is facing food shortage even today in-spite of the fact that it has experienced Green Revolution.
- Standard of living is another indicator. Indians have a poor standard of living as compared to the people of other nations. About 39% of the people are below poverty line.
- Life expectancy is also poor in India. Average life of an Indian is around 60 years which is quite low as compared to other nations.
- Birth rate in India is as high as 30 per thousand. This is quite high. No other nation is facing the problem of such a high birth rate. Preventive checks (family planning) are not much popular.
- Death rate is also as high as 11 per thousand. It shows that natural calamities like floods, diseases, hunger and squalor are not under full control.
- Marriage is a universal phenomenon. Marshall recommended self-restraints, celibacy, late marriages etc. to control population. In India, early marriage is a social evil. Hence high growth of population.

- Malthus theory has not turned out to be true due to several factors which have made their appearance only in recent times, yet the essentials of the theory have not lost its relevance especially in case of India and other developing countries.

6. India needs to start addressing issues concerning its growing elderly population. Discuss. Also, discuss the steps taken by the government to tackle these issues.

(200 words)

Approach

1. **Briefly introduce elderly population** ***(20 words)***
2. **Growing issues related to elderly population** ***(50 words)***
3. **Analysis about the issue** ***(60 words)***
4. **Steps taken by India in this regard.** ***(70 words)***

Hints

Ageing in India is exponentially increasing due to the impressive gains that society has made in terms of increased life expectancy. With the rise in elderly population, the demand for holistic care tends to grow.

Growing Issues related to elderly population:

- The elderly population is expected to grow from 8% in 2015 to 19% in 2050
- The challenge is highlighted in report issued released by UN population Fund, India titled "caring for our elders".
- The report observed maximum attention remains old women who are more vulnerable than men due to their longer life expectancy and meager or no income.
- There will be 12.5% of total population being over 60 by 2030
- Sex ratio of elderly has increased from 938 women to 1000 men in 1971 to 1033 in 2011 and is projected to increase to 1060 by 2016
- According to study done by Age well foundation,65% of old people are poor with no source of income
- **Growing urbanization:** the ever growing urbanization, nuclear family has created social alienation among elderly population,
- **Globalization:** the people of India are embracing western life style where parents are given less care.
- **Growing materialism:** traditional values of taking care of parents are degrading rapidly due to materialism.
- **Technological issue:** earlier children used to spend time with their parent but now due to advancement of mobile phone, internet and other technologies the old parents are greatly neglected.

Vulnerability of elderly population in India:

- Physiological**:** the elderly people suffer from number of old age related illness
- Psychological problem: older people are susceptible to psychological depression
- Emotional problem: due to loss of spouse, friends negligence and indifferent attitude of family members, abuse, fear, boredom, loss of controlled
- Social problems: due to loss of work associated, death of relatives, loss of work associated, lonely and isolation
- Financial problem: due to absence of inadequate or absence of pension
- Women stand at greater risk in old age as they are by and large poorly paid for work done during their lifetime and have meager or no savings
- 93% of workforce is in informal sector. There is no social security for them. Among them SC, ST, poor remain the most vulnerable

Analysis of the issue:

While the government and civil society needs to tackle the issue of growing elderly population. But unlike other countries, still there is rich tradition in India to look after the parents in old age. The old Indian tradition of carrying the parents by children in basket may not exist today; still even today Indians consider the serving of their parents as door to reach paradise.

Steps taken by India in this regard:

- Apart from old age house the government is opening large number of day care center for elderly.
- Rashtriya Vyoshriyojana has been launched to assist senior citizen suffering from old age relation ailment. Unclaimed fund lying in Employee state insurance and Provident fund as well as in banks will be used for empowerment of senior citizen.
- Vayoshreshtha Sammans - A Scheme of National Award for Senior Citizens. The main objective of the Scheme is to improve the quality of life of the Older Persons by providing basic amenities like shelter, food, medical care and entertainment opportunities and by encouraging productive and active ageing through providing support for capacity building of Government / Non-Governmental Organizations / Panchayati Raj Institutions / local bodies and the Community at large.
- India Gandhi National Old Age Pension Scheme (IGNOAPS): Under this scheme, financial assistance is provided to person of 60 years and above and belonging to family living below poverty line as per the criteria prescribed by Government of India
- The Pradhan Mantri Vaya Vandana Yojana (PNVVY) was launched in May 2017 to provide social security during old age. This is a simplified version of the VPBY and will be implemented by the Life Insurance Corporation (LIC) of India
- 'National Programme for the Health Care of Elderly' (NPHCE) during 2010-11 to address various health related problems of elderly people

Hence, India should prepare to meet the growing challenge of caring for its elderly population. All social service institutions in the country need to address the social challenges to elderly care in order to improve their quality of life. There is a need to initiate requisite and more appropriate social welfare programs to ensure life with dignity for the elderly. In addition, there is also a need to develop an integrated and responsive system to meet the care needs and challenges of elderly in India.

7. Does religion plays a significant role in the growth of the population in India? Explain with examples. Also, discuss the spatial variation in the population growth of India.

(200 words)

Approach

1. **Briefly introduce relation between socio-economic factor, religion and population growth** ***(40 words)***
2. **Highlight trend of population growth of various religious communities of India and socio-economic factor affecting it.** ***(60 words)***
3. **Elaborate on trend of population growth across various regions and states in India and reason behind it.** ***(60 words)***
4. **Conclusion** ***(20 words)***

Hints

Socio-economic development of a society majorly determines population growth. Though religion do have a relation to population growth rate but fertility rates in India are more closely related to education levels, health care services and the socio-economic development within a state, than to religious beliefs.

Religion and Population:

- After partition proportion of Muslims increased from 9.9% to 14.23% while the proportion of Hindus decreased from 84.9% to 79.8% from 1951 to 2011. Since 2001 the percentage of Christians and Jains did not significantly change at 2.3% and 0.4%, respectively, while the proportion of Buddhists decreased from 0.8% to 0.7%, and that of Sikhs reduced from 1.9% to 1.7%.
- The data on population by Religious Communities of Census 2011 show that between 2001 and 2011, Hindu population grew by 16.76 per cent, while that of Muslims by 24.6 per cent. The population of both communities grew faster during the previous decade, at 19.92 per cent and 29.52 per cent, respectively. As a long-term trend, say demographers, the communities' growth rates are converging.
- The Muslim population still grows at a faster rate than the Hindu population, but the gap between the two growth rates is narrowing fast. The decadal Muslim rate of growth is the lowest it has ever been in India's history, as it is for all religions
- As per another report richer families and states with better health facilities, per capita income and higher female literacy have lower fertility rates in India.
- In India, fertility differences have been starker among regions than among religious groups. The Muslim population in Uttar Pradesh increased 25.19%, while the Muslim population in Kerala increased 12.83% between 2001 and 2011. Over the same period, the Hindu population increased 18.9% in Uttar Pradesh and 2.8% in Kerala.

Spatial variation in population growth in India:

- The States like Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Puducherry, and Goa show a low rate of growth not exceeding 20 per cent over the decade. Kerala registered the lowest growth rate not only in this group of states but also in the country as a whole.
- A continuous belt of states from west to east in the north-west, north, and north central parts of the country has relatively high growth rate than the southern states. It is in this belt comprising Gujarat, Maharashtra, Rajasthan, Punjab, Haryana, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Sikkim, Assam, West Bengal, Bihar, Chhattisgarh, and Jharkhand, the growth rate on the average remained 15-25 per cent.
- Another way to interpret population growth rates is through the difference in poor and rich states. Empowered Action Group (EAG) states, which include the poorest in India – Rajasthan, UP, Uttarakhand, Bihar, Jharkhand, Madhya Pradesh and Chhattisgarh have higher population growth.
- Between 2001 and 2011, the population of EAG states grew 21 per cent compared to 15 per cent for the rest of India. Still, decadal population growth rates in even EAG states have fallen when compared to the decadal growth rate of 24.99 per cent between 1991 and 2001.
- Globally, there is a little evidence to link religion and fertility rates, with poorer, conflict-ridden states and countries with lower female empowerment reporting higher population growth rates. These overall fertility rates seem more related to the state's development.

8. In the post-independence period, Indian cities had remained auxiliary to the concerns of balanced regional development. In this regard, discuss the need for inclusion of city issues and town planning in regional planning and development.

(250 words)

Approach

1. **Briefly introduce India's urban development scenario** ***(30 words)***
2. **Explain the need for cities in regional planning and development in India** ***(100 words)***
3. **Discuss on how to streamlining Urban Development in India in sustainable way.** ***(100 words)***
4. **Conclusion** ***(20 words)***

Hints

In the post-independence period, city as a territorial unit in regional planning and development had largely not been the focus; the urban was neglected in favour of the rural by most national leaders at the time (Batra, 2009). The Planning Commission (2011) projected that the number of people residing in urban areas will grow from 377 million to about 600 million by 2031, representing an increase of about 200 million in 20 years. With the recent introduction of smart cities, it can be seen that they are being thought of more comprehensively as planning units in order to build sustainability.

Need for Cities in Regional Planning and Development in India:

- Indian cities in contemporary times face tremendous growth that at the same time remains unsustainable. This necessitates that urban planning in India is tied up to more broad-based regional planning and development so that a strategy can be envisioned for urban areas on a regional scale taking into account broader economic, social and environmental factors.
- Such an approach requires knowledge of the macro and micro economic systems and their operations in a region including integrated governance, social differences amongst communities and also environmental conditions that can vary across places.
- Mitigation of such differences through a structured approach and provision of an integrated framework can greatly enhance sustainability for cities in regional planning and development in India. Many Indian cities, for example, Mumbai, Delhi, Bangalore, Hyderabad, Ahmadabad, Chennai, Kolkata, Surat, Pune and Jaipur face the problem of overcrowding. This may have an adverse effect on their sustainability with an increase in waste production, poverty, crime, rising real estate prices and resource requirements, etc.
- With increasing resource requirements, services such as supply of water and electricity will have to be managed more austerely or they might fail in coordinating demand with supply leading to a shortage. This calls for sound management of cities vis-à-vis regional planning and management such that cities work in conjunction with the larger policy apparatus. The absence of this can create bottlenecks and gaps in policy applications which are exacerbated when parts of cities remain underdeveloped.

Streamlining Urban Development in India:

- With higher consuming powers possible and sources of credit in India becoming increasingly present mostly in urban areas, India would be fast moving towards a development model that favors urban areas as centers of commerce. As a result, cities would become attractive destinations where economic activities would be concentrated.
- The consequent agglomeration and densification of economic activities along with increasing human habitation in urban areas provide greater economic efficiencies than dispersed rural areas with populations largely lacking in the skills required to participate in the modern economy.
- Under such circumstances, the spectre of the rural-urban divide develops which ignores the fact that rural/urban areas are largely coterminous with issues of migration and the development of intermediate formations such as peri-urban areas where the rural and the urban exist in nearby surroundings.
- With cities left largely to the agency of municipal bodies and capital, many government policies in regional planning and development aim to address rural backwardness in what can be termed as a 'prosperity gap' in many cases. With an integrated framework for inclusion of cities in regional planning and development, establishing networks between the economic prosperity of the cities and the rural areas suffering from backwardness are possible. The economic capital flows can be better managed so that local rural economies can be linked to the booming urban ones and benefit in part from urban prosperity.
- Proper knowledge of consumption entailed through the connectivity with nearby urban centres of consumption would help in raising farmers' incomes due to an integrated approach for cities. This would also provide a planning regime for urban centres to ascertain sources of food supply in a more efficient manner, which can help in managing food infation by streamlining supply sources. This could in turn help in providing an income support system for certain farming communities.

- Amenities such as affordable housing, employment and accessible public transportation form basic aspects of urban infrastructure that are not integrated into all cities. A comprehensive and an integrated approach is required that combines human habitation, economic growth and environmental planning for cities in India (King et al., 2011). This requires attention to cities for them to experience sustainable growth in sync with cohesive regional planning and development.
- Urban areas also face greater risks to life and property due to the anticipated effects of climate change such as flooding due to cloudbursts, greater damage due to landslides, etc. These place cities at the forefront of climate change adaptation and a total approach that includes cities in regional planning and development is necessary.
- Providing employment opportunities in cities must also be balanced with rural to urban migration. This acutely requires an integrated national approach for rural to urban migration in India. Migration is often accompanied with other issues such as health and safety issues
- To move towards sustainability, cities must also move towards affordability, focus on small scale settlements as well, make all possible use of technologies, pay attention to its functional infrastructure, avoid practices that are environmentally wasteful and manage resources. This requires all inclusive approach uniting regions or cities.

9. India is slowly cleaving into two countries- a richer, older South and a poorer, younger North. Critically analyze.

(200 words)

Approach

1. **Provide the present demographic data** ***(30 words)***
2. **Contrast of north and south Indian demography.** ***(60 words)***
3. **Analyze the statement and provide your assessment** ***(60 words)***
4. **Conclusion** ***(20 words)***

Hints

Due to unique socio-economic condition the demographic dividend of north and south India is different. The fertility rate of whole India is 2.6 where as in south India it is below 2.

North Indian Scenario:

- North Indian states are underdeveloped as compared to south India. Due lack of infrastructure, health, education, and employment northern India is poorer than southern states.
- The per capita land holdings in the north is lower and people are mainly dependent upon agriculture which is not much remunerative now
- Due to lack of education and awareness specially among women the family planning is poor, consequently the fertility rate of north is higher than south
- The government support via schemes like Jananisurakshayojana and improved institutional delivery has raised the fertility rate of north India

- **South India Scenario:**
  - The southern states are more prosperous as compared to northern India due to industrialization, urbanization and migration.
  - The social capital like health, infrastructure, education, employment is far developed in south India.
  - Due to rising literacy and women emancipation there is better family planning, consequently low fertility rate which is giving rise to elderly population.
  - Medical, psychological support is minimal for more than 71% of elders living in villages.

Analysis of situation in north and south India:

- On the basis of uniqueness of its geography, polity, and socio-economic situations, north and south are slowly cleaving.
- Southern Indian states like Kerala & Tamil Nadu have gotten better in human capital parameters like health, education, and employment. Operation of more industries in southern states as compared to north has also contrib uted in making people better off. But at the same time the fertility rate is rapidly decreasing in south. Owing to increased awareness about family planning and education, women in south have been able to take more matured decision regarding pregnancies. This has made southern states richer with demographically presence of more ageing population.
- While in north India apart from poverty, due deep rooted patriarchal system, along with lack of industrialization and desired rate of women empowerment, family planning system is inadequate. It has given rise to fertility rate ensuring more youth in north India.
- Undeniably, it is one of the trends observed in Indian landscape now. However, this trend is likely to change soon as fertility across India are falling, while it has happened little earlier in southern peninsula, in, north also, it will soon catch up.

10. Migration is a physical and social transformation and is also an instrument of cultural diffusion and social integration. Elaborate. Also, explain the nature of gendered mobility in India.

(250 words)

Approach

1. **Brief intro of migration trend in India** ***(40 words)***
2. **Migration as physical and social transaction** ***(70 words)***
3. **Migration as instrument of cultural diffusion and social integration** ***(70 words)***
4. **Nature of gender mobility in India** ***(70 words)***

Hints

Migration has been inherent feature of Indian society since the time of Indo Aryans. It has influenced the social, cultural, economic and political landscape of our nation. Of late, a lot of issues have also emerged because of migration, such as, language problems, racial and ethnic discrimination. Like Maharashtra government has reserved jobs only for the bonafide people

of Maharashtra and in case the outsiders wish to work there, they will first have to pass an entrance exam which is kept in their language and had to be answered in their language which is Marathi. Thus, the chances of the outsider getting a job are already cut off. Despite all this the flow of migrants has not reduced, showing how its inevitable in present scenario.

Migration as physical and social transaction

- People tend to move from place of low opportunity and low safety to the place of higher opportunity and better safety.
- Migration leads to the redistribution of the population within a country. Rural-urban migration is one of the important factors contributing to the population growth of cities.
- Migration benefits for the source region are the remittance sent by migrants.
- In physical transaction it leads to exchange of people,goods,etc.
- In social transaction it leads to exchange of culture, dietary, languages, etc. for example migrants of Bihar introduced Chhat puja in different parts of country.

Migration as instrument of cultural diffusion and social integration:

- The new ideas related to new technologies, family planning, girl's education, etc. Get diffused from urban to rural areas through them.
- Migration leads to intermixing of people from diverse cultures. It has positive contribution such as evolution of composite culture and breaking through the narrow considerations and widens up the mental horizon of the people at large.
- But it has serious negative consequences such as anonymity, which creates social vacuum and sense of dejection among individuals.

Nature of gender mobility in India:

- The female migration growth rate has been 2.4% as compared to 1.85% for male over last 30 years. Over 55% of female migrants were in age group of 15-59 in urban areas
- Marriage continue to be the predominant reasons for migration of women
- The gender specific pattern of labor employment has also resulted in migration of female.
- The emergence of nuclear family, increasing participation of educated women in activates outside homes has resulted into their migration
- Changing pattern of consumption have resulted in demand for women centered services such as domestic help, child care giver and full time home based care taker.
- Poor and asset less community who belong to lower caste tribe migrated more.
- Although the migration rate of female has increased in recent past, still due to stereotype thinking and patriarchal nature many females in rural and urban areas are devoid of education, work, etc. because they are not allowed to migrate to cities or to places of greater opportunities.

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NOTES

SET-1.3: QUESTIONS

POPULATION AND MIGRATION

Q1. Discuss the trends in emigration focusing on its major thrust.

Q2. India currently holds the largest demographic dividend of the world which provides opportunity to export services to the ageing developed nations and enhance its economic growth. Analyze.

Q3. Ageing global population and contracting workforce have increased the possibilities of emigration of human capital from young countries like India". Critically analyze.

Q4. Incentives from government in form of cash and paid leaves coupled with expansion of primary health care across the country have resulted in reduced maternal and infant mortality rate in India. Comment

Q5. The emphasis laid by UN-Habitat III on planning for urban centers coupled with its adjoining peri-urban and rural areas in an integrated manner has provided solution to India's rapidly expanding cities" Elucidate.

Q6. Elaborate on the factors that determine the settlement patterns? Also discuss the features of the various type of rural settlement in India.

Q7. Development of satellite town is the important remedy for tackling the issue of haphazard urban development. How far do you agree with this statement; illustrate.

Q8. Environmental concerns have emerged as major area of urbanization and urban planning in India. What are the reasons behind this? What effective steps must be taken to ensure that Indian urbanization is environment friendly?

Q9. Urbanization in India is suffering from "spatial illegality", Discuss. How urbanization should be planned to establish the right to city for every resident?

Q10. Developmental activities along India's coastal areas have increased the erosion rate. Discuss the role of beach nourishment in coastal defence and impact of it on local ecosystems.

****

SET-1.3: ANSWERS

1. Discuss the trends in emigration focusing on its major thrust.

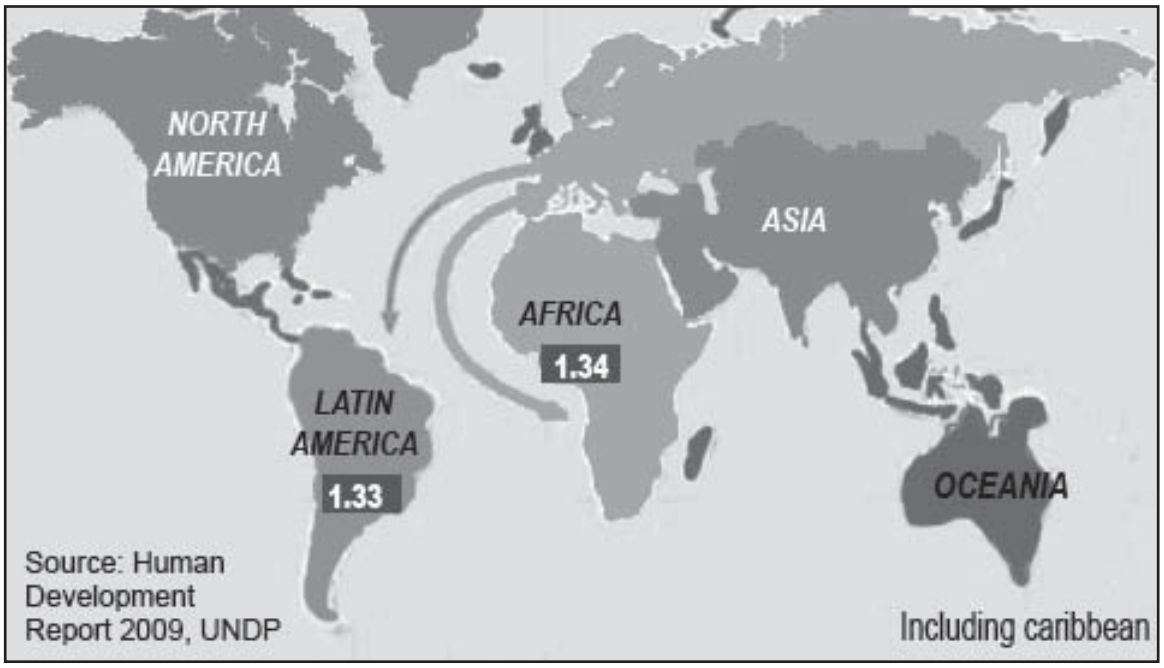
(250 words)

Approach

1. **Briefly describe Emigration trends** ***(50 words)***
2. **Explain major thrusts of emigration can be seen in the three phases through modern Indian history** ***(150 words)***
3. **Conclusion** ***(50 words)***

Hints

Emigration refers to the act of leaving one's own place of residence to settle in another. Within the country emigration has happened between states usually due to economic opportunities or marriages. India has seen the emigration of its residents for millennia due to its active linkages with the rest of the world. The major thrusts of emigration can be seen in the three phases through modern Indian history:



Emigration Trends from India

Phase I: The first wave took place during the British period when a large number of labourers were sent to Mauritius, Fiji, the Caribbean islands and other parts of the world by the imperial powers. Their descendents continue to reside in these countries as many did not return.

Phase II: The second wave of migrants went to settle in the neighbouring countries like Thailand, Malaysia, Singapore, Indonesia, Brunei and some African countries. This is a recent development under which professionals, artisans, traders, factory workers went out of the country in search of a better quality of life. This trend is still continuing. In the 1970s there was an oil boom in west Asia and a large number of skilled and semi skilled workers went there to avail of the opportunity. Some entrepreneurs, store owners, professionals, businessmen etc. went to the western nations as well.

Phase III: The third wave started in the 1960s and still continues to operate. In this period, high profile professionals like doctors, engineers etc. migrated out of India. In 1980s, software engineers, management consultants, financial experts, media persons etc. moved out of the country to work in countries like the U.S.A., Canada, U.K., Australia, New Zealand, Germany etc. After liberalisation in 1991, education and knowledge based Indian migration has made Indian Diaspora most powerful in the world. The global recession in 2007-08 was a setback and several Indians had to return due to the heavy cutback in job opportunities in the west.

Thus, India has seen continuous emigration and today Indian Diaspora is the largest in the world at 15.6 million people according to the UN World Migration report 2018.

2. India currently holds the largest demographic dividend of the world which provides opportunity to export services to the ageing developed nations and enhance its economic growth. Analyze.

(150 words)

Approach

1. **Briefly discuss India's rich demographic dividend and time to expand its employment vision.** ***(20 words)***
2. **Discuss the changing nature of changing nature of employment and need of technically advanced workforce.** ***(55 words)***
3. **Discuss different ways by which India can reap its rich demographic dividend and export services to ageing developed nations** ***(55 words)***
4. **Conclude briefly with need to expand horizon of Indian workforce and address issue of unemployment in India.** ***(20 words)***

Hints

India is going through its richest demographic period where its working age population has exceeded the dependent population. Currently, India is going through a 37 years period of rich demographic dividend which will last till 2055. India needs to reap this rich demographic dividend in the way European countries and East Asian economies like China and Japan did and achieved their apex level of economics dividend by adopting multi-dimensional ways. India has an opportunity to serve multi level workforce demand in various sectors in ageing developed nations and underdeveloped nations.

Changing nature of employment and need of technically advanced workforce

- The advent of fourth Industrial revolution characterized by automation embedded with modern technologies such as artificial intelligence, big data analysis, cloud computing and robotics has limited the scope of human interference in industrial as well as service sector.
- According to Forex report, in 2025, machines are expected to perform more current work tasks than humans compared to 71% being performed by humans as of now. Due to this transformation, it will have a major impact on the global workforce.
- Nearly 50% of all companies are expecting their full-time workforce to shrink by 2022 due to automation, but 40% are expecting to extend their workforce and more than 25% are expecting automation to create new roles in the enterprise.
- But, these technologies have created new pathways of creating new types of jobs. According to Forbes, Artificial Intelligence will create 58 Million New Jobs By 2022.

Different ways by which India can reap its rich demographic dividend and export services to ageing developed nations

- India has ability to serve to various developed countries like ageing Balkan states in Europe and Western European countries which are undergoing fourth stage of demographic transition which is characterized by ageing population and declining or negative population growth rate. By up-skilling and re-skilling its workforce, it can export Information Technology and other technical services to these countries.
- At the same time, there is a huge demand of technology driven services in underdeveloped countries where India can export services and increase its Forex reserves.
- Further, gap created by demand supply mismatch in employment can be addressed by re-skilling and up-skilling workforce on lines of global demands.
- Apart from basic skill developments programmes such as “Skill India Mission” and “Pradhan Mantri Kaushal Vikas Yojana”, government has introduced several programmes technology and research driven programmesuch as “STRIVE-(Skills Strengthening for Industrial Value Enhancement) and Atal Tinkering Labs to boost up skill development on lines with global demand of human resources.
- Apart from it government has formed a separate corpus in the form of Higher Education Financing Agency (HEFA) to promote and fast-track research and development in the country.
- The export of services to these developed nations will help India to strengthen its foreign trade and maintain its Balance of Payments in form of remittances and taxes.
- It will help India to foster economic growth and strengthen its position in global economic order.

Conclusion:

Continuous upsurge in unemployment across several sectors of Indian economy has urged policy makers to devise new markets and scope to provide employment to youths. Better human capital formation and increase in per capita income will also help India to better its Human Development Index rankings and attain Sustainable Development Goals pertaining to hunger, poverty, health and education. This will certainly transform 21st century into “The Asian Century” and will bring India among elite club of developed nations.

3. Ageing global population and contracting workforce have increased the possibilities of emigration of human capital from young countries like India". Critically analyze.

(150 words)

Approach

1. **Briefly discuss the increasing workforce of India, contracting workforce of developed countries and emigration of human capital from India.** ***(30 words)***
2. **Discuss problem of Brain Drain from India and reasons behind it and Steps needed to check it.** ***(90 words)***
3. **Conclude with importance of skilled human resources for a developing country like India.** ***(30 words)***

Hints

India with largest demographic dividend is the youngest country of the world and is expected to surpass China as the world's most populous country by 2027 according to World Population report, 2019 published by United Nations. World is currently unleashing the fourth industrial revolution which is characterized by less human interference due to innovative technologies such as artificial intelligence and robotics.

Increasing demographic dividend and limited opportunities has created unemployment in India but at the same time has created opportunities for it to export services to developed countries of the world which are in fourth stage of demographic dividend with contracting work force. As these countries are involved in research and development in various fields, they need talented pool of human resources. Although, this will provide opportunities to Indian workforce but will create problem of Brain Drain.

Brain Drain from India and reasons behind it

- Among the Asian countries, India continued its trend of being the top country of birth for immigrant scientists and engineers, with 9, 50,000 out of Asia's total 2.96 million.
- There was an 85% increase in immigration of human capital from India between 2003 to 2013 which is highest in the world.
- Unemployment in India is a serious social issue. Millions of engineer are graduated every year in India and among that only 4% gets a good job and rest 60% remain unemployed. Employment in India has seen a 46 year high at 8.5 % according to data published by NSSO.
- Lack of entrepreneurship attitude in India due to hardships faced by businesses due to corruption and licensing policies. Further, higher corporate taxation has limited the scope of global corporates who hesitate to invest in India.
- Better facilities and remuneration provided by developed countries to talented pool of the country attracts them.
- This leads to emigration of the top rung of human capital from the country such as Scientists, Engineers and doctors leading to vacuum in innovative leadership of respective sectors.

- This impacts research and development and outflow of innovative ideas from the country, causing India to depend on developed countries for this modern technology.
- If this talented pool can be checked from going out, India will be able to cater solutions for its domestic problems.

Steps needed to check Brain Drain

- India should think the China's way to check brain drain by providing facilities and remuneration as par the developed countries of the world.
- India needs to invest more on skill development so that a larger chunk of young population becomes so educated and skillful that brain drain in nullified by domestic talent pool.
- Ease of doing business needs to be improved in a better pace so that Indian talents could be able to produce companies like Telsa and Microsoft.

Conclusion:

Although India has the largest demographic dividend in the world and receives highest remittances from abroad along with producing best talented doctors, engineers and scientist in the world but it lacks skilled labour force to fulfill its domestic needs. It has also reduced India as a supplier of cheap labour force globally. There is a serious lack of R&D activities and initiatives in India which has created a gap in innovative spheres of various initiatives while our own scientists are working for global giants like Microsoft, Google, Telsa and organizations such as NASA and ESA. India must take initiatives to check 'Brain Drain' to fulfill its domestic obligations regarding better R&D.

4. Incentives from government in form of cash and paid leaves coupled with expansion of primary health care across the country have resulted in reduced maternal and infant mortality rate in India. Comment

(150 words)

Approach

1. **Briefly discuss in improvement in MMR and IMR in India due to improved healthcare facility in India.** ***(40 words)***
2. **Discuss the reasons behind India's surge in Maternal and Infant Healthcare Status.** ***(170 words)***
3. **Conclude with significance of improving MMR and IMR with respect to fulfilling India's domestic obligation and international commitments.** ***(40 words)***

Hints

The World Health Organization (WHO) congratulated India for great reduction in maternal mortality since 2005, especially in recent years, reducing the maternal mortality ratio (MMR) by 77%, from 556 per 100 000 live births in 1990 to 130 per 100 000 live births in 2016 .India has

reduced its infant mortality rate (IMR) by 42% over 11 years--from 57 per 1,000 live births in 2006 to 33 in 2017. Both these achievements are ground breaking and has significantly reflected India's improving female healthcare and reduction in India's gender gap. The maternal mortality ratio (MMR) and Infant Mortality Ratio (IMR) together are measure of improvement of female healthcare. Although India has achieved these milestones, it still lags behind the global average in both the parameters.

Reasons behind India's surge in Maternal and Infant Healthcare Status

- In India, the eight socio-economically backward states of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan, Uttaranchal and Uttar Pradesh, categorized as the Empowered Action Group (EAG) states improved significantly due to prioritized action taken on them. MMR in these states have reduced from 246 to 188, in the last three years, however remained below national average.
- Improvement in female literacy rate in India due to initiatives such as "Beti Bachao Beti Padhao" has significantly helped women to take preventive measures during pregnancy.
- Assistance from "ASHA (Accredited Social Health Activist) from pre-natal to ante-natal healthcare and accompanying pregnant women to primary health care centers has helped to raise the numbers of institutional deliveries.
- Cash incentives under Pradhan Mantri Matritva Sayog Yojna and Janani Suraksha Yojna has further attracted pregnant women for institutional delivery and post-delivery checkups (as cash is provided in three installments).
- Availability of low cost and free generic medicines through Pradhan Mantri Bhartiya Jan Aushadhi Pariyojana Kendra (PMBJPK) has ensured availability of medicines to people of low income.
- Nutritional supplements provided by some states such as Odisha and Maharashtra in form of augmented food items having high nutritional values during and after pregnancy has ensured health of lactating mothers.
- Paid leave up to 26 weeks during and after pregnancy for working women as proposed by Maternity Benefit (Amendment) Act, 2016 has provided more time to working women for child care.
- Operationalization of sub-centres, Primary Health Centres, Community Health Centres and District Hospitals for providing 24x7 basic and comprehensive obstetric care services, has further reduced the scope of non-institutional deliveries.
- Universal Immunization Programme (UIP) and setting up of Special New Born Care Units (SNCUs) along with New Born Stabilization Units (NBSUs) in Primary Health Care facilities has improved infant health care at grass root level.
- Home based newborn care through ASHA has been initiated to improve new born practices at the community level and early detection and referral of sick new born babies.

Conclusion:

Both MMR and NMR are indicators of female health in a country which highlights reduction in Gender Gap, women empowerment and Human Development Index of a country. Further, it is also the parameter to showcase the country's obligations to various sustainable development goals such as Good Health and Well Being (Goal 3) and Gender Equality (Goal 5). Further, development of Human Capital in a country is also aided by better childhood care and improvement in health facility, which is important for a country like India which is having largest demographic dividend in the world.

5. The emphasis laid by UN-Habitat III on planning for urban centers coupled with its adjoining peri-urban and rural areas in an integrated manner has provided solution to India's rapidly expanding cities" Elucidate.

(150 words)

Approach

1. **Briefly discuss aim and approach of UN-Habitat and its 'New Urban Agenda' proposed at UN-Habitat III conference.** ***(30 words)***
2. **Discuss proposals of UN-Habitat III and solution provided by it to India's Urbanization problems.** ***(90 words)***
3. **Conclude with ability of 'New Urban Agenda' to foster sustainable urbanization in India in line with Goal 11 of SDG.** ***(30 words)***

Hints

UN Habitat has been constantly developing the best practices in the world to promote better urban settlements since its inception in 1979, which is necessity of the current global pattern due to rapid urbanization. It is mandated by the United Nations General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter to all.

UN Habitat III has envisaged to focus on planning for urban centers coupled with its adjoining peri-urban and rural areas in an integrated manner. Rapid expansion of Indian cities and its huge economic output (2/3rd of the total economic output) has driven policy makers to integrate proposals of UN Habitat III to integrate proposals of sustainable development of adjoining peri-urban and rural areas coupled with urban centers.

Proposals of UN-Habitat III and solution provided by it to India's Urbanization problems

- UN-Habitat III revealed "New Urban Agenda", according to which is a set of 175 commitments that countries need to adhere to tackle the staggering challenges of urbanization. Though our pace of urbanization was slow until now, with only 31.16% of Indians living in cities, it is expected to accelerate.
- It took 40 years for 230 million Indians to become urban citizens. For the next 250 million, it is expected to take only 20 years.
- Indian cities are not livable as per global standards and are crumbling under congestion, pollution and lack of basic facilities for a huge segment of the population 65 million people who live in slums.
- Most of the slums which are amalgamated into cities after its expansion pre-exist as peri-urban and rural areas along side cities. These settlements provide unskilled labourers, vegetables, milk and other services to the urban settlement.
- After Urban expansion, these settlements are amalgamated into cities and showcase its under-development due to their congestion and unplanned habitation. Most of the global cities as well as Indian cities are facing this problem.

- For Example: In NCR region in India, most peri-urban and rural settlements have been amalgamated into main city due to expansion. These areas which were formerly under developed now supports congested lanes , lacks sanitation and basic amenities and supports a number of illegal small scale industries which often cause water, soil and air pollution.
- Congestion and pollution caused by these cities has polluted underground water-table, surface water and air badly.
- 'The New Urban Agenda' by UN-Habitat III has proposed development of semi-urban and adjoining rural areas, has capability of solving India's urbanization problems in a better way.
- It also considers other factors such as planning, environment, transport, housing, finance and health. These steps will be effective in solving problems of congestion, sanitation and pollution in these cities.

Conclusion:

Apart from fulfilling aspirations of Indian cities, UN-Habitat aims to fulfill India's commitments pertaining to attaining sustainable development goals. One of the SDGs, Goal 11 on Sustainable Cities and Communities, aims to "make cities and human settlements inclusive, safe, resilient and sustainable". "The New Urban Agenda' proposed by UN-Habitat III has ability to sustain rapid urbanization in an effective way and solve the problem of unsustainable urbanization of India.

6. Elaborate on the factors that determine the settlement patterns? Also discuss the features of the various type of rural settlement in India.

(200 words)

Approach

1. **Give a brief description of the factors that determine the settlement patterns** ***(50 words)***
2. **Discuss the features of the various type of rural settlement in India** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

Human Settlement means cluster of dwellings of any type or size where human beings live. For this purpose, people may erect houses and other structures and command some area or territory as their economic support-base. Thus, the process of settlement inherently involves grouping of people and apportioning of territory as their resource base. There are various factors and conditions responsible for having different types of rural settlements in India. These include:

- **Physical features** – nature of terrain, altitude, climate and availability of water; Usually rural settlements are located near water bodies such as rivers, lakes, and springs where water can be easily obtained, People choose to settle near fertile lands suitable for agriculture
- **Cultural and ethnic factors** – social structure, caste and religion

- **Security factors** – defence against thefts and robberies; During the times of political instability, war, hostility of neighbouring groups villages was built on defensive hills and islands
- **Rural settlements in India can broadly be put into four types:**
- **Clustered, agglomerated or nucleated:** The clustered rural settlement is a compact or closely built up area of houses. In this type of village, the general living area is distinct and separated from the surrounding farms, barns and pastures. The closely built-up area and its intervening streets present some recognizable pattern or geometric shape, such as rectangular, radial, linear, etc. Such settlements are generally found in fertile alluvial plains and in the north-eastern states.
- **Semi-clustered or fragmented:** Semi-clustered or fragmented settlements may result from tendency of clustering in a restricted area of dispersed settlement. More often such a pattern may also result from segregation or fragmentation of a large compact village. In this case, one or more sections of the village society choose or is forced to live a little away from the main cluster or village. Such settlements are widespread in the Gujarat plain and some parts of Rajasthan.
- **Hamleted:** Sometimes settlement is fragmented into several units physically separated from each other bearing a common name. These units are locally called panna, para, palli, nagla, dhani, etc. in various parts of the country. This segmentation of a large village is often motivated by social and ethnic factors. Such villages are more frequently found in the middle and lower Ganga plain, Chhattisgarh and lower valleys of the Himalayas
- **Dispersed or isolated:** Dispersed or isolated settlement pattern in India appears in the form of isolated huts or hamlets of few huts in remote jungles, or on small hills with farms or pasture on the slopes. Extreme dispersion of settlement is often caused by extremely fragmented nature of the terrain and land resource base of habitable areas. Many areas of Meghalaya, Uttaranchal, Himachal Pradesh and Kerala have this type of settlement.
- There are several challenges in rural settlement inadequate supply of water, prevalence of water borne diseases such as cholera and jaundice, drought and flood very often etc. offer a great challenge and opportunity for planners to plan for more sustainable livings.
- Function of Rural Settlements
- Patterns of Rural Settlements
- Changing Pattern of Rural Settlements

7. Development of satellite town is the important remedy for tackling the issue of haphazard urban development. How far do you agree with this statement; illustrate.

(200 words)

Approach

1. **Briefly introduce the term satellite town** ***(50 words)***
2. **Why development of satellite town is necessary and how it helps in urban development** ***(100 words)***
3. **Conclusion** ***(50 words)***

Hints

A town designed to house the overspill population of a major city, but located well beyond the limits of that city, and operating as a discrete, self-contained entity is called "satellite town". These towns develop when a town or a city reach a certain limit of congestion and exhaustion. These have their own identity but are under the influence and power of the major city.

- Satellite cities offer the atmosphere of the smaller city — downtown, work, school and entertainment and culture places are all in close proximity.
- Some satellite cities have significant universities and may even be the university town of 50-100 years ago, now all grown up with a diversified industrial and employment base.
- **The purpose of these satellite towns** are to accommodate the impending economic and population growth expected in the major cities of the region.
- Satellite towns tend **to decongest the overcrowding of the main city** by providing habitation to the over spilled population of the main city. In general, there is daily commutation of a major portion of the population of satellite towns to the main cities mainly for work.
- However, many satellite towns are characterized by the presence of industrial and other establishments which provide an employment base in the town itself and a reverse commuting tendency can be observed as in Faridabad, a satellite town of Delhi.
- Many satellite towns become manufacturing hubs while the related main city concentrates on the services.
- Development of satellite towns also leads to easing of traffic burdens of the main city, and in turn decreases the vehicular pollution levels in the main city.
- By setting up industries in the satellite towns, the problems of slum development inside the main city can be minimized to some extent.
- Development of satellite towns has the advantage of being properly planned as there is more space and lesser population.

Conclusion:

Thus development of satellite town with proper government intervention is necessary for urban development.

8. Environmental concerns have emerged as major area of urbanization and urban planning in India. What are the reasons behind this? What effective steps must be taken to ensure that Indian urbanization is environment friendly?

(250 words)

Approach

1. **Give a brief description of environmental concerns in the context of urbanization** ***(50 words)***
2. **Why urbanization has impacted environment** ***(70 words)***

3. **What effective steps must be taken to ensure that Indian urbanization is environment friendly** ***(80 words)***

4. **Conclusion** ***(50 words)***

Hints

Economic development has been accompanied by increased urbanization throughout the world and same has been with India also. However the increased urbanization has also resulted into negative impacts on environment in terms loss of green cover, loss of natural spaces like wetlands, river encroachment, air pollution, water pollution etc. to name a few. This requires that urgent steps are taken to reverse the trend.

Why urbanization has impacted environment:

- Conception of urban areas as high density, contiguous, concretized areas lead to removal of trees, loose soil spaces etc. which otherwise act as environmental stabilizers by helping in removing air pollutants, water recharging etc.
- Absence of environmental concerns in master plans or violation of these lead to encroachment of wetlands, river beds in Chennai, Gurugram, and Noida etc. The flooding of these cities due to heavy rains is a result of this only.
- High levels of population growth and Encroachment of green spaces: very high rate of population growth of metro cities have led to encroachment of green spaces like wetlands, forests, rivers etc. It makes urban areas vulnerable to extreme events like foods, draught etc.,
- Energy intensive living style: although they cover less than 2% of the earth's surface and have 54% of population, cities consume 78% of the world's energy and produce more than 60% of all carbon dioxide and significant amounts of other greenhouse gas emissions, mainly through energy generation, vehicles, industry, and biomass use. Same is case in India.
- Too much focus on economics rather than environmental sustainability lead to continuous expansion of some cities beyond their environmental carrying capacity. Land was considered as real estate and not as an ecological component.
- Absence of life cycle approach in planning resulted into the poor waste disposal facilities, mismatch between inputs needed and population planned.
- Individualistic life style which results into less use of public transport facilities and higher pollution.
- All these are threatening the urban areas in form of greater air pollution in Indian cities, contamination of underground water through landfill leachates, depletion of underground water resource, formation of urban heat islands, threat of inundation due to flooding and rising sea level.
- In recent there has been a greater recognition of the fact that urban areas should be environmentally sustainable and greater focus should be on urban areas to mitigate climate change. As a result of this a number of steps have been taken and more are needed.

Steps taken:

- Sustainable habitat and green building codes: Green Building codes and energy efficient appliances has been promoted to reduce energy consumption.

- Focus on clean fuel and public transport: introduction of BS 4 fuel norms, CNG vehicles, Metro based public transport system to reduce air pollution and GHG emission from automobile sector.
- Government has launched Nagar UdyanYojana and urban forestry initiative to increases green spaces in urban areas.
- NGT has been focusing on protecting wetlands, rivers, bird sanctuaries from occupation and destruction.

However a lot more needs to be done. Till now the sustainable development concept has not entered into the minds of people and agencies. There is to integrate into policy making process and in the minds of common man through green accounting methods. Inventorying the ecosystem services in urban areas and then planning without their destruction should be taken up. Annual stocktaking is another step which will help in measuring the steps taken against the steps required.

9. Urbanization in India is suffering from "spatial illegality", Discuss. How urbanization should be planned to establish the right to city for every resident?

(200 words)

Approach

1. **Give a brief description of Urbanization in India and also introduce the term "spatial illegality" in your answer** ***(40 words)***
2. **Discuss the problems related to the urbanization** ***(60 words)***
3. **Discuss, How urbanization should be planned to establish the right to city for every resident** ***(60 words)***
4. **Conclusion** ***(40 words)***

Hints

Urbanization is the societal trend where the proportion of people living in cities increases while the proportion of people living in the country side diminishes. It is the process of becoming urban, moving to cities, changing from agriculture to other pursuits common to cities, such as trade, manufacturing, industry and management, and corresponding changes of behaviour patterns.

Problems related to the urbanization:

- Indian Urbanization suffer from haphazard and unplanned development, Over Crowding, stress on resources and basic services like Water supply, Drainage and Sanitation, Transportation and Traffic inefficiencies and pollution in urban areas.
- Spatial illegality is one of the core problems of Indian urbanization. It means unequal access to public services among legally recognised and planed areas of city and illegal areas like slums and unauthorized colonies of the city. People living in these areas are not considered as urban thus excluded. In Delhi's last reliable statistic on this in 2000, only 24 per cent of the city lived in a "planned colony." Everyone else, nearly three-fourths of the city, lived or lives some distance from this legal and planned norm.

- Basic amenities in these areas like piped water supply, sewerage, sweeping and sanitation, waste collection and disposal and public transport are either missing of left to the discretion of local authorities. This creates infrastructural inefficiencies, economic unavailability and social stress among residents.

How urbanization should be planned to establish the right to city for every resident:

- These challenges can be overcome by acknowledging the Right to City. It prioritises collective right over the individual right to urban space. It gives every inhabitant, and not just the legal citizens, the right to not just occupy a pre-existing urban space but also to produce spaces according to their needs.
- RTC gives every occupant, irrespective of their legality, a claim over the city. It requires the State to act on the principles of social justice and provide equal services to each and every resident. Just like the Right to Education makes it the State's duty to ensure that every child is in school, acknowledging the RTC means that the State can no longer deny shelter or provision of services such as water to those living in unauthorised slums.
- Recently Delhi Jal Board Delhi Jal Board (DJB) announced a new horizon towards the idea of universal access to a basic urban service and human need: water. The "JalAdhikar Connection" (a Right to Water Connection) promises to let households within slums in Delhi apply for legal, metered water connections "irrespective of the status of their residence."
- There are examples of universal access to basic infrastructure like Ahmedabad gave networked infrastructure to its slums; overall indicators of access slowly rose for the city as a whole. The Bangalore Water Supply and Sewerage Board introduced a category of "shared taps" to precisely open up water connections into slums; it saw its financial health improve alongside the improvements in the city's overall indicators of health, work, housing quality and poverty.

Efficiency, economic viability and effectively of urban infrastructure system lies in scale and connectivity. Spatial inequality disrupts this process. Thus right to city will be the solution to overcome these challenges.

10. Developmental activities along India's coastal areas have increased the erosion rate. Discuss the role of beach nourishment in coastal defence and impact of it on local ecosystems.

(200 words)

Approach

1. **Briefly introduce the increased erosion rate along India's coastal areas due to developmental activities** ***(40 words)***
2. **Discuss the role of beach nourishment in coastal defence** ***(100 words)***
3. **Discuss the impact of beach nourishment on local ecosystems** ***(60 words)***

Hints

Coastal erosion is a worldwide occurrence principally along sea shores but also along many lake shorelines.

- 45% of India's 8,414-km long coastline is facing erosion, according to a study based on satellite data over 15 years, published in the Indian Academy of Science's journal Current Science.
- Developmental activities are often carried out without properly understanding the coastal dynamics, leading to long-term damage, particularly to local communities.

Beach nourishment in coastal defence:

- Beach nourishment is a process by which sediment usually sand, lost through erosion is replaced from other sources.
- A wider beach can reduce storm damage to coastal structures by dissipating energy across the surf zone
- Protecting upland structures and infrastructure from storm surges, Tsunamis and unusually high tides.
- Beach nourishment is typically part of a larger coastal defence scheme.

Impact of Beach nourishment on local ecosystems: -

Negative impact:

- Nourishment may cause direct mortality to some organisms in the target area by burying them under the new sand.
- Seafloor habitat in both source and target areas are disrupted for example when sand is deposited on coral reefs or when deposited sand hardens.
- Imported sand may differ in character like chemical makeup, grain size, non-native species from that of the target environment.
- Light availability may be reduced, affecting nearby reefs and submerged aquatic vegetation.
- Imported sand may contain material toxic to local species.
- Removing material from near-shore environments may destabilize the shoreline, in part by steepening its submerged slope.
- Related attempts to reduce future erosion may provide a false sense of security that increases development pressure.
- Waves during storms remove sand, flatten the profile and the 'shoreline' again migrates landwards.
- Newly deposited sand can harden and complicate nest-digging for turtles.
- Sand deposited on the upper beach may be subject to wind erosion, causing an unwanted increase in blown sand across the back shore.

Positive Impact:

- Nourishment can provide more/better habitat for turtles, as well as for sea birds and beach flora.
- Nourishment will increase the volume of beach and/or dune material, and will enhance the natural recovery of dune face erosion.
- Where large volumes of material are imported, nourishment can provide a wide upper beach for recreational use, and will gradually feed sediment to adjacent beaches due to long-shore drift.

NOTES

PREVIOUS YEAR SOLVED PAPERS

QUESTION

2020

Question: 1. **The process of desertification does not have climatic boundaries. Justify with examples.**

Question: 2. **Account for the present location of iron and steel industries away from the source of raw material, by giving examples.**

Question: 3. **The interlinking of revivers can provide viable solutions to the multi-dimensional inter-related problems of droughts, floods and interrupted navigation. Critically examine.**

Question: 4. **Account for the huge flooding of million cities in India including the smart ones like Hyderabad and Pune. Suggest lasting remedial measures.**

Question: 5. **India has immense potential of solar energy though there are regional variations in its developments. Elaborate.**

Question: 6. **Examine the status of forest resources of India and its resultant impact on climate change.**

Question: 7. **Discuss the geophysical characteristics of Circum-Pacific Zone.**

2019

Question: 1. **Assess the impact of global warming on the coral life system with examples.**

Question: 2. **Discuss the causes of depletion of mangroves and explain their importance in maintaining coastal ecology.**

Question: 3. **Can the strategy of regional resource-based manufacturing help in promoting employment in India?**

Question: 4. **Discuss the factors for localisation of agro-based food processing industries of North- West India.**

Question: 5. **What is water stress? How and why does it differ regionally in India?**

Question: 6. **How can the mountain ecosystem be restored from the negative impact of development initiatives and tourism?**

Question: 7. **How ocean currents and water masses differ in their impacts on marine life and the coastal environment? Give suitable examples.**

2018

Question: 1. **Defining blue revolution, explain the problems and strategies for pisciculture development in India.**

Question: 2. **What is the significance of Industrial Corridors in India? Identifying industrial corridors, explain their main characteristics.**

Question: 3. **Why is India taking keen interest in the Arctic region?**

Question: 4. **Define mantle plume and explain its role in plate tectonics.**

Question: 5. **What are the consequences of spreading of 'Dead Zones' on marine ecosystem?**

Question: 6. **Why is Indian Regional Navigational Satellite System (IRNSS) needed? How does it help in navigation?**

2017

Question: 1. **Petroleum refineries are not necessarily located nearer to crude oil producing areas, particularly in many of the developing countries. Explain its implications.**

Question: 2. **In what way can floods be converted into a sustainable source of irrigation and all weather inland navigation in India?**

Question: 3. **What characteristics can be assigned to monsoon climate that succeeds in feeding more than 50 percent of the world population residing in Monsoon Asia?**

Question: 4. Account for variations in oceanic salinity and discuss its multi-dimensional effects

Question: 5. How does the cryosphere affect global climate?

Question: 6. How does the Juno Mission of NASA help to understand the origin and evolution of the Earth?

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ANSWERS

2020

Question: 1. The process of desertification does not have climatic boundaries. Justify with examples.

Solution:

Introduction

- Desertification has been described as "the greatest environmental challenge of our time" and climate change is making it worse.
- Desertification is defined by the United Nations (1980) as "diminution or destruction of the biological potential of the land which can lead ultimately to desert-like conditions."
- According to United Nations Convention to Combat Desertification (UNCCD), "Desertification means land degradation in arid, semi-arid and dry sub humid areas resulting from various factors, including climatic variations and human activities."
- So, rather than desertification meaning the literal expansion of deserts, it is a catch-all term for land degradation in water-scarce parts of the world. This degradation includes the temporary or permanent decline in quality of soil, vegetation, water resources or wildlife, for example.
- Drylands encompass around 38% of the Earth's land area, covering much of North and southern Africa, western North America, Australia, the Middle East and Central Asia.

Causes of Desertification:

- The direct causes of desertification can be broadly divided between those relating to how the land is – or isn't – managed and those relating to the climate.
- **Warming of Land Surface:** Both natural variability in climate and global warming can also affect rainfall patterns around the world, which can contribute to desertification. For example, widespread drought – and associated desertification – in the Sahel region of Africa in the second half of the 20th century has been linked to natural fluctuations in the Atlantic, Pacific and Indian Oceans, while research also suggests a partial recovery in rains was driven by warming sea surface temperatures in the Mediterranean.

- **Overexploitation:** Impact of climate change on humans reduces options for adaptation and livelihoods, and can drive people to overexploit the land. Removing trees can upset the balance of nutrients in the soil and takes away the roots that helps bind the soil together, leaving it at risk of being eroded and washed or blown away. For example, clearing the Amazon forests runs the risk of causing the local climate to dry, adding to the risk of desertification.
- **Food production:** Food production is also a major driver of desertification. Growing demand for food can see cropland expand into forests and grasslands, and use of intensive farming methods to maximise yields. Overgrazing of livestock can strip rangelands of vegetation and nutrients.

Question: 2. Account for the present location of iron and steel industries away from the source of raw material, by giving examples.

Solution: Introduction

➤ **Role of the Iron & steel industry in the world**

- The iron and steel industry is a very complex sector that is strongly related with the rest of the economy due to the importance of steel products for industries such as construction, automotive, and other manufacturing sectors.
- Moreover, the iron and steel industry demands significant amounts of raw materials and energy, and most companies producing raw materials are located remote from the areas of highest steel demand.

➤ **Location of Iron and Steel Industry**

- The other raw materials besides iron ore and coking coal, essential for iron and steel industry are limestone, dolomite, manganese and fire clay. All these raw materials are gross (weight losing), therefore, the best location for the iron and steel plants is near the source of raw materials.
- In India, there is a crescent shaped region comprising parts of Chhattisgarh, Northern Odisha, Jharkhand and western West Bengal, which is extremely rich in high grade iron ore, good quality coking coal and other supplementing raw materials.

➤ **Its location is determined by various factors such as:**

- **Raw Material:**
  - Near iron ore mines: To reduce the transportation cost, Industries are located near mines with Iron ore, manganese, limestone, dolomite deposits. For example: Rourkela in India and Kuznetsk Basin in Western Siberia.
  - Near coal Fields: Inefficiency of railway engines during the Industrial Revolution times made it cheaper to transport iron ore to coalfields not vice versa. For example: Appalachian-Pennsylvania in USA, Wuhan in China.
- Transportation: Location near coastal regions reduces the cost of transporting raw material (usually imported) from port to factories. For example, the Tata Iron and Steel plant lies very close to the Mumbai-Kolkata railway line and about 240 km away from Kolkata, which is the nearest port for the export of steel. The rivers Subarnarekha and Kharkai provide water to the plant.

- Modern Technology: such as electric smelters, Open hearth system etc. have helped in shifting of steel industries away from coal and iron-ore reserves by making efficient use of scrap metal & also reducing energy requirement. For example, Bhushan steel plant in Ghaziabad.
- Industrial Inertia: Industries continue to be located in the same area despite decline of locational advantages e.g. depletion of raw material. For example, Ruhr in Germany; Pittsburg in the USA.
- Developmental policies of government for backward regions: Establishment of iron and steel industry in Bhilai, Salem and Rourkela were based on decision to develop backward tribal areas of the country.
- Strategic reasons: After WWII, the USA and the USSR adopted a policy to not allow the concentration of the industry in one region. Thus, in the USA some plants were setup in the western region such as California and the USSR in the eastern side towards Pacific coast.
- Over time, Iron and Steel Industry started shifting towards coastal regions such as steel industry in Osaka Kobe, Japan, Steel plant at Vishakhapatnam, Ratnagiri, and the coastal cities of the USA such as Cleveland, Detroit and Chicago. The reasons are:
  - Depleting coal resource in mainland changed economics of cost of transportation of raw material versus that of finished product.
  - Near ports, steel can be exported and raw material can be imported with ease.

Question: 3. The interlinking of revivers can provide viable solutions to the multi-dimensional inter-related problems of droughts, floods and interrupted navigation. Critically examine.

Solution:

Introduction

- Interlinking Project has been proposed, as early, during the British Colonial Era by Arthur Cotton. River linking project is a mega scale engineering concept which aims to link, Himalayan Rivers, rivers flowing through northeast and peninsular rivers, to balance the deficit and excess water areas.
- Interlinking involves the process of diverting surplus river water through a network of canals to relatively drier areas either within a state or among two or more states.
- The project is managed by National Water Development Authority with 60 rivers.

➤ **River linking project is a suitable way for water management as:**

- It addresses disparity in water distribution across regions (water surplus to water deficient regions) and seasons (reservoirs will hold water and release during the dry season).
- It prevents occurrence of natural calamities like flood by controlling surplus river water flow and drought (eg. Ken-Betwa Project).
- It promotes agriculture and afforestation in arid regions. Eg. Indira Gandhi canal in Rajasthan.

- Providing an infrastructure to promote inland navigation to reduce transport cost and to reduce pollution caused due to road transportation.

➤ **Adverse Impact of Interlinking**

- It blocks the flow of fresh water into sea, affecting the marine life.
- Construction of structure lead to deforestation which creates ecological imbalance. Water logging, increased salinity and even water pollution due to inland waterway navigation.
- Submergence of large part of protected forest reserve, for example of large part of Panna Tiger reserve during Ken-Betwa linkage also leads to displacement of people.
- Mihir Shah Committee pointed out that river linking can affect the natural nutrient supply of agricultural lands, which will impact nature and population.
- Constructions can affect forest, which are natural ground water rechargers.
- Course of river changes after some time. For example, Teesta used to flow into Ganga, and now after an earthquake, it started to flow into Brahamputra. Linking them permanently will not be ecologically viable.
- River linking project requires a lot of funds which might lead to borrowing from foreign countries and increasing indebtness.

Way Forward:

- It is said that the course of rivers changes every 100 years, and hence, the project should be well planned.
- There is a need of comprehensive environment impact assessment so as to adopt the best alternative to minimize negative ecological impact so as to ensure sustainable development.
- Other than interlinking of rivers, Effective and efficient utilisation of existing water resources such as ground water, rain water harvesting, water preserving irrigation practices etc. must be made priority..

Question: 4. Account for the huge flooding of million cities in India including the smart ones like Hyderabad and Pune. Suggest lasting remedial measures.

Solution:

Introduction

- Flood is defined as “an overflow of a large body of water over areas not usually inundated”. Thus, flooding in urban areas is caused by intense and/or prolonged rainfall, which overwhelms the capacity of the drainage system.
- The coastal urban flooding is a complex phenomenon which may occur in various forms such as: urban flooding due to high intensity rainfall; due to inadequate drainage and flooding caused by overtopping in the channels or rivers; flooding due to high tides, etc.
- A 2016 UN report estimated that 40 million people in India will be at risk from sea-level rise by 2050.

- Waterlogging — a prelude to urban flooding — is a common sight in urban India during the monsoon. Urban flooding has also become increasingly common, as the changing weather pattern resulted in more high intensity rain in fewer rain days. While this was initially seen only in cities like Mumbai and Delhi now the scourge has been extended to smart cities like Hyderabad and Pune which have a high ease of living index performance

➤ Reasons for Urban Flooding:

- Urban flooding is caused by three main factors – meteorological, hydrological and human factors.
  - **Meteorological factors** include heavy rainfall, cyclonic storms and thunderstorms.
  - **Hydrological factors** include presence or absence of overbank flow channel networks and occurrence of high tides impeding the drainage in coastal cities.
  - **Human factors** include land use changes, surface sealing due to urbanization (which increases run-off), occupation of flood plains and obstruction of flood flows, urban heat island effect (which has increased the rainfall in and around urban areas), etc.
- **Urbanisation:** Rapid urbanization combined with a lack of efficient waste disposal systems have left several water bodies in the cities in poor condition. Blocked waterways and reduced width and depth of canals, while the speed and scale of construction reduces the permeability of the ground.
- **Improper Drainage:** In Indian cities and towns, large habitations are coming up in low-lying areas, often encroaching over drainage channels. Encroachment in the immediate upper catchments of hilly urban area has also caused serious flooding in the flood plains of cities surrounded by hills.
- **Population Growth:** Most of our cities have now reached a saturation point in terms of population growth and accommodation, and the developmental activities have now shifted to low-lying areas and areas next to the riverbanks. So, whenever a city experiences a large amount of rainfall within a short time, there are chances it gets flooded.

➤ Impact of the devastation due to floods:

- **On economy:** Damage to infrastructure, roads and settlements, industrial production, basic supplies, post disaster rehabilitation difficulties etc.
- **On human population and wildlife:** Trauma, loss of life, injuries and disease outbreak, contamination of water etc.
- **On environment:** Loss of habitat, tree and forest cover, biodiversity loss and large scale greenery recovery failure.
- **On transport and communication:** Increased traffic congestion, disruption in rail services, disruption in communication- on telephone, internet cables causing massive public inconvenience.

➤ Measures to address urban flooding in India:

- **Water-Sensitive Urban Design and Planning (WSUDP) and a green infrastructure approach for stormwater management:** Identification, protect and use of open spaces and water bodies as critical green infrastructure to manage run-off and mitigate urban flooding. This must be done in addition to identification of urban catchments and prioritisation based on level of risk and vulnerability.
- **Drainage Infrastructure:** Prepare drainage master plans for cities with short-, medium-, long-term and periodic strategies to augment stormwater infrastructure in cities. This must be aided by state-of-the-art urban watershed modelling.
- **Identifying Risk Prone Areas:** Identify vulnerable and high-risk areas and prepare monsoon action plans for those areas, based on context. Informal areas are more vulnerable due to high built-up area density and lack of infrastructure. This needs to be aided by a state-of-the-art rain atlas for cities, providing spatial rainfall maps with 15-minute intervals.

- **Urban Stormwater Management:** Formulate a nodal authority for urban stormwater management which should be responsible for preparation of drainage masterplan at the local level and coordinate strategies with city master plan preparations.
- **Utilising International best practices:** Implementing 'Mobile Walls' like in Germany, and 'sponge' cities in line with cities in China which involves replacing concrete pavements with porous pavements to ensure better filtration.
- **National Disaster Management (NDMA) Guidelines:** In 2010, NDMA had issued guidelines on Urban Flood Management in India -to create a National Hydro-meteorological Network for providing early warning, use of Doppler Weather Radars to be expanded to cover all urban areas in the country, an inventory of the existing storm water drainage system to be prepared etc.
- **Rainwater Harvesting:** Due to urbanisation, groundwater recharge has decreased and the peak runoff from rainfall and consequent flooding has increased. It will serve the twin purposes of lowering the peak runoff and raising the ground water table. Many municipal corporations in India have already made rainwater harvesting compulsory.

Way Forward:

- It is important to note urbanisation is an inevitable process and urban areas will continue to grow demographically and spatially. Hence, all existing and new developmental programmes and projects shall incorporate disaster resilient specifications in design and construction.
- Mumbai launched a state-of-the-art Integrated Flood Warning System (IFLOWS) in June, 2020. The warning system helps identifying imminent floods due to high rainfall or cyclones.
- The Chennai Flood Warning System — that provides spatial flood warnings for the city — was launched in October 2019.
- These systems help build resilience and can inform the public and authorities regarding risks. The India Meteorological Department launched the Mausam mobile application that provides rain forecasts including warnings.
- The Karnataka government launched the Meghasandesha mobile application, which provides real-time rainfall measurements, along with forecasts for rain, flooding and thunderstorms for capital city Bengaluru.
- While these measures look good on paper, they must be followed through by effective implementation, taking operation and maintenance and coordination with stakeholders including architects, planners, hydrologists, groundwater experts, etc, into account.
- These strategies must be prepared and implemented with the support and contribution of and the local community.

Question: 5. India has immense potential of solar energy though there are regional variations in its developments. Elaborate.

Solution: Introduction

Life on earth is heliocentric as most of its energy is derived from the sun. Imminent climatic changes and the demand for clean energy sources have induced significant global interest in solar energy. It has been observed that, solar as viable alternative

for power generation among the available clean energy sources has the highest global warming mitigation potential. Solar energy incident on the earth's surface, also called as insolation primarily depends on parameters like geographic location, earth–sun movements, tilt of the earth's rotational axis and atmospheric attenuation due to suspended particles.

India is one of the best recipients of solar energy due to its favourable location in the solar belt (40◦S to 40◦N). The National Solar Mission (NSM) launched in January 2010 has given a great boost to the solar scenario in the country. But due to the geographical expanse of the country there are seen regional variations in the development of this renewable energy resource.

Annual radiation of solar energy is highest in northern region, especially in Ladakh and least in the North-Eastern Region. Some areas of Gujarat, Rajasthan, Madhya Pradesh, Andhra Pradesh and Maharashtra also receive a large amount of solar radiation as compared to other areas of India. The solar radiation level receives lowest in some parts of Arunachal Pradesh and Sikkim. According to Ministry of Power Uttar Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Gujarat will be the major producer of solar energy by the year 2022 due to the high solar potential, irradiation etc. available in these states.

Seeing the potential of solar hotspot regions in the country, recently the government has dedicated a solar power plant to the country in Rewa, Madhya Pradesh. It has been acknowledged in India and abroad for its robust project structuring and innovations. It has also received World Bank Group President's Award for innovation and excellence.

India due to its geographical advantages can harness a tremendous amount of solar power but for that it requires huge technological advancement and financial support. Organisation like International Solar Alliance can help India become a major player in generating solar power. With an ambitious solar mission, and positively evolving policy instruments, the nation will rightly adorn the epithet of 'Solar India' in the near future.

Question: 6. Examine the status of forest resources of India and its resultant impact on climate change.

Solution: Introduction

According to the 16th India State of Forest Report (ISFR) the total forest and tree cover of the country is 80.73 million hectare which is 24.56 percent of the geographical area of the country. Area-wise Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra. In terms of forest cover as percentage of total geographical area, the top five States are Mizoram (85.41%), Arunachal Pradesh (79.63%), Meghalaya (76.33%), Manipur (75.46%) and Nagaland (75.31%). The total mangrove cover in the country is 4,975 sq. km. An increase of 54 sq. Km in mangrove cover has been observed. Top three states showing mangrove cover increase are Gujarat (37 sq. km) followed by Maharashtra (16 sq. km) and Odisha (8 sq. km).

The report presents a gloomy picture of the forests in North Eastern States. The forest cover of six states, excluding Assam, has decreased by nearly 18 per cent between 2011 and 2019.

But there are regions which are under the brunt of deforestation due to development initiatives like the expansion of the Talabira coal mine in Odisha, requires the cutting of over 130,000 trees.

Impact on Climate Change

- Trees remove carbon dioxide from the atmosphere through photosynthesis. Cutting down forests will cause a decline in photosynthetic activity which results in the atmosphere retaining higher levels of carbon dioxide. Forests also store an enormous amount of organic carbon which is released into the atmosphere as carbon dioxide when forests are cleared by burning. Clearly, deforestation contributes to global warming and ocean acidification.
- Water recycling is the movement of rain from the forest to land masses further inland. When rain falls on forests the water is intercepted by the forest canopy. Some of this intercepted water is returned to the atmosphere by evaporation and transpiration (release of water vapor into the atmosphere through stomata on tree leaves) while the rest is returned to the ocean as river runoff. In a healthy forest about three fourth of the intercepted water is returned to the atmosphere as moisture laden air masses which move inland, cool and are converted to rain. Land cleared by deforestation returns only about one fourth of the rain water to the atmosphere. This air mass has less moisture and delivers less rain further inland. Deforestation inhibits water recycling and converts inland forest to dry land and potential waste land.
- Severe flooding is a result of deforestation because removal of the forest leaves little vegetative cover to hold heavy rains. The inability of land void of forest to hold heavy rain water will also trigger mudslides. Severe flooding and mudslides are extremely costly because they devastate homes and communities.
- However, new research from the Indian Institute of Technology (IIT), Kharagpur, shows that a majority of Indian forests are exceptionally resilient to large variations in rainfall and short droughts caused by climate change. The research, which used canopy cover and rainfall changes as criteria to deduce resilience, revealed that forests in wetter regions and scrubs in drier regions would be more resilient to rainfall decline.

Question: 7. Discuss the geophysical characteristics of Circum-Pacific Zone.

Solution:

Introduction

Circum-Pacific Zone is a zone along the Pacific Ocean and is bordered by various tectonic plates like Juan de Fuca, Cocos, Indian-Australian, Nazca, North American, and Philippine Plates.

This zone contributes to nearly 70% of earth's volcanoes which gave it the name "Ring of Fire" and around 90% of World's earthquake .Various island arc and oceanic trenches- Mariana trench (the deepest oceanic trench) are also found in this area. Such geophysical phenomena can be attributed to certain characteristics of this region.

The lithospheric plate below the Circum-Pacific zone is always in transition which leads to the formation of above mentioned features. The plates in the region overlap each other at convergent boundaries creating subduction zones. Subduction zone is an area where a plate is overridden by the other and the plate underneath is pushed inside, where the rock melts due the prevailing temperature creating magma. Abundance of magma creates pressure which is eventually released on the surface of the earth in the form of volcanoes.

The part of the Circum-Pacific Zone where the plates slide past each other (Transform boundary) creating friction and tension which is leads to the formation of earthquake.

The above characteristics are the reasons which make this area a unique geophysical spot on the earth and home to various geophysical phenomena and features.

2019

Question: 1. Assess the impact of global warming on the coral life system with examples.

Solution:

Introduction

Destruction of coral reef can be induced by a variety of factors, alone or in combination. However, unprecedented global warming and climate changes combined with growing local pressures have resulted in destruction of coral reefs to a large extent.

Impact of global warming on the coral life system:

- **Coral Bleaching:**
  - The impacts from coral bleaching are becoming global in scale, and are increasing in frequency and intensity.
  - Mass coral bleaching generally happens when temperatures around coral reefs exceed 1 degree Celsius above an area's historical norm for four or more weeks. Sea surface temperature increases have been strongly associated with El Niño weather patterns.
  - However, light intensity, (during doldrums, i.e. flat calm conditions), also plays a critical role in triggering the bleaching response. If temperatures climb to more than 2o C for similar or longer periods, coral mortalities following bleaching increase.

- **Rising sea levels:**
  - Observations since 1961 show that the average temperature of the global ocean has increased even at depths of 3000m (IPCC report), and that the ocean has been absorbing more than 80% of the heat added to the climate system. Such warming causes sea level rise and creates problems for low lying nations and islands.

- **Ocean acidification:**
  - It refers to a change in ocean chemistry in response to the uptake of carbon dioxide from the atmosphere. The amount of carbon dioxide in the atmosphere is in equilibrium with that in seawater, so when atmospheric concentrations increase so do oceanic concentrations.
  - Carbon dioxide entering seawater reacts to form carbonic acid, causing an increase in acidity.
  - Each year, the ocean absorbs about one-quarter of the carbon dioxide emitted from the burning of fossil fuels (oil, coal, and natural gas).

- Since the Industrial Revolution, ocean acidity has increased by about 30%, a rate that is more than 10 times what has previously occurred for millions of years. Further, ocean acidity levels are expected to increase by an additional 40% above present levels by the end of this century.

Conclusion:

Coral reefs harbour the highest biodiversity of any ecosystem globally and directly support over 500 million people worldwide, mostly in poor countries. However, according to UNESCO, the coral reefs in all 29 reef-containing World Heritage sites would cease to exist by the end of this century if we continue to emit greenhouse gases. Limiting global average temperature to well below 2°C above preindustrial levels in line with the Paris Agreement provides the only chance for the survival of coral reefs globally.

Question: 2. Discuss the causes of depletion of mangroves and explain their importance in maintaining coastal ecology.

Solution: Introduction

Mangrove forests form a unique wetland ecosystem, inhabiting the edge of land and sea, thriving in seawater. Over the past four decades 35% of global mangrove forests have been destroyed. This

degradation of mangrove forests has a knock-on effect on some of the world's most endangered species which rely on them for habitat such as the proboscis monkey and the Bengal tiger.

Causes of depletion of mangroves:

- **The natural causes:**
  - Cyclones, typhoons and strong wave action especially in the geographically vulnerable Andaman and Nicobar Islands;
  - Browsing and trampling by wildlife (e.g. deer) and livestock (goats, buffaloes and cows), which are often left to graze freely, especially in areas close to human habitation;
  - Damage by oysters to the young leaves and plumules of Rhizophora and Ceriops plants; crabs, which attack young seedlings, girdle the root collars and eat the fleshy tissues of the propagules
  - insect pests such as wood borers, caterpillars (which eat the mangrove foliage and damage the wood as well) and beetles;

Anthropogenic causes:

- Anthropogenic activities such as construction of houses and markets causing soil erosion and soil sedimentation has lead to their destruction. For example in Sunderbans collection of tiger prawn seeds for trade has greatly affected the other animals found in these forests.
- Indiscriminate tree felling and lopping, mainly for fuel wood, fodder and timber, especially in areas close to human habitation.

- Indiscriminate conversion of mangroves on public lands for aquaculture (e.g. for prawn culture at Chorao, Goa), agriculture, mining (e.g. along the Mapusa estuary in Goa), human habitation and industrial purposes.
- Encroachment on publicly owned mangrove forest lands, e.g. cultivation of paddy observed on government land, which involved uprooting of natural and planted seedlings;
- Lack of interest of private landowners (village communities and individuals) in conserving and developing the mangroves on their lands.
- Illegal large-scale collection of mangrove fruits for production of medicines, which hinders their natural regeneration.
- Discharge of industrial pollutants into creeks, rivers and estuaries, which is a major problem in some regions of the world.

➤ **Importance of mangroves in maintaining coastal ecology:**

- Mangrove plants have (additional) special roots such as prop roots, pneumatophores which help to impede water flow and thereby enhance the deposition of sediment in areas (where it is already occurring), stabilise the coastal shores, provide a breeding ground for fishes.
- Provide a safe and favourable environment for breeding, spawning, rearing of several fishes.
- They supply woods, firewood, medicinal plants and edible plants to local people.
- Mangroves moderate monsoonal tidal floods and reduce inundation of coastal lowlands.
- They prevent coastal soil erosion.
- They protect coastal lands from tsunami, hurricanes and floods.
- Mangroves enhance the natural recycling of nutrients.
- Mangrove supports numerous florae, avifauna and wildlife.

Conclusion:

Mangrove forests play a major role with more valuable ecological services. Therefore conservation of the same is the need of the hour not only for the for coastal biodiversity but also for wellbeing of the mankind.

Question: 3. Can the strategy of regional resource-based manufacturing help in promoting employment in India?

Solution: Introduction

A local resource-based approach applies a cost-effective use of local skills, enterprises, labour and materials in the infrastructure delivery process. The process optimizes the social and economic impact of investments in Manufacturing by ensuring that these investments are channeled through the local economy, so creating job opportunities and stimulating local markets, entrepreneurship and industry while safeguarding cost effectiveness, quality and sustainable asset delivery.

Reason for Opting for local resource-based technologies:

- Government development objectives aim to generate employment and income opportunities for the local population and domestic construction industry.

- The infrastructure concerned requires relatively modest investments, e.g., rural roads, secondary and tertiary irrigation channels and small and medium-scale structures.
- Local resources including labour, skills, enterprises and materials are available.
- Scarcity of foreign exchange makes the use of imported inputs an economically unattractive option.
- A significant proportion of the population is UN- or under-employed
- Wage levels are low.

How it can help in promoting employment in India?

Local resource-based approach is to deliver public (and private) investments in infrastructure as a means of expanding employment opportunities for the unemployed, raising productivity, providing social and economic infrastructure assets and facilities, permitting trade and generally improving well-being.

- Given the relative scarcity of capital and skilled labour, and the relative abundance of unskilled labour, countries with low incomes can rapidly achieve pro-poor growth by applying employment friendly technologies in as many sectors as possible. This would rapidly increase the demand for unskilled and low-skilled labour.
- Several investment programmes have a huge employment creation potential if delivered via employment-friendly technology and local enterprises. Investment in public infrastructure accounts for as much as 40 to 60% of national public investment in most developing countries. Public investment programmes therefore represent one of the few remaining government policy instruments through which productive employment opportunities can be stimulated and more balanced economic and social development promoted.
- Promotion of local resource-based approach in manufacturing is done in order to optimize their impact on poverty reduction in labour-surplus countries and provides technical assistance for this purpose.

Benefits of a local resource-based approach:

- It enables higher delivery and maintenance rates of basic assets and services essential for socioeconomic development such as vital access roads, water supplies, markets and health facilities with the same level of investment and at comparable or better quality standards.
- Creates jobs, particularly for the unskilled, poorer men and women within the community. This results in the injection of incomes into the local communities, with the immediate effect of increasing their purchasing power. This, in turn, results in improving living standards such as improved diets, ability to access socio-economic amenities such as schools, clinics, etc.
- Stimulates local entrepreneurship, community participation and local economic development with important income distribution effects.
- Enables the involvement of the local private sector and industry, that is, contractors, suppliers and manufactures of local materials, tools and equipment. Hence nurtures and develops the local construction and manufacturing industry, retains investment locally and saves on foreign exchange required for foreign imports.

- Develops skills in the delivery process that can be used in other income generating activities, as well as in subsequent maintenance works.
- Offers opportunities for employment creation, social reintegration, and the stimulationof local socio-economic development in countries emerging from either man-madecrises or natural disasters. In such countries governments have few macro-economic tools at their disposal to revive their economies and to enable economic and social recovery. Public investment in infrastructure provides one such tool.

Conclusion:

Thus, Regional Development leads to the distribution of employment opportunities on an equitable basis and they are not let to confine only to a handful of states which are creation gaps in the per capital income among different regions.

Question: 4. Discuss the factors for localisation of agro-based food processing industries of North- West India.

Solution: Introduction

The agro-based industry depends on the raw material produced by the agricultural sector. It includes industries related to textiles, sugar, paper and vegetable oil. The products comprise mostly consumer goods. Agro- based industry is important from the point of view ofcontribution to industrial production and employment generation.

Factors affecting location of Agro-based food processing Industry in North-west India:

- Location of port facilitated import of capital goods, chemicals, etc., and the export of finished goods.
- In North- west India Mumbai got progressively well connected through rail and road links with cotton growing areas of Gujarat and Maharashtra in the interior.
- Availability of raw cotton, market, transport including accessible port facilities, labour, moist climate, etc. contributed towards its localisation. This industry has close links with agriculture and provides a living to farmers, cotton boll pluckers and workers engaged in ginning, spinning, weaving, dyeing, designing, packaging, tailoring and sewing.
- Development of chemical industry around North-West India made available the necessary inputs.
- Availability of capital and financial resources helped the industry grow.
- Availability of Cheap labour for the industry.
- Inexpensive water transport, supported by a good network of railways, roadways and waterways to facilitate movement of raw material to the mills.
- India stands second as a world producer of sugar. In recent years, there is a tendency for the mills to shift and concentrate in the western states, especially in Maharashtra; this is because the cane produced here has higher sucrose content. The cooler climate also ensures a longer crushing season. Moreover, the cooperatives are more successful in these states.

Challenges:

- Agribusiness is characterized by raw materials that are mostly perishable, variable inquality and not regularly available.
- The sector is subject to stringent regulatory controls on consumer safety, product quality and environmental protection.
- Traditional production and distribution methods are being replaced by more closely coordinated and better planned linkages between agribusiness firms, farmers,retailers and others in the supply chains.

Conclusion:

Agro-based industries have to set up at rural areas where raw material may be available in plenty – helps in the upliftment of the rural economy. It provides rural population an opportunity for employment. Generates income and thereby improve economic condition of people – which in turn creates potential for demand based industries. Thus, several factors govern the location of an Industry. But we have to remember that these factors are dynamic in nature. We can't say that an industry will always remain in a particular place. Availability of new raw-materials, improvement in technology, development of new areas that influence the localization or location of industries.

Question: 5. What is water stress? How and why does it differ regionally in India?

Solution: Introduction

Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.)

- India placed thirteenth among the world's 17 'extremely water-stressed' countries, according to the Aqueduct Water Risk Atlas released by the World Resources Institute (WRI).
- Chandigarh was the most water-stressed, followed by Haryana, Rajasthan and Uttar Pradesh.

Regional differences in water stress in India:

- Some regions have been hit harder by the change in rainfall patterns. Parts of Uttar Pradesh, Bihar, Chhattisgarh and Maharashtra, for instance, have seen a significant shortfall in rainfall over the last decade compared to historical averages. Even in regions, such as Uttarakhand, where average rainfall has increased—this could be driven by more extreme rainfall over short spans of time, the type of rains that cause floods.
- There are harrowing conditions of water scarcity in peninsular India. Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Telangana and Gujarat are in a particularly bad way, with northern Karnataka and Maharashtra not receiving adequate rainfall for three or four consecutive years.
- The entire country is vulnerable to 'vegetation drought'; regions with low soil moisture such as the river basins of Mahi, Sabarmati, Krishna, Tapi and Cauvery are particularly susceptible due to low levels of soil moisture.

- It is extraordinary that Kerala should be in the grip of a water crisis in precisely the regions that were devastated by last year's floods. A combination of high temperatures and water scarcity has put crops such as cardamom, rubber and tea under stress, with pest attack risks on the rise.
- According to the NITI Aayog report, 21 cities, including New Delhi, Bangalore, Chennai, and Hyderabad, are set to run out of groundwater by 2020, affecting an estimated 100 million people.
- It warned that groundwater resources, which constitute 40 percent of India's water supply, were being depleted at unsustainable rates.
- Excessive groundwater extraction affects not just the quantity but also the quality of water.

Reasons of water stress at regional level in India:

- The gap between supply and demand will likely widen due to climate change and drought-like situations, drying of Himalayan springs that caused recent Shimla water crisis and uncontrolled groundwater extraction.
- Exacerbating these set of policies which encourage water wastage, deepening the water crisis that threatens the livelihoods and lives of millions in rural India.
- This growing demand for water is almost entirely driven by farmers. In India more than 80% of water demand is used for farming, and agricultural water consumption is expected to stay at these levels even in 2050.
- India's reliance on water for farming is partly self-inflicted. For instance, the government's minimum support price scheme incentivizes the production of water-intensive crops, such as rice and sugar cane, even in areas not suitable for these crops' production.
- For instance, the Punjab government is offering cash transfers to farmers for every unit of electricity they save to wean them away from pumping more water.
- Micro-irrigation practices, such as the use of drips and sprinklers, are not picking up at the desired pace. Economic Survey 2015-16 observes: "The key bottlenecks in the adoption of this technology are the high initial cost of purchase and the skill required for maintenance."
- Issues relating to coordination have further complicated water issues. Traditionally, different aspects of water have been managed in isolation by different ministries. This has now changed with the newly-formed Jal Shakti ministry, which has subsumed several different water-related departments.

Conclusion:

Therefore, power subsidies can be gradually withdrawn and instead drip and sprinkler irrigation subsidised. This should be accompanied by a shift away from paddy and sugarcane in rain fed regions, with subsidies and incentives being linked to such choices. Telangana have shown the way in furthering micro-irrigation through Mission Kakatiya, which entails the revival of over 40,000 tanks in the State. An immediate as well as medium-term policy response is called for. The first priority is to stave off a drinking water crisis by rationing the use of water for irrigation purposes. We will have to apply a good mix of centralized storage (in the form of conventional large reservoirs and large inter basin water transfer programs) and decentralized and distributed storage systems in farmers' fields and villages.

Question: 6. How can the mountain ecosystem be restored from the negative impact of development initiatives and tourism?

Solution:

Introduction

Mountains are an important source of water, energy and biological diversity. Furthermore, they are a source of such key resources as minerals, forest products and agricultural products and of recreation. As a major ecosystem representing the complex and interrelated ecology of our planet, mountain environments are essential to the survival of the global ecosystem. Mountain ecosystems are, however, rapidly changing.

Developmental initiatives and Tourism in Mountains: Impact:

Over the generations, mountain people have learned how to live with the threat of natural hazards and have developed well-adapted and risk-resilient land-use systems. However, there is growing evidence that many mountain regions have become increasingly disaster-prone over the past few decades.

- **Dams and Roads:** Dams and roads can be hazardous if they are not properly constructed and managed. Disasters in mountains, and the forces that trigger them, affect larger areas, sometimes entire watersheds or river systems.
- **Mining:** The forces that shaped the world's mountains also made them rich in minerals and metals, including gold, copper, iron, silver and zinc. Owing to increasing demand, mines are now being opened even in remote mountain areas, particularly in developing countries.
- Mining can bring large benefits, but it can also be devastating to fragile mountain ecosystems and local cultures, destroying the livelihood base of mountain communities. Massive quantities of waste, surface dumps and slag heaps are only the most visible consequences.
- **Mountain Tourism:** Mountain areas are second only to coasts and islands as popular tourism destinations, generating 15-20 percent of annual global tourism, or US$70-90 billion per year.

With more than 50 million visitors per year, mountains are some of the world's most important destinations for tourism.

Beautiful landscapes, sporting and recreational possibilities and the unique traditions, cultures and lifestyles of mountain people attract increasing numbers of visitors, mainly from lowland cities. The increasing exploitation of mountain areas by outside forces such as commercial agriculture, logging, mining and tourism enterprises puts additional dangerous pressure on these fragile ecosystems. As a result, such events harm not only mountain communities but also livelihoods further downstream, affecting millions of people.

Restoration of Mountainous Ecosystem:

About 10 per cent of the world's population depends on mountain resources. A much larger percentage draws on other mountain resources, including and especially water. Mountains are a storehouse of biological diversity and endangered species. Most global mountain areas are experiencing environmental degradation. Hence, the proper management of mountain resources and socio-economic development of the people deserves immediate action.

- **Infrastructure Development:** Only small dams and greater investments in road construction and restoration, improved road design, and better maintenance practices are needed to limit the negative impacts of mountain roads.
- **Eco-Tourism:** Tourism can have a range of impacts on mountain ecosystems, communities and economies. While many of the impacts described above are negative, tourism can also generate positive impacts as it can serve as a supportive force for peace, foster pride in cultural traditions, help avoid urban relocation by creating local jobs, increase visitor awareness and appreciation of natural, cultural and historical values and assets.
- Good Practice in Action-White pod, a unique tourist camp located in the Swiss Alps, is made up of semi-permanent dome-shaped tents, or pods, that serve as guest rooms, with a central chalet housing the dining room, common room and bathroom facilities. The pods are heated with woodburning stoves and all furniture is made from recycled materials or sustainably harvested wood.
- Minimize the use of motorized transport in and around mountain areas
  - Wherever possible, use local non-motorized means of transport, such as mules and horses, and avoid developing tours that are overly dependent on motorized transportation and activities.
  - Share vehicles and transportation infrastructure with other tour operators or service providers where possible.
  - Choose routes and time schedules that minimize congestion and distance travelled.
  - Avoid the use of vehicles with a larger seating or engine capacity than is required for the tour.
- Minimize trash generation
  - Avoid over-packaged goods and disposable items.
  - Purchase in bulk and use recyclable and refillable containers where possible.
  - Keep waste and chemicals away from natural water bodies.
  - Avoid the use of cleaning products, soaps, detergents and toothpaste near or in fresh water.
- Educate visitors about the effects of climate change on mountains and snow-based recreational activities. Offer suggestions for how they can reduce greenhouse gas emissions by, for example, using low-polluting vehicles, removing ski racks and replacing snow tires with normal tires at the end of the season, and carpooling or taking shuttles to recreational sites.

Conclusion:

To achieve sustainable mountain development, it is essential that all concerned stakeholders are involved and that awareness is raised about mountain ecosystems, their fragility and prevalent problems, and about ways of addressing them.

Question: 7. How ocean currents and water masses differ in their impacts on marine life and the coastal environment? Give suitable examples.

Solution: **Introduction**

The ocean water is dynamic. Its physical characteristics like temperature, salinity, density and the external forces like of the sun, moon and the winds influence the movement of ocean water. Ocean currents are the continuous flow of huge amount of water in a definite direction.

Water moves ahead from one place to another through ocean currents. Ocean currents has direct impact on the climate and economy of the region.

Common water masses in the world ocean are: Antarctic Bottom Water (AABW), North Atlantic Deep Water (NADW), Circumpolar Deep Water (CDW), Antarctic Intermediate Water (AAIW), Subantarctic Mode Water (SAMW), Arctic Intermediate Water (AIW), North Pacific Intermediate Water (NPIW), the central waters of various oceanic basins, and various ocean surface waters.

Ocean currents and water masses differ in their impacts on marine life and the coastal environment in different ways:

- Impact on biodiversity - The physical parameters of water masses are essential because they structure the water masses and determine the various habitats that provide the environmental conditions required for marine life.
- These conditions influence the production and the growth of plankton and fish species. The dispersion and dwelling of larvae for many benthic and pelagic species depend on hydrographical factors. They also play an important role for the exchanges between the sea and the atmosphere and between the various layers of water.
- While ocean currents has also direct impact on the marine biodiversity. For example mixing of ocean currents becomes a ground for fishing. Best example is eastern USA coast
- Osmo regulation and fertility- water masses formation and location of its formation has direct bearing on the marine biodiversity as salinity and temperature of water masses changes with its location.
- While ocean currents also changes the salinity of coastal region which changes the marine biodiversity. It has also direct bearing on temperature of region also. Best example is north atlantic drift of Atlantic region. Due to north Atlantic drift, Murmansk port of Russian region will remain ice free.

2018

Question: 1. **Defining blue revolution, explain the problems and strategies for pisciculture development in India.**

Solution: **Introduction**

The term “blue revolution” refers to the remarkable emergence of aquaculture as an important and highly productive agricultural activity. Blue Revolution, the Neel Kranti Mission has the vision to achieve economic prosperity of the country and the fishers and fish farmers as well as contribute towards food and nutritional security through full potential utilization of water resources for fisheries development in a sustainable manner, keeping in view the bio-security and environmental concerns.

Problems of pisciculture development in India

- **Problems of ocean fish farming:**
  - The cost of inputs per unit of fish weight is higher than in extensive farming, especially because of the high cost of fish feed. Netting involves regular and labour intensive cleaning. In ocean farming, the transfer of disease organisms from the wild fish to the aquaculture fish is an ever present risk. The very large number of fish kept long-term in a single location contributes to habitat destruction of the nearby areas
  - Factory fish farming which is known as aquaculture is generally big, dirty and dangerous, just like factory farming on land. – Factory fish farms may interfere with the livelihoods of commercial and recreational fishermen by displacing them from traditional fishing grounds or harming wild fish populations.

- **Problems of inland fish farming:**
  - Social problems: Norms and religious values excluded women or other groups from participation in certain activities. Lack of family encouragement considering lower prestigious occupation.
  - Inadequate family labour: Multiple use of pond water especially domestic purposes restrict the commercial fish farming. Multiple ownership of land is the cause of dispute and opinion diversification.

Disputed ownership of water areas.

- Poaching from fish pond, poisoning in fish pond due to jealousy or revenge, Lack of contract farming, Presence of middlemen in the fish trade who reduce the profit margin of fish farmers.
- Economical problems: High costs of cultural inputs especially fish feed, lack of financial assistance, adequate loan from financial agencies, lack of remunerative price for the commodity, fluctuating fish prices in market, small size of ponds (majority of farmers are small and marginal farmers), lack of regulated market facilities, too much competition in fishery business.
- Technological problems: Lack of value addition for enhancing profit margin. The market for processed fish is limited in the domestic market and is restricted to fish pickles, papads, cutlets and the like. Fish production technology is a complex technology. Lack of timely availability of inputs nearby, lack of quality feed in local market, lack of location specific improved technology, inadequate knowledge and skill about scientific fish farm management.

Strategies of pisciculture development in India:

- Growth of aquaculture sector, particularly brackish aquaculture, is mainly export driven. Thus to sustain the momentum of growth, issues concerning ecological and economic sustainability of brackish aquaculture and its comparative advantage need to be studied on a multidisciplinary and regional framework.
- Brackish aquaculture should be encouraged only in the areas suitable for the purpose. These should be identified and delineated with the help of remote sensing and GIS techniques to minimise problems of ecological pollution and social conflicts.

- Develop adequate legal and institutional measures to regulate the aquaculture activity in the ecologically fragile zones. These should be implemented and enforced by the local authorities.
- Enforce quarantine measures on fish seed and feed to ensure that the imported material is neither infected nor unwanted.
- Financial institutions should be strengthen the flow of credit to aquaculture sector but with due consideration to ecology and regulatory framework governing this sector.
- For proper planning of freshwater as well as brakishwater aquaculture, there is a need to strengthen the current database, which is neither adequate nor easily amendable to proper empirical policy analysis.

In the present era of food insecurity, pisciculture shows enormous potential to feed the ever increasing human population. The pisciculture sector has become a modern, dynamic industry that produces safe, high valuable and high quality products, and has developed the means to be environmentally sustainable aquaculture is currently the need in India as elsewhere. Eco-friendly aquaculture in harmony with environmental and socio economic needs of the society has to be evolved.

Question: 2. What is the significance of Industrial Corridors in India? Identifying industrial corridors, explain their main characteristics.

Solution:

Introduction

Industrial Corridors recognize the inter-dependence of various sectors of the economy and offer effective integration between industry and infrastructure leading to overall economic and social development. Industrial corridors constitute world class infrastructure such as high-speed transportation.

Significance of Industrial Corridors in India:

- An industrial corridor in India is a package of infrastructure spending allocated to a specific geographical area, with the intent to stimulate industrial development.
- The aim is to create an area with a cluster of manufacturing or other industry. Such corridors are often created in areas that have pre-existing infrastructure, such as ports, highways and railroads. These modalities are arranged such that an “arterial” modality, such as a highway or railroad, receives “feeder” roads or railways.
- Industrial corridor provides opportunities for private sector investment in the provision of various infrastructure projects associated with the exploitation industrial opportunity. However, the successful utilization of opportunities that arises from industrial corridors depends on availability of efficient transport and other infrastructure support systems.
- Corridor approach for industrial development primarily takes advantage of the existence of proven, inherent and underutilized economic development potential within the influence region.
- Apart from the development of infrastructure, long-term advantages to business and industry along the corridor include benefits arising from smooth access to the industrial production units, decreased transportation and communications costs, improved delivery time and reduction in inventory cost.

Industrial corridors in India and their main characteristics:

- Delhi-Mumbai Industrial Corridor (DMIC):– The Delhi–Mumbai Industrial Corridor Project (DMICDC) is a planned industrial development project between India's capital, Delhi and its financial hub, Mumbai. It is one of the world's largest infrastructures spread across six states. The project has received a major boost from India and Japan, due to an agreement to set up a project development fund.
- Chennai-Bengaluru Industrial corridor: – It is expected to boost commerce between south India and East Asia by enabling quicker movement of goods from these places to the Chennai and Ennore ports. – The project with assistance from the Japan International Cooperation Agency (JICA) will be developed in collaboration with the governments of three southern states. 2 major backbone infrastructure projects will be created for the corridor. Both Road and Rail connectivity for Freight movement will be upgraded in this corridor.
- The East Coast Economic Corridor (ECEC): – The ECEC running along the entire east coast of India from Kolkata to Kanyakumari is a multimodal, regional maritime corridor that can play a vital role in unifying the large domestic market, as well as integrating the Indian economy with the dynamic global value chains of Southeast and East Asia.
- It would play a crucial role in the Government of India's (GoI) Make in India campaign and also supports the port-led industrialization strategy under the Sagar Mala initiative and the Act East Policy by linking domestic companies with the vibrant global production networks of East and Southeast Asia.
- Amritsar kolkata industrial Corridor (AKIC): – In order to give a boost to industrial development in the densely populated States of Northern and Eastern India. The AKIC will also leverage the Inland Water System being developed along National Waterway-1 which extends from Allahabad to Haldia.
- North East Myanmar Industrial Corridor: – It has been initiated from the Tokyo Declaration for India-Japan Special Strategic and Global Partnership for enhanced connectivity and development in Northeast which would catalyze economic development and increase prosperity in the region.
- Thus, an industrial corridor is a package of infrastructure spending allocated to a specific geographical area, with the intent to stimulate industrial development. An industrial corridor aims to create an area with a cluster of manufacturing or other industry which assist in faster development of the region.

Question: 3. Why is India taking keen interest in the Arctic region?

Solution: Introduction

Although India may be far from the Arctic region physically, yet the impact of melting of the Arctic ice on the global climate is likely to be significant. India also understands the geo-strategic importance of the Arctic region.

Importance of arctic region for India:

- To study monsoon pattern: To study the hypothesized tele-connections between the Arctic climate and the Indian monsoon by analyzing the sediment and ice core records from the Arctic glaciers and the Arctic Ocean.
- To characterize sea ice in Arctic using satellite data to estimate the effect of global warming in the northern polar region.

- To conduct research on the dynamics and mass budget of Arctic glaciers focusing on the effect of glaciers on sea-level change.
- To carry out a comprehensive assessment of the flora and fauna of the Artic vis-à-vis their response to anthropogenic activities. In addition, it is proposed to undertake a comparative study of the life forms from both the Polar Regions.
- For exploration of hydrocarbons: The opening of the sea routes and the exploration of hydrocarbons present economic opportunities which Indian companies can also exploit.
- China's ability to navigate the Northern Sea Route (NSR) is another factor in India's military strategy in that region.

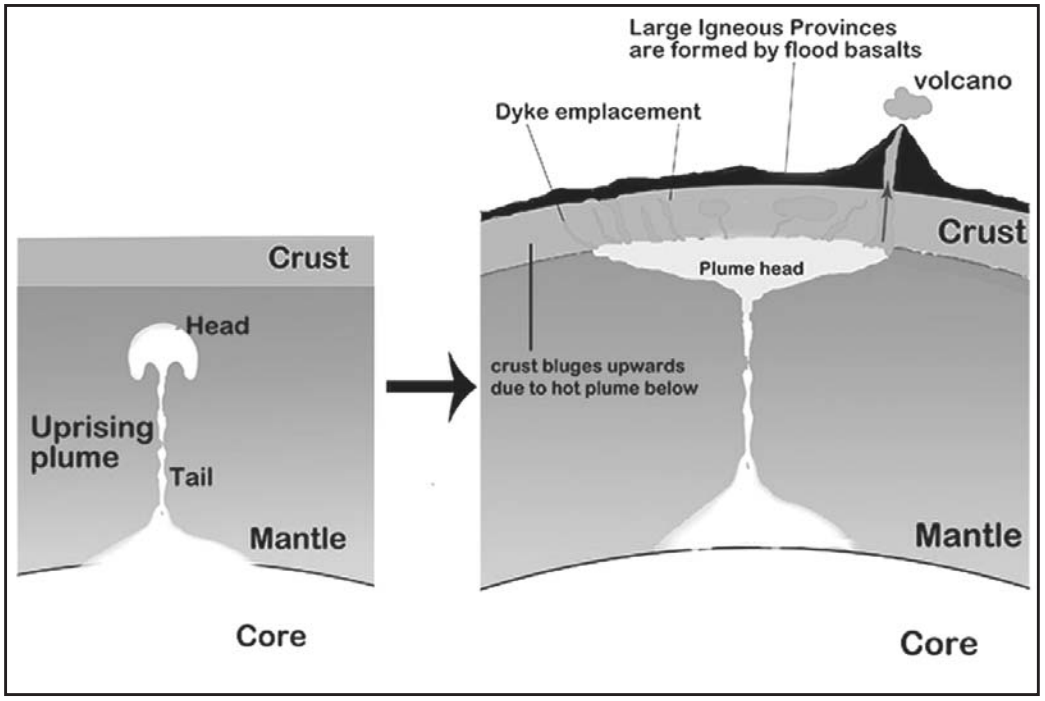
Observer role of India Arctic Council: India which has a significant expertise in this area from its association with the Antarctic Treaty System can play a constructive role in securing a stable Arctic. India in its new role as a permanent observer in the Arctic Council is committed to contribute to the deliberations of the council to develop effective cooperative partnerships that can contribute to a safe, stable and secure Arctic.

India cannot remain immune from the developments in the region even though the area is remote and far away. India has a long tradition of polar research. It maintains a permanent research station in Svalbard. On the negative side, the enhancement of economic activity in the Arctic Region will accelerate global warming and lead to large sea level rise impacting the global climate to which India cannot remain indifferent.

Question: 4. Define mantle plume and explain its role in plate tectonics.

Solution: Introduction

A mantle plume is an upwelling of abnormally hot rock within the Earth's mantle. It is a large column of hot rock rising through the mantle.



The heat from the plume causes rocks in the lower lithosphere to melt. The largest (and most persistent) mantle plumes are presumed to form where a large volume of mantle rock is heated at the core-mantle boundary, about 1,800 miles below the surface, although smaller plumes may originate elsewhere within the mantle. Once the temperature increases sufficiently to lower the rock density, a column of the hotter-than-normal rock starts to rise very slowly through the surrounding mantle rocks.

Role of mantle plume in plate tectonics:

- The rising column of hot rock reaches the base of the lithosphere, where it spreads out, forming a mushroom-shaped cap to the plume. The overlying lithosphere is pushed up and stretched out as the plume cap spreads. Heat transferred from the plume raises the temperature in the lower lithosphere to above melting point, and magma chambers form that feed volcanoes at the surface.
- Because the plume remains anchored at the core-mantle boundary, it does not shift position over time. So, as the lithospheric plate above it moves, a string of volcanoes (or other volcanic features) is created.
- The material and energy from Earth's interior are exchanged with the surface crust in two distinct modes: the predominant, steady state plate tectonic regime driven by upper mantle convection, and a punctuated, intermittently dominant, mantle overturn regime driven by plume convection. This second regime, while often discontinuous, is periodically significant in mountain building and continental breakup.
- When a plume head encounters the base of the lithosphere, it is expected to flatten out against this barrier and to undergo widespread decompression melting to form large volumes of basalt magma. It may then erupt onto the surface.
- Numerical modelling predicts that melting and eruption will take place over several million years. These eruptions have been linked to flood basalts, although many of those erupt over much shorter time scales (less than 1 million years). Examples include the Deccan traps in India, the Siberian traps of Asia, etc.
- The eruption of continental flood basalts is often associated with continental rifting and breakup. This has led to the hypothesis that mantle plumes contribute to continental rifting and the formation of ocean basins. In the context of the alternative "Plate model", continental breakup is a process integral to plate tectonics, and massive volcanism occurs as a natural consequence when it onsets.

Thus, mantle plumes are thought to be strong enough to induce rifting and the formation of plates. The relationship between plate- and plume-tectonics is considered in view of the growth and breakdown of supercontinents, active rifting, the formation of passive volcanic-type continental margins, and the origin of time-progressive volcanic chains on oceanic and continental plates.

Question: 5. What are the consequences of spreading of 'Dead Zones' on marine ecosystem?

Solution: Introduction

Dead zones are low-oxygen, or hypoxic, areas in the world's oceans and lakes. Because most organisms need oxygen to live, few organisms can survive in hypoxic conditions. That is why these areas are called dead zones. Dead zones in the coastal oceans have spread exponentially since the 1960s and have serious consequences for ecosystem functioning.

Effects of dead zones on marine ecosystem:

- An ocean dead zone is an invisible trap that there is no escaping from for marine life. Fish can't detect dead zones before entering the areas. Unfortunately, once fish wander into a dead zone, it's hard to escape and survive. The oxygen shortage causes the fish to lose consciousness and die shortly after.
- Other sea dwellers, such as lobsters and clams, are also unable to get away because they naturally move slowly.
- Fish suffer greatly from dead zones because the extreme changes in the oxygen level changes their entire biology. Their organs become smaller, meaning they can't reproduce or function in the necessary ways that allow them to flourish. The females are unable to produce as many eggs and the males can't properly impregnate the females to keep the species alive.
- By depriving organisms of sunlight and oxygen, algal blooms negatively impact a variety of species that live below the water's surface. The number and diversity of benthic, or bottom-dwelling, species are especially reduced.
- The less biodiversity that exist underwater, the more the balance of the entire ocean is disrupted. This also leads to economic instability for local fisherman.
- Elevated nutrient levels and algal blooms can also cause problems in drinking water in communities nearby and upstream from dead zones. Harmful algal blooms release toxins that contaminate drinking water, causing illnesses for animals and humans.
- Algal blooms can also lead to the death of shore birds that rely on the marine ecosystem for food. Wading birds, such as herons, and mammals, such as sea lions, depend on fish for survival. With fewer fish beneath algal blooms, these animals lose an important food source.

Scientists have identified 415 dead zones worldwide. Conservation of the marine ecosystem is crucial for its survival and its success hinges on the collaborative spirit of cities, farmers, agri-business and policy makers to embrace science-based solutions, both on the ground and at the policy level. By following these simple methods of keeping the environment clean and keeping communities aware of methods of industrial practices used by factories, we can ultimately draw an end to dead zones and provide a better environment for the ocean, animals and people that live in these areas.

Question: 6. Why is Indian Regional Navigational Satellite System (IRNSS) needed? How does it help in navigation?

Solution: Introduction

The Indian Regional Navigation Satellite System (IRNSS), with an operational name of NAVIC is an autonomous regional satellite navigation system that provides accurate real-time positioning and timing services. It covers India and a region extending 1,500 km (930 mi) around it, with plans for further extension.

Objective of Indian Regional Navigational Satellite System:

- The objective of the project is to implement an independent and indigenous regional space borne navigation system for national applications.

- For long India, like many other countries, had been dependent on the services that were being rendered by the foreign navigation systems. The usage and availability of satellite data depended largely upon how good relations were maintained with said countries.
- This technological dependency brought with it the grave vulnerability especially in the case of hostile situations.
- The immediate reason to initiate indigenous navigation capabilities was Kargil War in 1999, when USA denied India access to vital satellite based information.
- Before the launch of IRNSS, the availability so far of the satellite data was without any contractual services obligation that gave an easy escape for such service provider to withdraw their services at any point of time.
- The system is expected to provide accurate real-time position, velocity and time observables for users on a variety of platforms with a 24 hour x 7 day service availability under all weather conditions

How does it help in navigation?

- The IRNSS design requirements call for a position accuracy of < 20 m throughout India and within the region of coverage extending about 1500 km beyond.
- The system is expected to provide accurate real-time position, velocity and time observables for users on a variety of platforms with a 24 hour x 7 day service availability under all weather conditions
- It give real time information for 2 services i.e. standard positioning service open for civilian use and Restricted service which may be encrypted for authorised user like for military.
- It will help to mitigate the disaster effects by providing information of disaster timing, safe location and also help the disaster relief management to make earlier plans and save the lives of people in India as well as up to 1500 km around it.
- It will help the mariners for far navigation and fisherman for get information about the valuable fisheries location and any disturbance in Sea.

It will help to make friendly relations with others countries by providing real time information during any calamity or disaster for mitigates its after effect and for making early plans.

Hence, India has become one of the 5 countries having their own navigation system like GPS of USA, GLONASS of Russia, Galileo of Europe and BeiDu of China. So India dependence on other countries for navigation purposes has reduced on significant level.

2017

Question: 1. Petroleum refineries are not necessarily located nearer to crude oil producing areas, particularly in many of the developing countries. Explain its implications.

Solution:

Introduction

An oil refinery or petroleum refinery is an industrial process plant where crude oil is processed and refined into more useful products such as petroleum naphtha, gasoline, diesel fuel, asphalt base, heating oil, kerosene, and liquefied petroleum gas.

- **Some of the reasons for petroleum refineries not located near oil fields are**
  - For Petroleum refineries, the raw material sources were less decisive factors for industrial location.
  - Because industries were already setup in coalfields and did not move away due to industrial inertia.
  - Petroleum refining does not lead significant weight-loss, unlike the aluminum/ copper/sugarcane/ timber processing.
  - Virtually all the by-products can be used. Therefore, refineries can be set up
    - Near the raw material or
    - Near the market or
    - at an intermediate break of the bulk location (ports/coastal locations)
  - Multinational companies do not feel confident to setup refineries inside the middle-east or South America because of Arab-Israel war, Israel-Palestine issue and other terrorist activities.
  - In country such as India mostly government has established oil refineries just to develop the growth pole in that region E.g. Mathura oil refinery, Panipat oil refinery etc.
  - In the wake of development of various oil and gas pipelines the importance of oil field as a locational factor for refinery industry has reduced.

Implications

- If the refinery is situated closer to oil fields then once the oil is exhausted the refinery will also become useless.
- Oil refining close to production site represents a weight loss of 10-11 % only thus not much cost saving in transport even if located near raw material site.
- In India it has helped in the development of the cities such as Mathura, Panipat by providing employment opportunities.

Question: 2. In what way can floods be converted into a sustainable source of irrigation and all weather inland navigation in India?

Solution:

Introduction

The term flood is generally used when the water-flows in rivers, streams and other water bodies cannot be contained. Floods occur regularly in India affecting about 12% of area.

Floods as sustainable source of irrigation

- **Reducing run-off**
  - Infiltration method through afforestation
  - Through digging wells
  - Biopore infiltration method
- **Reducing flood peaks by volume reduction**

- By constructing dams and detention basins
- Marshy areas, old quarries and mines can act as detention basins

- **Reducing flood level**
  - Stream channelization (close network of canals reduces flood hazard)
- **Flood diversion**
  - It includes diverting flood water in marshes, depressions and spreading it thinly over paddy fields and dry lands E.g. Ghaggar Reversion Scheme.

Flood as all-weather inland navigation

- By the method of network of canals from the flood prone rivers the water in canal can also be used for inland navigation.
- Interlinking of rivers will help in pan India development of inland navigation.
- Channel improvement can also be done by deepening, widening, straightening, lining and cleaning out of vegetation and debris from river channel.

Question: 3. What characteristics can be assigned to monsoon climate that succeeds in feeding more than 50 percent of the world population residing in Monsoon Asia?

Solution:

Introduction

The tropical monsoon climate experiences abundant rainfall like that of the tropical rain forest climate, but it is concentrated in the summer season. The monsoon type of climate has helped in defining the Asian culture, economy, polity and way of living on a large scale. Some of its characteristics are,

- The major controlling factor over the monsoon climate is its relationship to the monsoon circulation.
- The Monsoon is a seasonal change in wind direction.
- It is mostly associated with on-shore wet monsoons in the summer and off-shore dry monsoons in the winter.
- The rainfall caused by this climate is torrential in nature.
- They are best developed in the Indian sub-continent, Burma, Thailand, Laos, Cambodia, parts of Vietnam and south China
- Outside this zone, the climate is modified by the influence of the on-shore Trade Winds all the year round, and has a more evenly distributed rainfall.
- The basic cause of monsoon climates is the difference in the rate of heating and cooling of land and sea.
- The natural vegetation of tropical monsoon lands depends on the amount of the summer rainfall. Trees are normally deciduous because of the marked dry period, during which they shed their leaves to withstand the drought.
- Tropical monsoon climates have monthly mean temperatures above 18 °C in every month of the year and feature wet and dry seasons.
- The diurnal range of temperature of small.
- Locally, Orographic (Relief) uplift is an important mechanism for promoting precipitation. As air travels into the Indian subcontinent, it is uplifted by the Himalayas, causing cloud development and precipitation.

Question: 4. Account for variations in oceanic salinity and discuss its multi-dimensional effects

Solution:

Introduction

Salinity is defined as the ratio between the weight of the dissolved materials and the weight of the sample sea water. The average salinity in the oceans and the seas is 35‰ however it has significant spatial variations as follows

Horizontal Distribution

- On an average salinity decreases from equator towards poles. However highest salinity is recorded at tropics and not at the equator because of high rainfall at equator.
- Marginal areas of the oceans bordering the continents have lower salinity than their central parts because freshwater is added to the marginal areas through the rivers.
- There is no control of latitudes on the distribution of salinity in the inland seas as salinity of the partially enclosed seas in higher latitudes is controlled by influx of melt water. E.g. Baltic Sea records relatively lower salinity than the North Sea though both are in almost same latitude.

Vertical Distribution

- Salinity increases with increasing depth in high latitudes.
- Salinity is low at the surface at the equator due to high rainfall and transfer of water through equatorial currents but higher salinity is noted below the water surface.
- However, on an average higher salinity is found in the upper layer of the oceanic water and it decreases with depth.
- Thus, the upper zone of maximum salinity and the lower zone of minimum salinity is separated by a transition zone which is called Halocline zone.

Effects of variation in ocean salinity

- The freezing and boiling points are greatly affected and are controlled by addition or subtraction of salts in seawater.
- Salinity and density of seawater are positively correlated.
- Evaporation is controlled by salinity of the oceans thus the tropical cyclones which are driven by evaporation are indirectly controlled by salinity.

Question: 5. How does the cryosphere affect global climate?

Solution:

Introduction

There are places on Earth that are so cold that water is frozen solid. These areas of snow or ice, which are subject to temperatures below 32°Ffor at least part of the year, compose the cryosphere.

Impact on global climate:

- Cryosphere is the region of highest albedo over the earth system. Thus, it helps regulating the overall heat budget of the earth.

- Due to differences in the temperature of the cryosphere and the tropical regions, the atmospheric phenomenon such as planetary winds, ocean currents etc. occur.
- Cryosphere is the significant place for carbon sequestration as huge amount of carbon is trapped within these soils in the form of methane.
- Decrease in cryosphere due to global warming may lead to increase in sea level which will further lead to change in climatic pattern.
- Because Polar Regions are some of the most sensitive to climate shifts, the cryosphere may be one of the first places where scientists are able to identify global changes in climate.

Thus, citing sea ice melt, UNEP has urged stronger measures to protect fragile cryosphere environment.

Question: 6. How does the Juno Mission of NASA help to understand the origin and evolution of the Earth?

Solution: Introduction

Juno is a NASA spacecraft. It is exploring the planet Jupiter. Juno launched from Earth in 2011. The spacecraft did not land. Juno is called an "orbiter." This kind of spacecraft flies around, or orbits, a planet.

As it is being said that the story of evolution of Jupiter is the story of the solar systems thus Juno's principal goal is to understand the origin and evolution of Jupiter. Underneath its dense cloud cover, Jupiter safeguards secrets to the fundamental processes and conditions that governed our solar system during its formation. As our primary example of a giant planet, Jupiter can also provide critical knowledge for understanding the planetary systems being discovered around other stars.

With its suite of science instruments, Juno will investigate the existence of a solid planetary core, map Jupiter's intense magnetic field, measure the amount of water and ammonia in the deep atmosphere, and observe the planet's auroras.

Juno will let us take a giant step forward in our understanding of how giant planets form and the role these titans played in putting together the rest of the solar system.

Specifically, Juno will…

- Determine how much water is in Jupiter's atmosphere, which helps determine which planet formation theory is correct (or if new theories are needed)
- Look deep into Jupiter's atmosphere to measure composition, temperature, cloud motions and other properties
- Map Jupiter's magnetic and gravity fields, revealing the planet's deep structure
- Explore and study Jupiter's magnetosphere near the planet's poles, especially the auroras - Jupiter's northern and southern lights - providing new insights about how the planet's enormous magnetic force field affects its atmosphere.]

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