AEC Environmental Science

Theory into Practice – II

Important Questions & Detailed Answers

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Q1 Why is resettlement and rehabilitation of people affected by mining and dam projects a major challenge in India?

The resettlement and rehabilitation (R&R;) of people affected by large-scale developmental projects such as dams and mining is a major challenge in India because it involves the involuntary displacement of populations, triggering a cascade of severe economic, social, and environmental problems.

Loss of Livelihood and Economic Security

When people are relocated to new areas, their traditional productive skills may no longer be applicable. This leads to a degradation of their production systems, resulting in the sudden loss of employment opportunities and secure income sources.

Destruction of Social Fabric

Displacement often scatters communities that have lived together for generations. When families from one cohesive area are displaced to separate, unfamiliar locations, the internal social fabric and cultural networks of that community are broken.

Administrative Delays and Implementation Gaps

Although India has formulated national policies on R&R; (such as the policies of 2003, 2004, and the National Rehabilitation and Resettlement Policy of 2007), these programs constantly face heavy administrative delays and regional political issues.

Inadequate Compensation

Effective R&R; requires a time-bound resettlement plan that offers fair compensation for the land and other assets lost, which is historically difficult to execute properly.

Case Study: Narmada Bachao Andolan (NBA)

The Narmada Bachao Andolan is the most prominent example of these challenges. Emerging in the 1980s, this movement protested the lack of proper rehabilitation and resettlement programs for the adivasis, farmers, and local communities displaced by the construction of the Sardar Sarovar Dam across the Narmada River. The NBA highlighted how marginalized communities are forced to bear the cost of "development" without receiving adequate alternative livelihoods or compensation. The protests were so impactful that they exposed the flaws in the project's R&R; plans on an international stage, eventually forcing the World Bank to withdraw its funding from the dam project.

Q2 Environmental legislation in India has proven successful in providing legal protection to the natural environment. Discuss.

Environmental legislation in India has indeed proven to be a crucial and successful mechanism for providing robust legal protection to the natural environment. Supported by the Indian Constitution, India has enacted a series of targeted laws to combat ecological degradation.

1. Wildlife Protection and Conservation

The Wildlife (Protection) Act of 1972 provided the legal foundation to establish national parks and wildlife sanctuaries, and strictly prohibited the hunting and trade of endangered species. Its success is evident in the initiation of targeted conservation projects for the lion (1972), tiger (1973), crocodile (1974), and the brown antlered deer (1981).

2. Halting Deforestation

The Forest (Conservation) Act of 1980 successfully targeted deforestation by legally preventing state governments from using reserved forestland for non-forestry purposes without prior approval from the Central Government. This enabled a landmark 1997 Supreme Court ruling that stopped illegal mining in forest areas across the country.

3. Institutionalizing Pollution Control

The Water (Prevention and Control of Pollution) Act of 1974 and the Air (Prevention and Control of Pollution) Act of 1981 successfully established an institutional framework by creating the Central and State Pollution Control Boards (CPCB and SPCBs). These boards have legal authority to inspect industrial plants, set emission and effluent standards, and refuse operating consent to violating industries.

4. Comprehensive Environmental Safeguards

The Environment (Protection) Act of 1986 — enacted after the Bhopal Gas Tragedy — serves as a powerful "umbrella legislation" designed to fill gaps left by previous laws. It empowers the Central Government to restrict polluting industries, set safety procedures for hazardous substances, and coordinate pollution prevention programs.

5. Protecting Biodiversity and Indigenous Rights

The Biological Diversity Act of 2002 established the National Biodiversity Authority, restricting the transfer of Indian genetic material abroad and regulating biopiracy. The Scheduled Tribes and Other Traditional Forest Dwellers Act of 2006 recognized the forest rights of indigenous populations, balancing socio-economic needs with environmental protection.

Q3 **Discuss the ways in which Project Tiger has helped in biodiversity conservation in India.**

Launched on April 1, 1973, Project Tiger has played a crucial role in biodiversity conservation in India by preserving areas of biological importance as a national natural heritage.

1. Protecting Valuable Ecosystems and Gene Pools

The project expanded from an initial nine reserves to 27 reserves covering over 37,000 square kilometers, acting as an undisputed custodian of a major gene pool. These reserves serve as a highly protected repository for some of India's most valuable ecosystems and diverse wildlife habitats.

2. Implementing a 'Core-Buffer Strategy'

The project utilizes a dual-zone conservation approach. The core area is kept strictly free from human disturbances, completely prohibiting forestry operations, grazing, and collection of minor forest produce. The buffer zone acts as a 'multiple use area' that provides supplemental habitat for wildlife spilling over from the core.

3. Fostering Eco-development and Local Support

To relieve human pressure on core conservation units, the project provides eco-developmental inputs to surrounding villages in buffer zones. This allows indigenous communities regulated access to non-timber forest produce and has been highly instrumental in mustering local support for wildlife conservation programs.

4. Intensive Protection Measures

The strict protection mechanisms enforced inside these reserves have led to considerable conservation achievements, successfully increasing the tiger population from 268 to 2,967 while simultaneously safeguarding diverse flora and fauna sharing their habitat.

Q4 Discuss the Water Act, 1974 and Air Act, 1981 in brief.

The Water (Prevention and Control of Pollution) Act, 1974

The Water Act was a landmark legislation that established the institutional framework for pollution control in India. The Act defines water pollution as the direct or indirect discharge of sewage, industrial effluents, or any liquid, gaseous, or solid substance that alters the physical, chemical, or biological properties of water, making it harmful to public health, animals, or aquatic organisms.

- Establishment of Regulatory Bodies: Created the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) to promote cleanliness of streams and wells.
- Standard Setting and Enforcement: Boards are authorized to lay down and modify standards for water bodies and trade effluents.
- Inspection and Consent: SPCBs have legal authority to take samples of industrial effluents. Industries must obtain "consent" to operate; boards can refuse permission if effluent samples exceed permissible limits.

The Air (Prevention and Control of Pollution) Act, 1981

Enacted using Article 253 of the Constitution, the Air Act extended the pollution control framework to the atmosphere. It defines an air pollutant comprehensively as any solid, liquid, or gaseous substance — explicitly including noise — present in concentrations injurious to humans, living creatures, plants, property, or the environment.

- Implementation Authority: Implementation was entrusted to the existing CPCB and SPCBs created under the Water Act.
- Air Quality and Emission Standards: Boards are empowered to lay down standards for overall air quality and specific emission standards for automobiles.
- Pollution Control Areas: State boards can declare specific regions as "air pollution control areas" and legally prohibit use of certain polluting fuels within those zones.
- Judicial and Inspection Powers: Authorities have the power to enter and inspect industrial plants, examine control equipment, and approach courts to restrain polluters.

Q5 **Discuss the impact of coal mining in Parsa East and Kete Basen coal field in Hasdeo Aranya. Discuss development vs environment conservation.**

The Hasdeo Aranya is one of the largest contiguous stretches of dense forest in Chhattisgarh, Central India — highly rich in biodiversity and serving as a crucial elephant corridor. The allocation of the Parsa East and Kete Basen (PEKB) coal blocks has sparked significant conflict, as open-cast coal mining threatens to destroy thousands of hectares of pristine forest and displace indigenous Gond and other tribal communities.

Environmental Impact of Mining

- Mining and heavy industries can seriously damage ecosystems and generate non-biodegradable solid waste that remains in the environment nearly indefinitely.
- Forests are frequently cleared, depleting biodiversity, reducing carbon absorption capacity, and impairing future human development.
- The Forest (Conservation) Act of 1980 mandates that mining in forest areas is a "non-forestry activity" requiring prior Central Government approval.

Displacement of Communities

Mining is one of the primary drivers of involuntary human displacement in India. When people are uprooted from their native ecosystems, their traditional productive skills often become inapplicable. Moving families to separate locations destroys the internal social fabric of the community.

Opinion: Development vs. Environment Conservation

The conflict must be resolved through the lens of Sustainable Development — progress that meets present needs without compromising the ability of future generations to meet their own needs.

- Mandatory Impact Assessments: No project should be cleared without a scientifically conducted Environmental Impact Assessment (EIA).
- Redefining Development: True development measures the enhancement of quality of life — including indigenous people's rights over natural resources, dignity, and participation in decision-making.
- Public Vigilance: Citizens have a duty to monitor development patterns and bring serious environmental problems to authorities to enforce safeguards.

Q6 **(a) Discuss the role of MNREGA in conservation of biodiversity in India.**

While MNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) is primarily a rural wage employment program, it has emerged as one of the world's largest ecological restoration initiatives.

Key Roles in Biodiversity Conservation

- Afforestation and Tree Plantation: Significant MNREGA funds are directed towards planting trees, creating drought-proofing barriers, and developing green belts — restoring degraded lands and providing habitats for local flora and fauna.
- Water Conservation and Wetland Restoration: The scheme funds excavation of ponds, water harvesting structures, and desilting of traditional water bodies — reviving aquatic ecosystems and

supporting aquatic biodiversity.

- Soil Conservation: MNREGA undertakes land development and soil conservation works like terracing and trenching. Preventing soil erosion helps maintain soil health and the micro-organisms within it.
- Eco-restoration: By regenerating the local natural resource base, MNREGA helps buffer rural communities against climate change and indirectly reduces anthropogenic pressure on deep forest reserves.

Related Conservation Frameworks (from Indian legislation)

- In-situ and Ex-situ Conservation: Protecting species in natural habitats (National Parks, Wildlife Sanctuaries, Biosphere Reserves) and outside them (Seed Banks, Zoological Parks, Botanical Gardens).
- The Biological Diversity Act, 2002: Enacted to conserve biological diversity, ensure sustainable use of its components, and ensure fair sharing of benefits from biological resources.
- Project Tiger: Uses a 'core-buffer strategy' to protect major gene pools and valuable ecosystems.

Q7 (a) Wildlife Sanctuaries vs. National Parks | (b) Species Diversity vs. Genetic Diversity

(a) Wildlife Sanctuaries vs. National Parks

Both Wildlife Sanctuaries and National Parks are primary methods of in-situ conservation — the practice of conserving wild and endangered species in their natural habitats. India has a vast network of protected areas, including 89 national parks and 500 wildlife sanctuaries. Examples include Kaziranga National Park and Dachigam / Manas wildlife sanctuaries.

- National Parks: Strictly protected areas where virtually no human activities (forestry, grazing, private land ownership) are allowed. Boundaries are fixed by legislation.
- Wildlife Sanctuaries: Comparatively less strict. Certain regulated human activities (grazing, firewood collection) may be permitted as long as they don't interfere with wildlife conservation. Boundaries are generally not as strictly defined.

(b) Species Diversity vs. Genetic Diversity

- Genetic Diversity: Variation at the level of individual genes within a single species. This genetic variability causes different traits to appear among individuals of the same species. It is the fundamental raw material from which new species arise through evolution and is used practically to breed disease-resistant crop varieties.
- Species Diversity: The total number and variety of plant and animal species present within a specific geographical region. It measures species richness in natural and agricultural ecosystems. A natural tropical forest possesses far greater species diversity than a human-made timber plantation. Regions exceptionally rich in endemic species and facing severe threats are classified as biodiversity 'hotspots'.

Q8 Discuss the impact of deforestation on the environment and biodiversity.

Deforestation, primarily driven by human population growth, agricultural expansion, urbanization, and industrialization, has severe and far-reaching consequences for both the environment and global

biodiversity.

Impacts on the Environment

- Climate Change and Global Warming: Forests are essential for absorbing carbon dioxide and maintaining oxygen levels. Deforestation reduces the environment's capacity to absorb CO2, directly contributing to global warming. In the long term, large-scale deforestation could threaten the possibility of life on Earth.
- Increased Risk of Natural Disasters: Removal of tree cover contributes to the frequency and severity of floods and landslides.
- Depletion of Renewable Resources: Destruction of forests impairs the maintenance of natural renewable resources, hindering sustainable human development for future generations.

Impacts on Biodiversity

- Habitat Loss and Extinction: Clearing of pristine forest areas destroys natural habitats of countless species, leading to drastic decline in both floral and faunal biodiversity. Deforestation is one of the primary human activities driving the current mega extinction of species worldwide.
- Ecological Imbalance: The sudden loss of forest cover creates severe ecological imbalances, depleting biological resources and disrupting intricate food webs.
- The Threat of Monoculture: When natural forests are cleared for timber, they are often replanted with single-species plantations (teak or sal). These artificial plantations lack the closed canopy and rich undergrowth of natural forests, unable to support the same level of biodiversity.
- Canopy Degradation: Even partial deforestation — such as excessive firewood collection — opens up the forest canopy, alters the microclimate of the forest floor, and negatively changes local biodiversity.

Q9 **Identify and explain three major threats to biodiversity in India. Explain the role of the National Green Tribunal (NGT) in promoting environmental justice.**

Three Major Threats to Biodiversity in India

1. Human Population Growth, Industrialisation, and Land Use Changes

The rapidly growing human population and associated industrialization have led to a mega extinction of species. Forests and grasslands are being converted into agricultural land, natural wetlands are drained, and mangroves are cleared for fuel wood and prawn farming. Natural habitats are degraded by monoculture plantations, excessive firewood collection, and the introduction of exotic weeds like Lantana bushes and 'congress' grass.

2. Poaching

Wildlife is extensively hunted and smuggled for large economic benefits. Examples include the illegal trade of tiger skin and bones, elephant ivory, rhino horns, and musk from deer. Tortoises, exotic birds, and corals are smuggled for the pet and decorative trades, while medicinal plants like Rauwolfia and Datura face severe over-harvesting.

3. Man-Wildlife Conflicts

Shrinking forest cover, human encroachment, and lack of food force wild animals into human settlements. In Sambhalpur, Odisha, habitat overlap led to elephants killing 195 humans over five years; in retaliation,

villagers killed 98 elephants. These conflicts pose a severe threat to the survival of large species like elephants, tigers, and leopards.

Role of the National Green Tribunal (NGT)

The National Green Tribunal (NGT) was established in 2010 as a specialized, fast-track environmental court.

- Expeditious Disposal of Cases: Handles disputes related to environmental protection, forest conservation, and enforcement of environmental legal rights quickly.
- Restitution and Compensation: Can order polluters to pay compensation for damages to individuals, properties, and the environment (applying the "Polluter Pays" principle).
- Accessible Justice: Provides a platform where citizens, activists, and NGOs can challenge ecologically damaging projects, ensuring voices of marginalized communities are heard and addressed.

Q10 Discuss the climate change adaptation strategy in brief.

Climate change adaptation refers to the process of adjusting to current and expected future effects of climate change to mitigate harm and minimize risks. A comprehensive adaptation strategy focuses on building resilience across several sectors.

Key Adaptation Strategies

- Infrastructure and Coastal Protection: Upgrading physical infrastructure to withstand extreme weather and rising sea levels — building seawalls, improving urban storm drainage, and elevating critical infrastructure in vulnerable coastal and flood-prone areas.
- Agricultural Adaptation: Developing and planting drought-resistant or flood-tolerant crop varieties, adjusting planting seasons, and adopting efficient irrigation techniques (like drip irrigation) to conserve water.
- Water Resource Management: Implementing strategies to handle altered rainfall patterns and freshwater scarcity — widespread rainwater harvesting, wastewater recycling, and building better water storage facilities to buffer against prolonged droughts.
- Ecosystem-Based Adaptation: Protecting and restoring natural habitats that act as ecological buffers. Conserving mangrove wetlands and forests helps absorb the shock of severe coastal storms, prevents soil erosion, and protects inland communities.
- Disaster Preparedness and Early Warning Systems: Installing robust forecasting and early warning systems for extreme events like cyclones, heatwaves, and floods to ensure vulnerable populations have time to evacuate or prepare.

In brief, an adaptation strategy shifts focus from merely trying to stop climate change (mitigation) to proactively preparing human communities and economies to survive and thrive in a changing environment.

Q11 What is global warming? What are its causes? Discuss in brief.

Global warming is the steady rise in the Earth's atmospheric temperature and the resulting changes in its radiation balance, primarily driven by human actions.

The Mechanism: The Greenhouse Effect

About 75% of the solar energy that reaches Earth is absorbed by its surface. The rest radiates back into the atmosphere. A portion of this radiated heat is trapped by greenhouse gases, primarily carbon dioxide (CO_2). Without this natural trapping of heat, most of the Earth's surface would be frozen with a mean temperature of -18°C, instead of the current average of about 15°C.

Causes of Global Warming

- Industrialisation and Population Growth: Rapid human population growth and industrialisation over the last few decades have heavily polluted the atmosphere, seriously affecting the climate.
- Fossil Fuels and Transportation: The rising use of fossil fuel-based energy and increased transportation are major causative factors contributing to greenhouse gas emissions.
- Other Human Activities: Urbanisation and the intensification of agriculture also significantly drive up levels of pollutants.
- Surge in Carbon Dioxide Levels: The concentration of CO_2 in the atmosphere has increased by 31% since pre-industrial times. This causes an unnatural amount of heat to be trapped in the lower atmosphere, forcing the planet to warm rapidly.

Evidence and Future Projections

- Historical Temperature Rise: The global average surface temperature has already increased by 0.6 ± 0.2°C over the last century. Globally, the 1990s was the warmest decade, and 1998 was the warmest year on record.
- Key Environmental Indicators: Increasing temperatures over land and ocean surfaces, melting of glacial and sea ice, rising sea levels, and increasing humidity.
- Future Projections: Climatologists project that global mean surface temperature will rise by an additional 1.4° to 5.8°C this century — a rate of warming greater than anything that has occurred in the last 10,000 years.
