

## **1. Assess the implications of climate change on India's forest ecosystems. What strategies can ensure their sustainable conservation?**

### **Introduction**

Forests are critical to India's ecological security, climate stability, and rural livelihoods. As emphasized by the **World Economic Forum**, the **health of India's forests is pivotal** to achieving its climate goals under the Paris Agreement. However, **climate change poses serious risks** to forest ecosystems by altering their composition, productivity, and ecological balance. A comprehensive approach is required to address these threats and ensure long-term conservation.

### **I. Implications of Climate Change on Forest Ecosystems in India**

#### **1. Shifting Forest Composition and Structure**

- Rising temperatures and erratic rainfall patterns are altering **forest types and tree species distribution**.
- **Example:** In the **Himalayas**, a **shift in the treeline** and replacement of native species with invasive ones is occurring.
- **Chir-pine dominance** in Uttarakhand has contributed to the **increased frequency of forest fires**.

#### **2. Biodiversity Loss and Habitat Fragmentation**

- Sea level rise and saline water intrusion affect **coastal mangrove ecosystems**.
- **Example:** **Sundarbans mangroves** are degrading, threatening species like the **Bengal tiger** and **estuarine crocodiles**.

#### **3. Increased Vulnerability to Pests and Diseases**

- Warmer conditions create suitable environments for **insect infestations and fungal growth**.
- **Example:** **Bark beetle outbreaks** in **Himachal Pradesh** and **locust attacks** in semi-arid regions have been linked to climate anomalies.

#### **4. Decline in Forest Produce and Livelihood Impact**

- Reduced productivity of **Minor Forest Produce (MFP)**—such as honey, gums, medicinal herbs—affects tribal and forest-dependent communities.
- **Example:** Communities in **Chhattisgarh** and **Jharkhand** report reduced yields of **tendu leaves** and **mahua flowers**.

### **II. Strategies for Sustainable Forest Conservation**

#### **1. Community-Based Forest Management**

- Empowering local communities with rights and responsibilities improves stewardship.
- **Example:** **Joint Forest Management (JFM)** in **Odisha** and **Madhya Pradesh** has shown success in involving local tribes.

#### **2. Restoration and Reforestation with Native Species**

- Restoring degraded forests with **climate-resilient native species** enhances ecological stability.
- **Example:** **Green India Mission** aims to restore **5 million hectares** of degraded land.

#### **3. Adoption of Climate-Responsive Silviculture**

- Adaptive forestry practices such as **species selection**, **staggered planting**, and **mixed cropping** improve forest resilience.
- **Example:** **Miyawaki plantation techniques** used in **Karnataka** and **Andhra Pradesh** promote rapid reforestation in degraded urban zones.

#### **4. Monitoring, Research, and Data-Driven Decisions**

- Strengthening **research institutions** and **real-time forest monitoring** is key.

- **Example: Indian Institute of Forest Management (IIFM)** provides critical policy inputs based on climate-forest interaction studies.

## 5. Policy and Legal Framework Strengthening

➤ National and state-level policies must align with conservation goals.

**Examples:**

- **Forest Conservation Rules 2022 (FCR-2022)** aim to streamline project clearances while protecting forests.
- **National Action Plan on Climate Change (NAPCC)** includes the **National Mission for a Green India**, focusing on adaptation and carbon sequestration.

## Conclusion

Climate change has profound and multifaceted impacts on India's forest ecosystems—threatening biodiversity, livelihoods, and ecological services. A **holistic strategy** combining **community participation, climate-smart forestry, scientific research, and supportive policy mechanisms** is essential to ensure the **sustainable conservation of forests**. Strengthening India's forests is not only an environmental necessity but also a strategic priority for **climate resilience and inclusive development**.

## 2. Critical minerals are pivotal to India's green energy transition. How can India ensure responsible mineral extraction while safeguarding ecological balance?

### Introduction

The shift towards a **green economy**—driven by renewable energy, electric mobility, and sustainable infrastructure—has intensified the demand for **critical minerals**. These include **lithium, cobalt, nickel, rare earth elements (REEs), graphite**, and others, which are essential for **solar panels, EV batteries, wind turbines, and grid storage systems**. However, the extraction of these minerals must be balanced with **ecological conservation**, especially in a resource-sensitive and biodiversity-rich country like India.

### I. Role of Critical Minerals in India's Green Transition

India's **critical minerals list**, recently released by the **Ministry of Mines**, identifies **30 strategic minerals**, including:

- **Lithium, cobalt, nickel, graphite** – essential for **battery storage and electric vehicles (EVs)**.
- **Rare earth elements (REEs)** like **neodymium and dysprosium** – used in **wind turbine magnets and EV motors**.
- **Copper and vanadium** – vital for **solar grids and long-duration energy storage**.
- **Platinum group elements (PGE)** – critical for **hydrogen fuel cells and electronics**.

These minerals underpin India's **climate goals (Net Zero by 2070)**, renewable energy targets, and energy security.

### II. Challenges in Mineral Extraction and Environmental Risks

- **Ecological degradation** due to open-cast mining and deforestation.
- **Water pollution and soil erosion** from mining by-products.
- **Biodiversity loss** in mineral-rich areas overlapping with forests and tribal habitats.
- **Social conflict** arising from displacement of indigenous communities and lack of benefit-sharing.

### III. Strategies for Responsible Mineral Extraction

#### 1. Adoption of Sustainable and Low-Impact Mining Techniques

- **Remote sensing, GIS, AI, and autonomous vehicles** to improve precision and minimize land disturbance.
- **Post-mining land reclamation and biodiversity restoration** to mitigate ecological damage.
- **Use of geo-textiles and slope stabilization** to control erosion and water runoff.

#### 2. Strengthening Environmental Regulations

- Enforce **stringent Environmental Impact Assessments (EIAs)** and periodic audits.
- Establish **no-go zones** in ecologically sensitive regions.
- Mandate **offset mechanisms** for biodiversity loss and carbon emissions.

#### 3. Recycling and Circular Economy

- Promote **urban mining**: extraction of critical minerals from **e-waste, used batteries, and electronics**.
- Develop a **circular value chain** by designing products for **easy disassembly and mineral recovery**.
- ✓ **Example:** Lithium and cobalt recovery from battery packs in India's e-mobility sector.

#### 4. Strategic International Partnerships

- Secure diversified supply chains through **bilateral agreements**.
- ✓ **Example:** India-Australia Critical Minerals Investment Partnership.
- Engage in global alliances like the **US-led Mineral Security Partnership (MSP)**, **IEA**, and **IRENA** for technology transfer and capacity building.

#### 5. Domestic Exploration with Environmental Safeguards

- Increase public-private investment in **exploration of untapped reserves** using eco-sensitive protocols.
- Encourage **deep-sea and offshore mineral exploration**, where feasible, with robust ecological oversight.

#### 6. Community Engagement and Benefit Sharing

- Involve **local and tribal communities** in planning and decision-making.
- Strengthen models like the **District Mineral Foundation (DMF)** for equitable benefit distribution.
- Ensure **Free, Prior, and Informed Consent (FPIC)** in mineral-rich tribal belts.

#### 7. Asset Acquisition Abroad

- Through platforms like **KABIL (Khanij Bidesh India Ltd)**, India can invest in **critical mineral assets overseas**, reducing pressure on domestic ecosystems.

#### IV. Way Forward

According to **UNCTAD**, nations must move beyond mere raw material extraction and build **domestic value chains** for clean energy technologies. India should:

- Encourage **indigenous manufacturing of solar cells, battery packs, and turbines**.
- Invest in **R&D for alternative materials and mineral substitutes**.
- Align its **National Mineral Policy** with **climate goals** and **forest conservation policies**.

#### Conclusion

Critical minerals are the backbone of India's **energy transition and technological progress**, but unsustainable extraction could undermine **environmental and social justice goals**. A balanced approach—grounded in **green mining, recycling, inclusive governance, and strategic international cooperation**—is essential to ensure that India's mineral wealth becomes a **pillar of sustainability, not ecological vulnerability**.