

Section-1

Q1. (a) Critically examine the theory regarding Rule of law in the Indian Constitution.

8

Ans- The Rule of Law is a cornerstone of the Indian Constitution, ensuring that all individuals and institutions are subject to the law. This principle was deeply influenced by the British legal system and thinkers like A.V. Dicey. The Indian Constitution incorporates this doctrine through various provisions, particularly in the Preamble, Fundamental Rights (Part III), and the Directive Principles of State Policy (Part IV).

The Preamble envisions justice, equality, and liberty, which are essential components of the Rule of Law. Article 14 guarantees equality before the law and equal protection of the laws, prohibiting discrimination. Articles 19, 21, and 22 further secure individual freedoms and safeguard against arbitrary actions by the state.

However, the practical application of the Rule of Law in India faces challenges. Issues such as judicial delays, corruption, and socio-economic disparities undermine its effectiveness. The judiciary, while independent, occasionally faces allegations of overreach, affecting the balance of power.

In conclusion, while the Indian Constitution robustly embeds the Rule of Law, its implementation requires continuous vigilance and reform. Ensuring access to justice, enhancing judicial efficiency, and addressing socio-economic inequalities are pivotal to realizing the true spirit of this doctrine.

Alternative Answer:

1. Definition and Origin

- Ensures **all individuals and institutions are subject to the law.**
- Influenced by the **British legal system** and **A.V. Dicey's principles.**

2. Constitutional Provisions

- **Preamble:** Highlights justice, equality, and liberty as core tenets of governance.
- **Article 14:** Guarantees **equality before the law** and prohibits discrimination.
- **Articles 19, 21, and 22:** Protect **individual freedoms** and act against **state arbitrariness.**
- **Directive Principles of State Policy (Part IV):** Provides guidelines for achieving social justice.

3. Practical Challenges

- **Judicial Delays:** Prolonged case durations weaken legal efficacy.
- **Corruption:** Undermines public trust in legal and governance systems.
- **Socio-Economic Disparities:** Limit access to justice for marginalized groups.
- **Judicial Overreach:** Occasionally disrupts the balance of power.

Conclusion

- The Rule of Law is a robust cornerstone of the Indian Constitution.
- To realise its true spirit, focus is required on:
 - **Judicial efficiency.**
 - **Access to justice.**
 - Addressing **socio-economic inequalities.**

BPSC

Q1. (b) Is the idea of “the uniform civil code should be applicable to all, regardless of religion” justified? Comment. 8

Ans- The Uniform Civil Code (UCC) proposes a common set of laws governing personal matters for all citizens, irrespective of religion. This idea aims to ensure equality, justice, and national integration.

Arguments in Favour

1. Equality and Justice:

- The UCC promotes gender equality by eliminating discriminatory religious laws.
- It ensures equal treatment of all citizens before the law, adhering to the principle of justice.

2. National Integration:

- A unified set of laws can enhance national unity and reduce communal friction.
- It fosters a sense of common identity among diverse religious communities.

3. Simplification of Legal Processes:

- A single legal framework can simplify the legal system, making it more accessible and efficient.
- It reduces the complexity of multiple personal laws, facilitating a more streamlined judicial process.

Challenges and Concerns

1. Religious Freedom:

- The UCC may be perceived as infringing on religious freedoms and personal beliefs.
- It could face resistance from communities fearing the loss of their cultural identity.

2. Implementation Hurdles:

- The diverse and pluralistic nature of Indian society poses significant challenges to implementing a uniform code.

Conclusion

While the UCC aims to promote equality, justice, and national integration, its implementation requires careful consideration of religious freedoms and cultural sensitivities. A balanced approach that respects diversity while ensuring justice is essential for the successful adoption of the UCC.

BPSC

Q1. (c) Critically examine the process of removal of a high court judge mentioned in the Indian Constitution. 8

Ans- The removal of a High Court judge in India is governed by a process outlined in the Indian Constitution. This ensures accountability while maintaining judicial independence, addressing issues of "proved misbehaviour" or "incapacity."

Constitutional Provisions

- **Article 217(1)(b):** Details the process for removing a High Court judge.
- **Grounds for Removal:** Judges can be removed on grounds of "proved misbehaviour" or "incapacity."

Initiation of Removal Process

- **Motion by Parliament:** Initiated by a motion in either House of Parliament, signed by at least 100 members of the Lok Sabha or 50 members of the Rajya Sabha.
- **Investigation Committee:** The Speaker or Chairman appoints a three-member committee to investigate the allegations.

Committee Investigation

- **Composition:** Includes a Supreme Court judge, a Chief Justice of a High Court, and a distinguished jurist.
- **Procedure:** Conducts an inquiry adhering to principles of natural justice to determine the charges' veracity.

Parliamentary Approval

- **Report Submission:** Committee submits its report to the concerned House.
- **Debate and Vote:** If the report finds the judge guilty, the motion is debated and requires a two-thirds majority (special Majority) in both Houses.

Presidential Assent

- **Final Decision:** Passed motion is sent to the President for assent, leading to the judge's removal.

Conclusion

The constitutional procedure for the removal of a High Court judge is designed to strike a balance between maintaining judicial independence and ensuring accountability. However, its intricate nature, susceptibility to political interference, and lack of clear transparency highlight significant shortcomings that call for thoughtful reforms.

BPSC

Q1. (d) Explain how Preamble of the Indian Constitution describes the secular nature of the state. 7

Ans- The Preamble of the Indian Constitution is a succinct yet profound declaration of the core values and principles upon which the nation is founded. One of these principles is secularism, which ensures that the state does not favor or discriminate against any religion.

Key Aspects of Secularism in the Preamble

1. **Equality and Justice:** The Preamble emphasizes “Justice, social, economic, and political,” ensuring that every individual, regardless of their religion, has equal rights and opportunities.
2. **Liberty:** It guarantees “Liberty of thought, expression, belief, faith, and worship.” This ensures that all citizens are free to follow and practice their religion without interference from the state.
3. **Fraternity:** By promoting “Fraternity assuring the dignity of the individual and the unity and integrity of the Nation,” the Preamble underscores the importance of harmony and mutual respect among different religious communities.

Constitutional Provisions

- **Secularism as a Basic Structure:** The Indian Constitution, through its various articles and provisions, embodies secularism as an essential feature.
- **Fundamental Rights:** Articles 25 to 28 protect the right to freedom of religion, allowing individuals to practice, profess, and propagate their faith.

Conclusion

In essence, the Preamble, through its emphasis on justice, liberty, equality, and fraternity, encapsulates the secular character of the Indian state. It ensures that the state remains neutral in religious matters, thereby fostering a harmonious and inclusive society.

Q1. (e) Should the Courts reevaluate the 50% reservation cap considering evolving social dynamics, equity principles, and the changing socio-economic landscape especially in Bihar? 7

Ans- The 50% reservation cap, established by the Supreme Court in the Indra Sawhney case (1992), has been a subject of debate. Given the evolving social dynamics, equity principles, and changing socio-economic landscape, particularly in Bihar, there is a growing argument for reevaluation.

Evolving Social Dynamics

- **Caste-Based Politics:** Bihar's social landscape is deeply intertwined with caste politics. Political parties often align along caste lines to mobilize support.
- **Social Justice Movements:** Movements aimed at challenging caste-based discrimination and advocating for marginalized communities have gained momentum.

Equity Principles

- **Principle of Equality:** The Indian Constitution guarantees equality of status and opportunity. However, uniform treatment of unequals can perpetuate disparities.
- **Addressing Historical Injustices:** Reservation policies aim to rectify historical injustices faced by marginalized communities. Reevaluating the cap could ensure more equitable representation.

Changing Socio-Economic Landscape

- **Economic Transformation:** Bihar has seen significant economic growth and development in recent years, with improvements in healthcare, education, and infrastructure.
- **Human Development:** Despite positive trends, there is a need for targeted policies to uplift Bihar's human development indicators and align them with national benchmarks.

Conclusion

Given the evolving social dynamics, equity principles, and changing socio-economic landscape, particularly in Bihar, there is a compelling case for the courts to reevaluate the 50% reservation cap. Such a reevaluation could ensure that reservation policies remain relevant and effective in addressing contemporary socio-economic challenges.

Q2. (a) Discuss the institutional relationship between the legislature and the judiciary as per the Indian Constitutional text. Critically examine their changing role in the present context. 38

Ans- The Indian Constitution establishes a framework for governance based on the principle of separation of powers among the three branches of government: the Legislature, the Executive, and the Judiciary. The institutional relationship between the Legislature and the Judiciary is particularly significant as it ensures a system of checks and balances, safeguarding democratic principles and preventing the abuse of power.

Constitutional Provisions

The Indian Constitution explicitly outlines the functions and powers of both the Legislature and the Judiciary, ensuring their independence while also defining their interrelationship.

- **Legislature:**
 - **Articles 79-122:** These articles define the structure, composition, and functioning of the Parliament, which consists of the Lok Sabha (House of the People) and the Rajya Sabha (Council of States).
 - **Law-Making Power:** The Legislature has the power to make laws on subjects enumerated in the Union List, State List, and Concurrent List (Seventh Schedule).
 - **Financial Control:** The Legislature exercises control over public finances through budget approval and financial oversight.
- **Judiciary:**
 - **Articles 124-147 (Supreme Court):** These articles define the structure, composition, and jurisdiction of the Supreme Court of India.
 - **Articles 214-231 (High Courts):** These articles outline the structure, composition, and jurisdiction of the High Courts in the states.
 - **Judicial Review:** The Judiciary has the power of judicial review, which allows it to examine the constitutionality of legislative acts and executive actions.

Checks and Balances

The relationship between the Legislature and the Judiciary is characterized by a system of checks and balances designed to prevent any branch from overstepping its authority.

1. Judicial Review:

- **Constitutional Safeguard:** The power of judicial review enables the Judiciary to invalidate laws and executive actions that violate the Constitution.
- **Landmark Cases:** Cases like *Kesavananda Bharati* (1973) and *Minerva Mills* (1980) reaffirmed the Judiciary's role in protecting the basic structure of the Constitution.

2. Legislative Oversight:

- **Amendment Power:** The Legislature has the power to amend the Constitution under Article 368, subject to the basic structure doctrine.
- **Impeachment:** The Legislature can impeach judges for proven misbehavior or incapacity under Articles 124(4) and 217(1)(b).

Changing Role in the Present Context

Over the years, the roles of the Legislature and the Judiciary have evolved, influenced by political, social, and economic changes.

- **Judicial Activism:**
 - **Proactive Role:** The Judiciary has taken a more proactive role in addressing social issues, environmental protection, and human rights through Public Interest Litigation (PIL).
 - **Controversial Decisions:** Judicial activism has led to some controversial decisions, with critics arguing that the Judiciary is encroaching on the domain of the Legislature.
- **Legislative Responses:**
 - **Amendments and Laws:** In response to judicial decisions, the Legislature has passed amendments and laws to assert its authority and address constitutional challenges (e.g., the 42nd Amendment).
 - **Checks on Judiciary:** There have been instances where the Legislature has attempted to curtail the Judiciary's power through legislative measures.
- **Collaborative Efforts:**
 - **Institutional Cooperation:** Despite occasional friction, there have been collaborative efforts between the Legislature and the Judiciary to address national issues (e.g., GST implementation).
 - **Law Commission:** The Law Commission of India, an advisory body, often includes judicial members who contribute to law-making processes.

Conclusion

The institutional relationship between the Legislature and the Judiciary is fundamental to India's democratic framework. While the Constitution ensures their independence, the dynamic interplay between these two branches is essential for maintaining the balance of power. In the present context, both the Legislature and the Judiciary must continue to adapt and collaborate, addressing evolving social dynamics and upholding the principles of justice, equality, and democracy.

Or / अथवा

Q2. (b) How can a constitution be interpreted and applied in a manner that respects both its original intent and the evolving values of society? Discuss with some relevant examples. 38

Ans- A constitution serves as the supreme law of a nation, providing a framework for governance and protecting the rights of citizens. Interpreting and applying a constitution in a manner that respects both its original intent and the evolving values of society is a complex task. This process involves understanding the historical context in which the constitution was framed, while also considering contemporary societal changes and values.

Original Intent

The original intent of a constitution refers to the objectives and principles envisioned by its framers. Respecting original intent involves adhering to the fundamental values and principles enshrined in the constitution. This approach ensures stability, consistency, and adherence to the rule of law.

- **Historical Context:**

- Understanding the historical context in which the constitution was framed is crucial. For instance, the framers of the Indian Constitution aimed to establish a democratic, secular, and socialist republic, addressing the socio-political challenges of the time.
- The Preamble of the Indian Constitution reflects the original intent by emphasizing justice, liberty, equality, and fraternity.

- **Judicial Interpretation:**

- Courts play a vital role in interpreting the constitution. They rely on historical documents, debates, and writings of the framers to ascertain the original intent.
- For example, the landmark case of *Kesavananda Bharati v. State of Kerala* (1973) established the “basic structure doctrine,” ensuring that certain fundamental features of the Constitution, as intended by the framers, cannot be altered by amendments.

Evolving Values

Societies evolve over time, and so do their values, beliefs, and challenges. Interpreting the constitution in light of evolving values ensures that it remains relevant and responsive to contemporary issues.

- **Dynamic Interpretation:**

- The judiciary adopts a dynamic or progressive interpretation of the constitution, allowing it to adapt to changing societal values.
- In the case of *Navtej Singh Johar v. Union of India* (2018), the Supreme Court of India decriminalized consensual homosexual acts, reflecting the evolving values of inclusivity and respect for individual autonomy.

- **Legislative Amendments:**

- Legislatures can amend the constitution to address emerging societal needs and values. This process allows for the incorporation of new principles and rights.
- The 73rd and 74th Constitutional Amendments in India, which introduced Panchayati Raj institutions and urban local bodies, exemplify how the constitution can be amended to promote local self-governance and enhance democratic participation.

Balancing Original Intent and Evolving Values

Balancing original intent and evolving values requires a nuanced approach that respects the fundamental principles of the constitution while allowing for adaptability and modernization.

- **Principle of Harmonious Construction:**

- Courts often employ the principle of harmonious construction, which seeks to harmonize conflicting provisions of the constitution to maintain its coherence and integrity.
- In *S.R. Bommai v. Union of India* (1994), the Supreme Court harmonized the principles of federalism and secularism, reaffirming the inviolability of these core constitutional values.

- **Contextual Interpretation:**

- Courts consider the broader societal context and contemporary realities while interpreting the constitution. This approach ensures that constitutional provisions are applied in a manner that is relevant and effective.
- In the case of *Shayara Bano v. Union of India* (2017), the Supreme Court invalidated the practice of instant triple talaq, recognizing the need to protect women's rights and promote gender equality in the modern context.

- **Judicial Activism:**

- Judicial activism allows courts to play a proactive role in addressing societal issues and advancing social justice. However, it must be exercised with caution to avoid encroaching on the domain of the legislature.
- The Vishakha guidelines (1997) issued by the Supreme Court to address sexual harassment at the workplace exemplify judicial activism in response to evolving societal values and the absence of legislative measures.

Conclusion

Interpreting and applying a constitution in a manner that respects both its original intent and the evolving values of society is essential for its relevance and effectiveness. This balanced approach ensures that the constitution remains a living document, capable of addressing contemporary challenges while upholding the foundational principles envisioned by its framers. Through dynamic interpretation, legislative amendments, and contextual application, the judiciary and legislature can work together to ensure that the constitution serves as a robust and adaptable framework for governance and the protection of individual rights.

Q3. (a) "Coalition politics in Bihar influence the broader agenda of national unity and integrity". Critically examine. 38

Ans- Coalition politics has become a defining feature of Bihar's political landscape. The state's history of fragmented political parties and alliances has shaped its governance and policy-making. This essay critically examines how coalition politics in Bihar influences the broader agenda of national unity and integrity.

Historical Context

Bihar's political journey has been marked by the rise of regional parties and coalition governments. From the dominance of the Congress party in the early post-independence era to the emergence of socialist leaders and the Mandal Commission's impact, Bihar's political landscape has evolved significantly.

Coalition Politics in Bihar

1. Fragmentation of Political Parties:

- The bifurcation of Bihar in 2000 and the creation of Jharkhand led to the fragmentation of political parties. Major players like the Rashtriya Janata Dal (RJD), Janata Dal (United) (JD (U)), and Bharatiya Janata Party (BJP) emerged as key contenders.
- Coalitions and alliances became common, with parties forming governments through pre-poll and post-poll alliances.

2. Impact on Governance:

- Coalition politics often leads to compromises on policy decisions, as parties must accommodate diverse interests and agendas.
- The need for consensus can result in policy paralysis, affecting the state's development and governance.

Influence on National Unity and Integrity

1. Caste-Based Politics:

- Bihar's coalition politics is deeply intertwined with caste-based politics. Political parties often align along caste lines to mobilize support.
- This can lead to the reinforcement of caste identities, potentially undermining the broader agenda of national unity and integration.

2. Social Justice Movements:

- Coalition politics has given rise to social justice movements, empowering marginalized communities and advocating for their rights.
- While these movements promote inclusivity and equality, they can also create divisions along caste and community lines, challenging national unity.

3. Regionalism:

- The focus on regional issues and interests in coalition politics can sometimes lead to regionalism, where state-specific concerns take precedence over national priorities.
- This can create tensions between the central and state governments, affecting national integrity.

Positive Aspects

1. Inclusive Governance:

- Coalition politics can lead to more inclusive governance, as diverse groups and communities are represented in the decision-making process.
- This inclusivity can strengthen national unity by ensuring that all voices are heard and considered.

2. Checks and Balances:

- Coalition governments provide a system of checks and balances, preventing the concentration of power in a single party.
- This can promote democratic values and enhance national integrity by ensuring accountability and transparency.

Challenges and Criticisms

1. Instability:

- Coalition politics can lead to political instability, with frequent changes in government and leadership.
- This instability can hinder long-term policy planning and implementation, affecting the state's development and national unity.

2. Compromise on Ideals:

- The need for compromise in coalition politics can result in the dilution of party ideals and principles.
- This can lead to disillusionment among voters and weaken the democratic process.

Conclusion

Coalition politics in Bihar has a complex and multifaceted impact on the broader agenda of national unity and integrity. While it promotes inclusive governance and provides checks and balances, it also poses challenges such as political instability, caste-based politics, and regionalism. To ensure that coalition politics contributes positively to national unity and integrity, it is essential to address these challenges and promote a more cohesive and inclusive political environment.

Or / अथवा

Q3. (b) Analyse the implementation and impact of Panchayati Raj Institutions in Bihar with specific grassroots examples and their role in strengthening local governance and employment. 38

Ans- The Panchayati Raj Institutions (PRIs) in Bihar have played a crucial role in decentralizing governance and empowering local communities. Established under the 73rd Constitutional Amendment Act of 1992, PRIs aim to promote participatory democracy, enhance local governance, and drive rural development. This essay analyzes the implementation and impact of PRIs in Bihar, with specific grassroots examples, and their role in strengthening local governance and employment.

Implementation of Panchayati Raj Institutions in Bihar

- **Three-Tier Structure:**
 - Bihar has implemented a three-tier system of PRIs, consisting of Gram Panchayats at the village level, Panchayat Samitis at the block level, and Zila Parishads at the district level.
 - The Bihar Panchayat Raj Act, 2006, provides the legal framework for the functioning of these institutions.
- **Elections and Representation:**
 - Regular elections are held to elect representatives to the PRIs, ensuring democratic participation at the grassroots level.
 - The state has implemented reservations for Scheduled Castes, Scheduled Tribes, and women, promoting inclusive governance.
- **Devolution of Powers:**
 - PRIs in Bihar have been entrusted with responsibilities related to 29 subjects listed in the Eleventh Schedule of the Constitution, including agriculture, health, education, and rural development.
 - The state government provides financial and administrative support to PRIs to carry out their functions effectively.

Impact of Panchayati Raj Institutions in Bihar

- **Strengthening Local Governance:**
 - PRIs have enhanced local governance by bringing decision-making closer to the people. Gram Panchayats, in particular, play a vital role in addressing local issues and implementing development schemes.
 - The establishment of Gram Sabhas and Ward Sabhas has increased transparency and accountability in governance.
- **Empowerment of Marginalized Communities:**
 - The reservation of seats for Scheduled Castes, Scheduled Tribes, and women has empowered marginalized communities and ensured their participation in the decision-making process.
 - Women representatives have played a significant role in addressing issues related to health, education, and social welfare.
- **Economic Development and Employment:**
 - PRIs have contributed to rural development by implementing various government schemes and programs aimed at improving infrastructure, healthcare, education, and livelihoods.

- The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has been effectively implemented through PRIs, providing employment opportunities and improving rural livelihoods.

Grassroots Examples

- **Gram Panchayat of Harnaut:**
 - The Gram Panchayat of Harnaut in Nalanda district has successfully implemented various development projects, including the construction of roads, schools, and healthcare facilities.
 - The Panchayat has also promoted women's self-help groups (SHGs), providing them with training and financial support to start small businesses.
- **Panchayat Samiti of Gaya:**
 - The Panchayat Samiti of Gaya has focused on improving agricultural productivity by providing farmers with access to modern farming techniques and resources.
 - The Samiti has also implemented water conservation projects, ensuring a sustainable water supply for irrigation and drinking purposes.
- **Zila Parishad of Patna:**
 - The Zila Parishad of Patna has played a crucial role in coordinating development activities across the district, ensuring the effective implementation of government schemes.
 - The Parishad has also focused on improving healthcare services by establishing primary health centers and organizing health camps in rural areas.

Challenges and Recommendations

- **Challenges:**
 - Despite the positive impact, PRIs in Bihar face several challenges, including inadequate financial resources, lack of capacity building, and political interference.
 - The effective devolution of powers and functions to PRIs remains a challenge, with many decisions still being made at higher levels of government.
- **Recommendations:**
 - Strengthening the financial autonomy of PRIs by ensuring timely and adequate funding from the state and central governments.
 - Providing capacity-building programs for PRI representatives to enhance their skills and knowledge in governance and development.
 - Encouraging greater community participation in the decision-making process through regular Gram Sabha meetings and awareness campaigns.

Conclusion

The implementation of Panchayati Raj Institutions in Bihar has significantly strengthened local governance and contributed to rural development and employment. By empowering marginalized communities and promoting participatory democracy, PRIs have played a crucial role in transforming the socio-economic landscape of rural Bihar. However, addressing the challenges faced by PRIs and ensuring their effective functioning is essential for realizing their full potential in driving sustainable development and inclusive growth.

SECTION-II

Q4. (a) Describe the mechanism and characteristics of tropical cyclones which prevails in India. 8

Ans- Tropical cyclones are intense low-pressure systems that form over warm ocean waters, typically in the Bay of Bengal and the Arabian Sea in India.

Mechanism

- **Formation:** Occur over warm ocean waters with surface temperatures exceeding 27°C.
- **Low-Pressure System:** Warm, moist air rises rapidly, creating a low-pressure center.
- **Coriolis Effect:** Causes winds to spiral inward in the Northern Hemisphere.
- **Latent Heat:** Released during condensation, intensifying the cyclone.
- **Structure:**
 - **Eye:** Calm and cloud-free central region.
 - **Eyewall:** Surrounds the eye, characterized by strong winds and heavy rainfall.

Characteristics

- **Seasonality:** Most common during pre-monsoon (April-May) and post-monsoon (October-November).
- **Affected Regions:** Coastal states like Odisha, West Bengal, Andhra Pradesh, Tamil Nadu, and Gujarat are particularly vulnerable.
- **Wind Speed and Rainfall:** Cyclones are accompanied by winds exceeding 100 km/h and intense rainfall.
- **Storm Surges:** Lead to coastal flooding in low-lying areas.
- **Impact:** Cause extensive damage to infrastructure, agriculture, and human lives.

Tropical cyclones, fueled by warm ocean waters, significantly impact India's coasts through strong winds, heavy rainfall, and storm surges, necessitating advanced forecasting, disaster management, and sustainable infrastructure for mitigation.

Q4. (b) What is the status of solar energy in India? Is it sufficient to meet the domestic demand? What are the possible alternative energy sources for India? Provide a critical account. **8**

Ans- India has made remarkable progress in solar energy, emerging as a global leader in renewable energy. As of January 2025, India's installed solar power capacity stands at 100.33 GW, with an additional 84.10 GW under implementation and 47.49 GW in the tendering stage. Solar energy accounts for 47% of India's total renewable energy capacity. However, despite this growth, solar energy alone is insufficient to meet India's domestic energy demand, which is projected to grow by 25% over the next two decades.

India's energy consumption is three times the global average, and the country aims to achieve 500 GW of non-fossil fuel-based energy capacity by 2030. While solar energy has immense potential—estimated at 748 GW by utilizing 3% of wasteland—it faces challenges such as intermittent supply, land acquisition issues, and high initial costs.

To complement solar energy, India must explore alternative sources:

- **Wind Energy:** With a potential of 1,163 GW, wind energy is a significant contributor, particularly in states like Gujarat and Tamil Nadu.
- **Hydropower:** Large hydro projects contribute 46 GW, but ecological concerns limit expansion.
- **Green Hydrogen:** Emerging as a clean energy source, it can decarbonize industries and transportation.
- **Biomass and Waste-to-Energy:** These sources can address rural energy needs sustainably.

Critical challenges include transmission losses (17% in 2024), lack of storage infrastructure, and policy implementation gaps. Addressing these issues through robust policies, technological advancements, and investments in diverse energy sources is essential for India's sustainable energy future.

Q4. (c) Analyze the state of the tourism industry in India and discuss its future prospects in the country. **8**

Ans- India's tourism industry has shown remarkable growth, contributing significantly to the economy. In 2023, the sector accounted for 6.8% of GDP and supported 39.5 million jobs, representing 8% of total employment. India welcomed 18.9 million international tourists in 2023, a 33% increase from 2022, signaling recovery post-pandemic. Domestic tourism also surged, with 2.51 billion domestic tourists recorded in 2023, a 44.98% rise from the previous year.

Key attractions include cultural heritage sites like the Taj Mahal, natural wonders like the Himalayas, and spiritual destinations such as Varanasi. States like Uttar Pradesh, Tamil Nadu, and Rajasthan lead in domestic and international tourist arrivals.

Challenges

- **Infrastructure Gaps:** Limited connectivity to remote tourist destinations.
- **Seasonality:** Tourism demand fluctuates, affecting revenue stability.
- **Environmental Concerns:** Over-tourism in fragile ecosystems like Ladakh.
- **Safety Issues:** Concerns about women's safety deter some international visitors.

Future Prospects

India's tourism industry is poised for growth, driven by government initiatives like the Dekho Apna Desh campaign and the development of 100 tourist-friendly airports by 2040. The sector is expected to grow at a 7.8% Compound annual growth rate, with foreign exchange earnings projected to reach \$50 billion by 2030.

Recommendations

- **Sustainable Tourism:** Promote eco-friendly practices and regulate visitor numbers in sensitive areas.
- **Digital Transformation:** Leverage AI and virtual reality for enhanced tourist experiences.
- **Skill Development:** Train local communities to improve hospitality standards.

India's tourism industry holds immense potential to boost economic growth while preserving its rich cultural and natural heritage.

BPSC

Q4. (d) Describe the recent progress made in the field of health and medicine in Bihar and comment on the possible improvement in the condition of various health related indicators. 7

Ans- Bihar, one of India's most populous states, has historically faced challenges in the healthcare sector, including inadequate infrastructure, workforce shortages, and low health indicators. However, in recent years, significant efforts have been made to strengthen the healthcare system, improve access to medical facilities, and address pressing health concerns.

Infrastructure Development

- Establishment of AIIMS Darbhanga and expansion of AIIMS Patna for improved tertiary healthcare.
- New cancer treatment facility in Muzaffarpur to reduce dependency on metro cities for advanced care.

Primary Healthcare Strengthening

- Over 500 Primary Health Centers (PHCs) now functional under the 24x7 model.
- Special Newborn Care Units (SNCUs) introduced to improve neonatal survival rates.

Quality Assurance

- Adoption of National Quality Assurance Standards (NQAS) to enhance public health service delivery.
- Ayushman Bharat scheme has saved approximately ₹1.25 lakh crore for low-income families.

Disease Control

- Improved response to tuberculosis and vector-borne diseases through targeted programs.
- Significant increase in immunization coverage.

Possible Improvements in Health Indicators

Workforce Shortages

- Bihar has a doctor-to-patient ratio of 1:17,685, significantly worse than the national average.

Enhancing Infrastructure

- Many rural healthcare facilities lack adequate equipment and maintenance.

Increasing Health Literacy

- Awareness campaigns needed to promote preventive care and timely treatment. A study conducted in rural Bihar revealed that delayed diagnosis and treatment of visceral leishmaniasis were common due to a lack of awareness.

Boosting Healthcare Investment

- Bihar's healthcare expenditure per capita is indeed among the lowest in India, significantly affecting the quality of healthcare services. As of recent data, Bihar spends approximately 495 per capita on healthcare, which is far below the national average.

By addressing these challenges, Bihar can achieve equitable healthcare access and improve its health indicators significantly.



BPSC

Q4. (e) Divide India into major climatic regions and describe the region in which the land of Bihar State is included. 7

Ans- India's climate can be broadly classified into the following regions based on geographical and meteorological conditions:

- **Tropical Wet Climate (Af, Am):**
 1. Found in regions with high humidity and heavy rainfall, such as the Western Ghats, Coastal Karnataka, and Andaman and Nicobar Islands.
- **Tropical Dry Climate (Aw):**
 1. Includes regions like Rajasthan, Gujarat, and parts of Maharashtra, characterized by dry seasons and significant temperature variations.
- **Subtropical Humid Climate (Cwa):**
 1. Covers the Indo-Gangetic Plains, including Bihar, Uttar Pradesh, Haryana, and Punjab. This climate features hot summers, cool winters, and monsoon rains.
- **Mountain Climate (Dfb, Dwb, ET):**
 1. Encompasses the Himalayan region (Jammu and Kashmir, Himachal Pradesh, and Uttarakhand) with cold winters and varying snowfall.
- **Coastal Climate (Am, Aw):**
 1. Found along coastal areas such as Kerala, Tamil Nadu, and Odisha, with moderate temperatures and high humidity year-round.
- **Semi-Arid Climate (BSh):**
 1. Covers parts of Karnataka, Andhra Pradesh, and the central Deccan Plateau, characterized by low rainfall and hot summers.
- **Arid Climate (BWh):**

Includes desert areas such as Rajasthan and parts of Gujarat, defined by extremely low rainfall and high temperatures.

Bihar's Climatic Region

Bihar falls under the **Subtropical Humid Climate (Cwa)** zone:

- **Hot summers:** Temperatures exceed 40°C.
- **Cool winters:** Temperatures range from 8°C to 10°C.
- **Monsoon:** Heavy rainfall during June to September, vital for agriculture.

This climate plays a crucial role in shaping Bihar's agriculture-driven economy, highlighting the importance of monsoon patterns and climate resilience.

- Q5. (a) Bihar produces approximately 90% of India's makhana, yet it lags behind states like Punjab and Assam in exports. Analyse the key factors contributing to this paradox and discuss how the Makhana Board proposed for Bihar can aim to rectify these disparities. 38**

Ans- Bihar, the largest producer of makhana (fox nuts) in India, contributes approximately 90% of the country's total production. Despite this dominance, the state lags behind regions like Punjab and Assam in makhana exports. This paradox arises due to several factors, including infrastructural challenges, lack of modern processing facilities, and inadequate branding and marketing strategies. The proposed Makhana Board for Bihar aims to address these disparities and unlock the state's export potential.

Key Factors Contributing to the Paradox

- **Traditional Farming Practices:**
 - Makhana cultivation in Bihar is labour-intensive and relies heavily on traditional methods. Farmers often lack access to modern equipment and techniques, leading to lower productivity and quality compared to states like Punjab, which have embraced mechanized farming.
- **Inadequate Processing Facilities:**
 - Bihar faces a shortage of food processing units and storage facilities. This results in post-harvest losses and limits the ability to produce value-added makhana products, which are in high demand in international markets.
- **Absence of Branding and Marketing:**
 - Unlike Punjab and Assam, Bihar has not effectively leveraged branding and marketing strategies to promote its makhana. The lack of awareness about the state's GI-tagged makhana further hampers its market reach.
- **Export Challenges:**
 - Bihar's makhana industry struggles with export logistics and compliance with international standards. The presence of intermediaries and limited access to export promotion schemes exacerbate these issues.
- **Climate Vulnerabilities:**
 - Makhana cultivation in Bihar is highly susceptible to climate change and water scarcity. These factors impact the consistency and quality of production, making it less competitive in global markets.

Role of the Proposed Makhana Board

The establishment of the Makhana Board in Bihar, as announced in the Union Budget 2025-26, is a significant step toward addressing these challenges. The Board aims to provide comprehensive support to makhana farmers and enhance the state's export capabilities.

- **Infrastructure Development:**
 - The Board will focus on developing modern processing units and storage facilities. This will reduce post-harvest losses and enable the production of high-quality, value-added makhana products.
- **Minimum Support Price (MSP):**
 - Introducing MSP for makhana will protect farmers from price volatility and ensure fair compensation. This financial stability will encourage farmers to invest in modern cultivation techniques.

- **Formation of Farmer Producer Organizations (FPOs):**
 - The Board plans to organize makhana farmers into FPOs. These groups will facilitate collective bargaining, reduce the influence of intermediaries, and improve access to government schemes.
- **Export Promotion:**
 - The Board will work on diversifying export destinations and end products. Innovative marketing strategies and compliance with international standards will enhance Bihar's global presence in the makhana industry.
- **Research and Development:**
 - Continuous R&D efforts will be undertaken to improve makhana cultivation techniques and develop new products. This will make Bihar's makhana more competitive in both domestic and international markets.
- **Awareness and Training:**
 - The Board will provide training to farmers on modern farming practices and export procedures. Awareness campaigns will highlight the benefits of GI-tagged makhana and promote its unique qualities.

Recommendations for Success

To ensure the success of the Makhana Board and rectify the disparities in exports, the following measures are recommended:

- **Leveraging the GI Tag:**
 - Bihar should capitalize on the GI tag of its makhana to differentiate it from competitors. Branding campaigns emphasizing its nutritional value and unique qualities can attract international buyers.
- **Diversification of Products:**
 - Developing a range of makhana-based products, such as snacks and health supplements, will cater to diverse consumer preferences. This will increase market profitability.
- **Strengthening Export Logistics:**
 - Improving transportation and storage infrastructure will facilitate smoother exports. Partnerships with export agencies can help navigate international trade regulations.
- **Climate Resilience:**
 - Promoting water-efficient practices and climate-resilient farming techniques will mitigate the impact of climate change on makhana cultivation.
- **Government Support:**
 - Continuous administrative support and funding will be crucial for the Board's initiatives. Collaboration with national and international organizations can provide additional resources.

Bihar's dominance in makhana production presents a unique opportunity to transform the state's agricultural economy. The proposed Makhana Board has the potential to address the infrastructural, financial, and marketing challenges that hinder Bihar's export capabilities. By implementing targeted strategies and leveraging its GI-tagged makhana, Bihar can emerge as a global leader in the makhana industry. This initiative will not only boost the state's economy but also improve the livelihoods of thousands of makhana farmers.

Or / अथवा

- Q5.** (b) Bihar, despite its rich history and geographical significance, faces significant challenges in its transportation infrastructure. Analyse the historical factors that have contributed to the underdevelopment of transportation in Bihar. Critically examine the recent initiatives undertaken by the state government to improve connectivity. 38

Ans- Bihar, with its rich cultural and historical legacy, has long struggled with underdeveloped transportation infrastructure. Despite its geographical significance as a landlocked state with proximity to major trade routes, Bihar faces persistent challenges in connectivity. This analysis explores the historical factors contributing to this underdevelopment and critically examines recent initiatives by the state government to improve transportation infrastructure, incorporating relevant facts and figures.

Historical Factors Contributing to Underdevelopment

1. Colonial Legacy and Neglect

- During British rule, Bihar's transportation infrastructure was largely neglected in favor of regions like Bengal and Bombay, which were more economically lucrative.
- The Permanent Settlement system prioritized revenue collection over infrastructural development, leaving Bihar's rural areas disconnected.

2. Freight Equalization Policy

- Post-independence, the Freight Equalization Policy (1952) discouraged industrial investment in resource-rich states like Bihar.
- This policy reduced the incentive to develop transportation networks, as industries could access raw materials at equalized costs regardless of location.

3. Agrarian Economy and Lack of Industrialization

- Bihar's economy has historically been agrarian, with agriculture contributing 19.9% to the state's Gross State Domestic Product (GSDP), as highlighted in the Bihar Economic Survey 2024-25. The state has a net sown area of 50.5 lakh hectares, producing a total food grain output of 184.9 lakh tonnes. Despite this strong agricultural base, industrialization remains limited, with the industrial sector accounting for only 21.5% of the GSDP.
- The absence of large-scale industries meant fewer investments in railways, roads, and waterways.

4. Political Instability and Governance Issues

- Frequent changes in political leadership and governance challenges hindered long-term planning and execution of infrastructure projects.
- Corruption and bureaucratic inefficiencies further delayed the implementation of transportation initiatives.

5. Geographical Challenges

- Bihar's flood-prone regions, particularly along the Ganga and its tributaries, pose significant challenges to building durable transportation infrastructure. According to the Bihar Economic Survey 2024-25, 73% of the state's geographical area is prone to floods, affecting 28 out of 38 districts annually.
- The state's landlocked nature limits access to ports, making it reliant on neighboring states for trade connectivity.

Recent Initiatives to Improve Connectivity

1. Road Infrastructure Development

- **Amas-Darbhanga Expressway:** This ambitious project, part of the Bharatmala Pariyojana, spans 189 km and aims to connect key regions within Bihar, reducing travel time and boosting economic activities.
- **Four-Lane Highway Projects:** The state has initiated multiple four-lane road projects, including the Patna-Kolkata Expressway and Buxar-Bhagalpur Expressway, to enhance intra-state and inter-state connectivity.
- As of 2024, Bihar has over 4,000 km of national highways, a significant increase from 2,000 km in 2010.

2. Expansion of Rail Networks

- The state government, in collaboration with Indian Railways, has focused on electrification and doubling of rail lines to improve efficiency.
- Projects like the Hajipur-Bachhwara rail line electrification have been completed, enhancing connectivity in northern Bihar.
- Bihar's rail network spans over 3,700 km, with ongoing efforts to modernize stations and improve passenger amenities.

3. Enhancing Air Connectivity

- **Darbhanga Airport Expansion:** Operationalized under the Regional Connectivity Scheme (Ude Desh Ka Aam Nagrik), this airport has significantly improved access to northern Bihar, handling over 1 million passengers annually since its inauguration in 2020.
- Plans for additional airports in regions like Bhagalpur and Gaya are underway to cater to growing passenger demand. In 2005-06, Bihar had 248,000 air passengers, which increased to 4.286 million in 2023-24—representing a 17-fold growth.

4. Inland Waterways Development

- The National Waterway-1 project on the Ganga River aims to promote eco-friendly and cost-effective transportation of goods.
- Efforts are being made to develop terminals and jetties along the river to facilitate trade and reduce road congestion.
- The Patna terminal under NW-1 has a cargo handling capacity of 2.24 million metric tonnes annually.

5. Urban Transportation Initiatives

- **Patna Metro Project:** This rapid transit system, currently under construction, is expected to revolutionize urban mobility in the state capital, with Phase 1 spanning 32.5 km.
- Smart city initiatives in Patna and Gaya include plans for integrated transportation systems and improved public transit.

Critical Examination of Recent Initiatives

1. Achievements

- The completion of key road and rail projects has improved connectivity in previously inaccessible regions.
- Enhanced air connectivity has boosted tourism and reduced travel time for residents.
- The focus on inland waterways aligns with sustainable development goals and offers an alternative to road transport.

2. Challenges and Limitations

- **Land Acquisition Issues:** Delays in acquiring land for infrastructure projects remain a significant bottleneck.
- **Flood Management:** The state's vulnerability to floods continues to disrupt transportation networks, requiring innovative engineering solutions.
- **Funding Constraints:** Limited financial resources and dependence on central government support slow down project implementation.
- **Urban Congestion:** While projects like the Patna Metro are promising, urban areas still face severe traffic congestion due to inadequate public transport options.

Recommendations for Future Development

1. Integrated Planning and Policy Reforms

- Develop a comprehensive transportation master plan that integrates road, rail, air, and waterways.
- Streamline land acquisition processes and address governance challenges to expedite project execution.

2. Focus on Rural Connectivity

- Prioritize the development of rural roads under schemes like PMGSY (Pradhan Mantri Gram Sadak Yojana) to connect remote villages.
- Encourage public-private partnerships (PPPs) to fund and maintain rural infrastructure.

3. Flood-Resilient Infrastructure

- Invest in flood-resistant technologies and materials to ensure the durability of transportation networks.
- Collaborate with experts to design infrastructure that adapts to Bihar's unique geographical challenges.

4. Promotion of Green Transportation

- Expand the use of electric vehicles and develop charging infrastructure to reduce carbon emissions.
- Promote cycling and pedestrian-friendly infrastructure in urban areas.

5. Strengthening Institutional Capacity

- Establish dedicated agencies for monitoring and evaluating transportation projects.
- Enhance the capacity of local governments to plan and implement infrastructure initiatives effectively.

Bihar's transportation infrastructure has come a long way, but significant challenges remain. Historical factors like colonial neglect, policy biases, and governance issues have left a lasting impact on the state's connectivity. However, recent initiatives by the state government, including expressways, metro projects, and inland waterways, signal a positive shift towards modernization. By addressing existing challenges and adopting innovative solutions, Bihar can unlock its full potential and emerge as a model for sustainable and inclusive transportation development.

Q6. (a) How does lithium play a crucial role in the energy transition towards renewable energy? Discuss why the discovery of lithium reserves in the Salal-Haimana area of Jammu and Kashmir is significant for India. 19 + 19 = 38

Ans-Lithium, commonly known as “white gold,” plays a vital role in the worldwide transition to renewable energy. Its exceptional properties make it essential for efficient energy storage and the advancement of electric mobility

The recent discovery of substantial lithium reserves in the Salal-Haimana area of Jammu and Kashmir marks a transformative moment for India, offering immense potential for energy security and economic growth. Below are a detailed analysis of lithium’s role in the energy transition and the significance of this discovery.

Lithium’s Role in the Energy Transition towards Renewable Energy

1. Energy Storage Systems

- Lithium-ion batteries are the backbone of renewable energy storage systems.
- These batteries store excess energy generated by solar and wind power, ensuring a stable supply during periods of low generation.
- For instance, large-scale lithium-ion battery installations in countries like Australia and the U.S. have demonstrated their ability to stabilize power grids.

2. Electric Vehicles (EVs)

- Lithium-ion batteries power EVs, which are central to reducing greenhouse gas emissions.
- EV adoption is growing rapidly, with global sales surpassing 10 million units in 2022.
- Lithium’s high energy density and rechargeability make it ideal for EV batteries, enabling longer ranges and faster charging.

3. Decarbonizing Industries

- Lithium-ion batteries are used in industrial applications, such as forklifts and mining equipment, to replace fossil fuel-powered machinery.
- They also support the electrification of public transport systems, including buses and trains.

4. Grid Stability and Backup Power

- Lithium-ion batteries provide backup power during outages and help maintain grid stability.
- They enable the integration of intermittent renewable energy sources, such as solar and wind, into the grid.

5. Global Demand and Supply Dynamics

- The global demand for lithium is projected to reach 1.5 million metric tonnes by 2025, driven by the renewable energy and EV sectors.

- Major lithium-producing countries include Australia, Chile, and China, which dominate the supply chain.

Significance of Lithium Reserves in Salal-Haimana, Jammu & Kashmir

1. Scale of Discovery

- The Geological Survey of India (GSI) has identified inferred lithium resources of 5.9 million tonnes in the Salal-Haimana area.
- This discovery ranks among the largest lithium reserves globally, positioning India as a potential key player in the lithium market.

2. Strategic Importance

- India currently imports most of its lithium, making the discovery crucial for reducing import dependency.
- The reserves can support India's ambitious renewable energy targets, including achieving 500 GW of non-fossil fuel capacity by 2030.

3. Boost to Electric Mobility

- The reserves can supply raw materials for domestic lithium-ion battery production, reducing costs and enhancing the competitiveness of India's EV industry.
- This aligns with the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, which aims to promote EV adoption.

4. Economic Growth and Job Creation

- The development of lithium mining and processing industries can create thousands of jobs in Jammu and Kashmir and its peripheral states.
- It can also attract investments in battery manufacturing and related sectors, boosting the local economy.

5. Geopolitical Implications

- The discovery strengthens India's position in the global lithium supply chain, reducing reliance on countries like China.
- It enhances India's energy security and supports its leadership role in the International Solar Alliance.

6. Environmental Considerations

- Sustainable mining practices will be essential to minimize the environmental impact of lithium extraction.
- The reserves offer an opportunity to develop eco-friendly technologies for lithium processing.

Relevant Facts and Figures

- **Global Lithium Market:**
 - Australia is the largest producer, accounting for 52% of global lithium production.
 - The “Lithium Triangle” (Chile, Argentina, and Bolivia) holds over 50% of the world’s lithium reserves.
- **India’s Renewable Energy Goals:**
 - India aims to achieve 50% of its energy requirements from renewable sources by 2030.
 - The country plans to install 280 GW of solar capacity by 2030, requiring significant energy storage solutions.
- **Economic Potential:**
 - The global lithium market is expected to reach \$8.2 billion by 2028, growing at a CAGR of 14.8%.
 - India’s EV market is projected to grow at a CAGR of 49% between 2022 and 2030, reaching annual sales of 17 million units.
- **Environmental Impact:**
 - Lithium mining can lead to water scarcity and habitat destruction if not managed sustainably.
 - Recycling lithium from used batteries can reduce the need for new mining and lower environmental risks.

Lithium plays a pivotal role in the global energy transition, enabling the adoption of renewable energy and electric mobility. The discovery of significant lithium reserves in Jammu and Kashmir is a game-changer for India, offering opportunities to enhance energy security, boost economic growth, and achieve climate goals. However, sustainable mining practices and efficient resource management will be critical to unlocking the full potential of this strategic resource. By leveraging these reserves, India can emerge as a global leader in the renewable energy revolution.

Or / अथवा

- Q6. (b) Examine the spatial distribution of soil types in Bihar. Focusing on precision agriculture, analyse the potential of Bihar's soils to contribute to an evergreen agricultural revolution in India. Analyse the challenges and propose policy recommendations for Bihar to maximize agricultural productivity while ensuring sustainable soil management.** 38

Ans- Bihar, with its rich agricultural history, boasts diverse soil types shaped by its unique geography, abundant river systems, and climatic conditions. Understanding the spatial distribution of these soils is pivotal for developing precision agriculture strategies that contribute to an evergreen agricultural revolution in India. This revolution envisions sustainable productivity gains while preserving ecological balance.

Spatial Distribution of Soil Types in Bihar

Bihar is divided into three primary agro-climatic zones, each characterized by distinct soil properties:

- **North Bihar Plains:**
 - Dominated by **recent alluvial soils** deposited by the Ganga, Gandak, and Kosi rivers.
 - Nutrient profile: Rich in **potassium**, moderately rich in phosphorus, but often deficient in **nitrogen**.
 - High water retention capacity, making it ideal for paddy cultivation.
 - Regions like Madhubani and Darbhanga exemplify this soil type, where rice dominates cropping patterns.
- **South Bihar Plains:**
 - Features older alluvial soils, which are moderately fertile.
 - These soils often face alkalinity issues and are low in organic carbon, reducing their productivity.
 - Key crops include wheat, maize, and pulses, particularly in districts like Bhojpur and Aurangabad.
- **Kaimur Plateau and Southern Hills:**
 - Composed of red and lateritic soils, which are less fertile compared to alluvial soils.
 - These soils are acidic and have low water-holding capacity.
 - Despite these limitations, they support horticulture and plantation crops in areas like Rohtas and Gaya, especially when supplemented with lime and organic manure.

Potential for Precision Agriculture to Propel the Evergreen Revolution

Precision agriculture (PA) is a modern approach that leverages technologies like geographic information systems (GIS), GPS, drones, and sensors to optimize resource use and maximize yield. Bihar's soils, when managed scientifically, offer immense potential for an evergreen revolution:

- **Alluvial Soils in North and South Bihar:**
 - These soils are highly responsive to site-specific nutrient management (SSNM). Studies indicate that customized fertilizer recommendations using PA techniques can enhance yields by **15-20%**.
 - For example, pilot projects in **Purnia** using GIS-based soil fertility mapping reduced fertilizer overuse and improved soil health.
- **Horticulture on Red and Lateritic Soils:**
 - Precision irrigation, such as drip irrigation systems, can mitigate water scarcity issues while enhancing productivity.
 - Case studies in **southern Gaya** show a **30% increase** in mango and litchi production with PA tools.
- **Flood Management in North Bihar:**
 - Technologies like remote sensing can predict flood risks and guide crop selection to minimize soil erosion and damage.
- **Digital Soil Mapping:**
 - Districts like **Muzaffarpur and Saharsa** have demonstrated the success of GIS-based soil mapping, enabling farmers to adjust practices for long-term sustainability.

Challenges Hindering Sustainable Soil Management

Despite the potential of precision agriculture, Bihar faces several challenges:

- **Soil Degradation:**
 - Excessive use of chemical fertilizers (particularly urea) has reduced organic matter and microbial activity in soils.
 - Salinity and alkalinity issues are prominent in areas like Saran and Chapra.
- **Flooding and Waterlogging:**
 - Annual floods in North Bihar destroy soil structure and wash away essential nutrients.
- **Limited Awareness:**
 - Smallholder farmers lack knowledge about advanced agricultural technologies and soil health management.
 - Adoption of PA tools remains low due to high initial costs and limited government support.
- **Fragmented Landholdings:**
 - Over 90% of farms in Bihar are small and fragmented, hindering large-scale adoption of PA technologies.
- **Inadequate Infrastructure:**
 - Poor rural road connectivity and lack of modern irrigation infrastructure restrict the efficient implementation of sustainable practices.

Policy Recommendations

To address these challenges and unlock Bihar's agricultural potential, the following policy recommendations are proposed:

- **Promote Soil Health Management:**
 - Expand the soil health card scheme for farmers and incentivize the use of organic fertilizers and bio-fertilizers.
 - Regular soil testing at the block level to ensure accurate nutrient management.
- **Invest in Precision Agriculture:**
 - Provide subsidies and training programs for adopting GPS-enabled farm equipment and digital soil mapping tools.
 - Collaborate with research institutes like ICAR and Dr. Rajendra Prasad Central Agricultural University to develop region-specific PA models.
- **Flood Control and Drainage:**
 - Develop robust flood control measures, such as embankments and drainage systems, to protect North Bihar soils.
 - Promote agroforestry systems in flood-prone areas to reduce soil erosion.
- **Capacity Building for Farmers:**
 - Conduct awareness campaigns and workshops to educate farmers about PA technologies and sustainable practices.
 - Support farmer producer organizations (FPOs) to aggregate smallholders and improve economies of scale.
- **Encourage Crop Diversification:**
 - Incentivize crop rotation and diversification to break the cycle of nutrient depletion.
 - Promote the cultivation of oilseeds, pulses, and high-value horticultural crops.

Bihar's soils hold immense promise for advancing India's evergreen revolution. By leveraging the potential of precision agriculture and addressing existing challenges through targeted policies, Bihar can emerge as a model for sustainable and inclusive agricultural development. Long-term success will depend on balancing productivity with environmental sustainability, ensuring that future generations inherit soils rich in fertility and life.

SECTION-III

Q7. (a) What is the scope of the role of AI public health services? Discuss. 8

Ans- Artificial Intelligence (AI) has emerged as a transformative force in public health services, offering advancements in prevention, diagnosis, treatment, and planning.

1. Disease Surveillance and Early Detection

- AI enhances disease surveillance by analysing health data and identifying patterns of potential outbreaks.
- Real-time analytics help detect epidemics early, saving lives. With India witnessing frequent outbreaks like dengue, AI-based models improve prediction accuracy.

2. Precision Diagnostics and Treatment

- AI-powered imaging tools improve diagnostics, such as detecting tuberculosis or breast cancer with over 90% accuracy, according to research.
- Personalized medicine uses AI to tailor treatments based on patient genetics, reducing drug resistance in diseases like tuberculosis.

3. Public Health Delivery

- AI in telemedicine bridges the urban-rural healthcare gap. India's Aarogya Setu app can use AI to track COVID-19 infections and guide users on preventive measures.
- Wearable technology equipped with AI monitors chronic diseases like diabetes, reducing hospital visits and enabling real-time intervention.

4. Resource Optimization and Emergency Planning

- AI optimizes resource allocation, such as vaccine distribution, ensuring equitable access.
- Predictive analytics help plan responses to disasters like floods, safeguarding vulnerable communities.

AI's integration in public health significantly enhances efficiency and accessibility. Its responsible and ethical use can transform healthcare delivery in India and globally.

Q7. (b) With suitable examples, discuss the benefits of space technology for social development.

7

Ans- Space technology has become a catalyst for social progress, providing innovative solutions in various fields that significantly improve lives.

1. Disaster Management and Relief

- Satellites enable real-time disaster monitoring and early warnings.
- **Example:** During Cyclone Phailin (2013), ISRO's satellites provided timely data that facilitated the evacuation of over 1.2 million people, minimizing casualties.

2. Agriculture and Food Security

- Remote sensing technology monitors crop health, soil conditions, and water resources.
- **Example:** ISRO's RISAT-1 assists in estimating crop production and identifying drought-prone areas, supporting millions of Indian farmers.

3. Education and Healthcare Outreach

- Space-enabled connectivity bridges gaps in remote areas, enhancing education and healthcare access.
- **Example:** EDUSAT connects rural schools with quality educational resources, while telemedicine programs provide remote consultations to underserved areas.

4. Environmental Monitoring and Conservation

- Satellites track deforestation, urbanization, and climate change.
- **Example:** ISRO's Cartosat satellites monitor India's forest cover, aiding conservation policies.

5. Improved Connectivity and Governance

- Satellite communication ensures internet and telecommunication access in rural and isolated areas.
- **Fact:** Over 70% of India's rural regions now benefit from satellite-driven connectivity, boosting governance and economic opportunities.

Space technology fosters equitable growth, empowering sectors like disaster management, agriculture, education, and environmental conservation while driving sustainable development.

Q7. (c) With Suitable examples, discuss the probable role of recently developed technology in agricultural development of Bihar. 7

Ans- Bihar, with its fertile land and abundant water resources, has immense potential for agricultural growth. Recent technological advancements are transforming the state's agricultural landscape, enhancing productivity and sustainability.

1. Precision Agriculture

- Technologies like drones and Geographic Information Systems (GIS) are being used for soil health mapping and crop monitoring.
- **Example:** GIS-based soil health cards guide farmers in optimizing fertilizer use, improving yields while reducing costs.

2. Smart Irrigation Systems

- Automated irrigation systems, such as drip and sprinkler irrigation, ensure efficient water use in drought-prone areas.
- **Example:** The adoption of micro-irrigation techniques in southern Bihar has increased water efficiency by 30%.

3. Advanced Seed Varieties

- High-yield and climate-resilient seed varieties are being introduced to combat climate variability.
- **Example:** Drought-resistant paddy varieties have boosted rice production in flood-prone regions.

4. Digital Platforms for Market Access

- Mobile apps and e-marketplaces connect farmers directly with buyers, reducing dependency on intermediaries.
- **Example:** Platforms like e-NAM (National Agriculture Market) have empowered Bihar's farmers with better price realization.

5. Sustainable Practices

- **Alternate** Wetting and Drying (AWD) technology in paddy cultivation reduces methane emissions and water usage.
- **Example:** AWD adoption in northern Bihar has cut emissions by 10% while maintaining productivity.

Technological innovations are driving agricultural development in Bihar, ensuring higher productivity, sustainability, and farmer welfare. Their widespread adoption can position Bihar as a model for modern agriculture in India.

Q7. (d) Discuss the role of biotechnology with examples from the viewpoint of food security in states like Bihar where population pressure on various types of resources is very high.

7

Ans- Biotechnology plays a crucial role in ensuring food security, particularly in densely populated and resource-stressed states like Bihar. The emphasis is on how biotechnological interventions specifically address the food challenges faced due to high population pressure and environmental vulnerabilities.

1. Enhancing Crop Productivity

- Biotechnology helps develop high-yielding and stress-resistant crop varieties that increase agricultural output.
- **Example:** In Bihar, drought-resistant rice varieties such as “Sahbhagi Dhan” ensure stable production in drought-prone areas.
- **Relevance:** Bihar’s population density (1,106 per sq km, as per Census 2011) demands consistent food availability to meet rising needs.

2. Combating Pest and Disease Outbreaks

- Genetically Modified (GM) crops with pest-resistant traits reduce crop losses and reliance on chemical pesticides.
- **Example:** Bt brinjal, developed to resist fruit and shoot borer pests, holds potential for cultivation in Bihar’s horticulture sector.

3. Improving Nutritional Quality

- Biofortification addresses malnutrition by enriching crops with essential nutrients.
- **Example:** Iron- and zinc-enriched rice varieties are being introduced to fight widespread anemia in Bihar, where the National Family Health Survey reports high malnutrition rates.

4. Sustainable Agriculture

- Biotechnology promotes eco-friendly practices like biofertilizers, reducing dependence on chemical inputs.
- **Example:** Farmers in Bihar increasingly use biofertilizers to improve soil health and reduce input costs.

Biotechnology directly addresses the challenges of food security in Bihar by increasing agricultural productivity, reducing crop losses, improving nutritional outcomes, and promoting sustainability. Its targeted use can significantly alleviate the pressures of high population density and limited resources, ensuring long-term food security in the state.

Q7. (e) Write a note on the role of modern technology for wetland conservation.

7

Ans- Wetlands, being crucial ecosystems, provide services like water purification, carbon sequestration, flood control, and biodiversity support. However, they are under constant threat due to human activities and climate change. Modern technology plays a pivotal role in conserving these vital ecosystems:

- **Satellite Imagery and Remote Sensing:** Tools like ISRO's Bhuvan platform monitor wetlands such as Chilika Lake and Vembanad Lake, tracking changes in land use and water quality.
- **Real-time Data Monitoring:** IoT devices are used in Loktak Lake, Manipur, to monitor water quality and ecological parameters, ensuring timely interventions.
- **Drones and UAVs:** Drones have been deployed in the Sundarbans to map mangroves and monitor illegal activities like deforestation and encroachments.
- **Artificial Intelligence (AI) and Machine Learning (ML):** AI models are used to predict the impact of climate change on wetlands like Sambhar Lake, aiding in conservation planning.
- **Hydrological Modelling:** Advanced models simulate water flow and flooding patterns in wetlands such as the Kolleru Lake, helping in restoration and sustainable management.
- **Restoration Technologies:** Techniques like hydroseeding have been used to restore vegetation in degraded wetlands, including the East Kolkata Wetlands.
- **Community Engagement via Technology:** Mobile apps like the "Indian Wetlands" app by the Ministry of Environment engage citizens in reporting issues and learning about wetland conservation.
- **Citizen Science Programs:** Platforms like eBird India encourage public participation in monitoring bird species in wetlands like Keoladeo National Park.

By integrating these technologies with traditional methods, India is making significant strides in protecting its wetlands and ensuring their sustainability for future generations.

- Q8. (a) Discuss the role of artificial intelligence (AI) and machine learning (ML) in environmental monitoring and conservation in the Indian context. Analyse the potential benefits and challenges of utilizing these technologies, and propose a framework for their ethical and responsible use.** 36

Ans- Artificial Intelligence (AI) and Machine Learning (ML) are increasingly being used in environmental monitoring and conservation efforts worldwide. In the Indian context, these technologies are transforming the way we address critical environmental challenges, enabling efficient data analysis, predictive modeling, and real-time monitoring. Below is an in-depth discussion of their role, benefits, challenges, and a proposed framework for ethical and responsible use in India.

Role of AI and ML in Environmental Monitoring and Conservation

1. Air Quality Management

- AI-powered tools are used to monitor air pollution, analyze data from air quality sensors, and predict pollution levels.
- **Example:** The Central Pollution Control Board (CPCB) employs AI to identify pollution hotspots and forecast Air Quality Index (AQI).
- **Relevance:** Given that India has 22 of the world's 30 most polluted cities (2022), AI-driven interventions are essential to mitigate air quality issues.

2. Water Resource Management

- ML algorithms help optimize water use in agriculture, urban planning, and drought-prone areas.
- **Example:** AI-based smart irrigation systems ensure efficient water usage and reduce wastage.
- **Relevance:** With India facing an annual per capita water availability decline (1,544 cubic meters in 2019 to projected 1,367 cubic meters in 2031), AI is vital for sustainable water management.

3. Biodiversity Conservation

- AI systems utilize image recognition and acoustic monitoring to track endangered species, prevent poaching, and protect habitats.
- **Example:** Drones with AI capabilities are used to monitor wildlife in Kaziranga National Park, a UNESCO World Heritage Site.
- **Fact:** India is home to over 7-8% of the world's recorded species, requiring proactive conservation methods.

4. Disaster Risk Management

- ML models predict natural disasters such as cyclones, floods, and landslides, facilitating timely evacuation and resource allocation.
- **Example:** The Indian Meteorological Department (IMD) incorporates AI to improve the accuracy of extreme weather forecasts.

- **Relevance:** Frequent floods in states like Bihar and Assam highlight the importance of such technologies for disaster preparedness.

5. Precision Agriculture

- AI and ML are used for precision farming by analyzing soil health, weather patterns, and crop requirements.
- **Example:** Krishi Yantra, an AI-driven platform, helps farmers improve productivity by providing crop recommendations.
- **Relevance:** India's agriculture sector contributes 16% to its GDP but suffers from low productivity due to resource inefficiency.

6. Waste Management

- AI automates waste segregation processes, improving recycling efficiency and reducing landfill burden.
- **Example:** Startups like Banyan Nation leverage AI for smart waste management in Indian cities.

Potential Benefits of AI and ML in Environmental Conservation

1. Real-Time Data Monitoring

- AI enables continuous tracking of environmental parameters, ensuring timely interventions.
- **Example:** Real-time air quality sensors in Delhi alert policymakers about pollution spikes.

2. Enhanced Predictive Capabilities

- ML models predict future environmental trends and threats, aiding proactive decision-making.
- **Example:** AI forecasts crop yields based on weather and soil data, assisting farmers in planning.

3. Efficiency and Cost-Effectiveness

- Automation of data collection and analysis reduces human labor and operational costs.
- **Fact:** AI-powered drones cover large forest areas at lower costs compared to manual surveys.

4. Addressing Complex Issues

- AI tackles multi-dimensional environmental issues by analyzing large datasets.
- **Example:** Climate change models incorporate data from diverse sources to predict impacts on agriculture and ecosystems.

Challenges in Utilizing AI and ML for Environmental Conservation

1. Data Gaps and Quality Issues

- Incomplete and inconsistent datasets reduce the accuracy of AI models.

- **Example:** Limited biodiversity data from remote areas affects AI's conservation efforts.

2. High Deployment Costs

- Advanced AI systems require significant investment in hardware, software, and training.
- **Relevance:** Small-scale farmers often cannot afford AI-powered agricultural tools.

3. Limited Access in Rural Areas

- Infrastructure gaps, such as poor internet connectivity, restrict AI adoption in remote regions.
- **Fact:** Only 52% of rural India had internet access as of 2022.

4. Ethical Concerns

- Privacy issues and potential misuse of surveillance tools raise ethical questions.
- **Example:** Unregulated drone usage for wildlife monitoring might infringe on local communities' privacy.

5. Environmental Impact of AI

- Data centers powering AI models consume significant energy, contributing to carbon emissions.
- **Relevance:** Balancing AI deployment with sustainability goals is a key challenge.

Proposed Framework for Ethical and Responsible Use

1. Robust Data Governance

- Establish guidelines for data collection, sharing, and use to ensure transparency.
- **Example:** Create open-access datasets for research while safeguarding sensitive information.

2. Community Inclusion

- Engage local communities in the design and implementation of AI projects.
- **Relevance:** Participatory approaches ensure ethical considerations are addressed.

3. Policy and Regulation

- Develop standards for AI usage in environmental monitoring, focusing on accountability and privacy.
- **Example:** Regulate drone usage in wildlife conservation to avoid misuse.

4. Skill Development and Capacity Building

- Invest in training programs to equip stakeholders with AI and ML skills.
- **Example:** Collaborate with academic institutions for courses on AI in environmental science.

5. Promote Renewable Energy for AI Systems

- Encourage data centers to adopt solar and wind energy to minimize carbon emissions.

6. Interdisciplinary Collaboration

- Foster partnerships between environmental scientists, technologists, and policymakers.
- **Relevance:** Collaborative approaches address India's unique environmental challenges effectively.

Relevant Facts and Figures

1. Air Pollution Crisis:

- Over 1.7 million deaths in India were attributed to air pollution in 2019, emphasizing the need for AI interventions.

2. Biodiversity Importance:

- India ranks among the top 10 megadiverse countries, underscoring its global conservation responsibilities.

3. Agriculture Dependency:

- Over 50% of India's workforce depends on agriculture, highlighting the relevance of AI-driven farming solutions.

4. Global AI Market:

- The market size for AI in environmental applications is projected to exceed \$10 billion by 2030.

AI and ML present transformative opportunities for environmental monitoring and conservation in India. By enabling efficient resource management, predictive analytics, and real-time monitoring, these technologies can address critical challenges such as air pollution, biodiversity loss, and water scarcity. However, their adoption must be guided by ethical considerations, robust policies, and inclusive approaches to ensure sustainable and responsible use. With the right framework, AI and ML can become powerful tools in safeguarding India's environment for future generations.

Or / अथवा

Q8. (b) Discuss the potential and limitations of gene editing technologies like CRISPR-Cas9 in addressing global challenges such as food security, human health, and environmental conservation. Analyse the ethical and societal implications of these technologies. 36

Ans- Gene editing technologies, particularly CRISPR-Cas9, have revolutionized the fields of biotechnology, medicine, and agriculture. These tools offer unprecedented precision in modifying genetic material, enabling solutions to global challenges such as food security, human health, and environmental conservation. However, their application also raises ethical and societal concerns. Below is a detailed analysis of their potential, limitations, and implications.

Potential of Gene Editing Technologies

1. Addressing Food Security

- **Crop Improvement:** CRISPR-Cas9 enables the development of crops with enhanced traits such as drought resistance, pest tolerance, and higher nutritional value.
 - **Example:** Scientists have used CRISPR to develop rice varieties resistant to bacterial blight, a major crop disease.
 - **Fact:** The Food and Agriculture Organization (FAO) estimates that global food production must increase by 70% by 2050 to meet population demands. Gene editing can play a pivotal role in achieving this goal.
- **Livestock Enhancement:** Gene editing can improve livestock health and productivity by introducing disease-resistant traits.
 - **Example:** CRISPR has been used to create pigs resistant to Porcine Reproductive and Respiratory Syndrome (PRRS).

2. Advancing Human Health

- **Treatment of Genetic Disorders:** CRISPR-Cas9 offers the potential to correct genetic mutations responsible for diseases such as sickle cell anemia, cystic fibrosis, and muscular dystrophy.
 - **Example:** In 2020, a patient with sickle cell anemia was successfully treated using CRISPR-based therapy.
- **Cancer Therapy:** Gene editing can target and destroy cancer cells, offering new avenues for treatment.
 - **Fact:** The global cancer burden is expected to rise to 28.4 million cases by 2040, highlighting the need for innovative therapies.
- **Infectious Disease Control:** CRISPR can be used to develop antiviral therapies and vaccines.
 - **Example:** Researchers are exploring CRISPR-based approaches to combat HIV and COVID-19.

3. Environmental Conservation

- **Biodiversity Protection:** Gene editing can help conserve endangered species by addressing genetic vulnerabilities.

- **Example:** CRISPR has been used to study and potentially reverse genetic defects in cheetahs.
- **Combatting Invasive Species:** Gene drives, a CRISPR-based technology, can control populations of invasive species that threaten ecosystems.
 - **Example:** Gene drives are being explored to reduce populations of malaria-carrying mosquitoes.
- **Carbon Sequestration:** Gene editing can enhance the ability of plants to absorb carbon dioxide, contributing to climate change mitigation.

Limitations of Gene Editing Technologies

1. Off-Target Effects

- CRISPR-Cas9 may inadvertently edit unintended regions of the genome, leading to unpredictable consequences.
 - **Example:** Studies have shown that off-target mutations can disrupt normal cellular functions.

2. Technical Challenges

- Delivering gene-editing tools to specific cells or tissues remains a significant hurdle.
 - **Fact:** Current delivery methods, such as viral vectors, have limitations in terms of efficiency and safety.

3. Accessibility and Cost

- High costs and technical expertise required for gene editing limit its accessibility, particularly in low-income countries.
 - **Example:** The cost of CRISPR-based therapies can exceed \$1 million per patient.

4. Environmental Risks

- Gene editing in plants and animals may have unintended ecological consequences, such as gene flow to wild populations.
 - **Example:** The release of genetically modified organisms (GMOs) into ecosystems could disrupt biodiversity.

5. Ethical and Regulatory Barriers

- Ethical concerns and regulatory restrictions often delay the adoption of gene-editing technologies.
 - **Fact:** Over 40 countries have regulations or bans on human germline editing.

Ethical and Societal Implications

1. Human Germline Editing

- Modifying the human germline raises concerns about “designer babies” and eugenics.
 - **Example:** In 2018, a Chinese scientist faced global criticism for editing the genomes of twin embryos to make them resistant to HIV.

- **Fact:** Germline edits are heritable, affecting future generations without their consent.

2. Equity and Access

- Gene editing technologies may exacerbate social inequalities if only accessible to wealthy individuals or nations.
 - **Example:** High costs of CRISPR-based therapies could widen the gap between developed and developing countries.

3. Biodiversity and Ecosystem Balance

- The use of gene drives to control invasive species could have unintended ecological impacts.
 - **Example:** Altering mosquito populations may affect species that rely on them as a food source.

4. Public Perception and Acceptance

- Misinformation and lack of awareness about gene editing can lead to public resistance.
 - **Fact:** A 2021 survey found that 60% of respondents in India were unaware of CRISPR technology.

Proposed Framework for Ethical and Responsible Use

1. Robust Regulatory Frameworks

- Develop clear guidelines for the use of gene editing in agriculture, medicine, and conservation.
 - **Example:** Establish independent ethics committees to evaluate gene-editing projects.

2. Public Engagement and Education

- Conduct awareness campaigns to inform the public about the benefits and risks of gene editing.
 - **Example:** Collaborate with educational institutions to include gene editing in science curricula.

3. Global Collaboration

- Foster international cooperation to address ethical, regulatory, and technical challenges.
 - **Example:** The International Summit on Human Gene Editing promotes dialogue among scientists, ethicists, and policymakers.

4. Focus on Equity and Accessibility

- Ensure that gene-editing technologies are affordable and accessible to marginalized communities.
 - **Example:** Subsidize CRISPR-based therapies in low-income countries.

5. Environmental Risk Assessment

- Conduct comprehensive studies to evaluate the ecological impact of gene editing.
 - **Example:** Implement precautionary measures before releasing genetically modified organisms into the wild.

Gene editing technologies like CRISPR-Cas9 hold immense potential to address global challenges in food security, human health, and environmental conservation. However, their application must be guided by ethical considerations, robust regulations, and public engagement to ensure equitable and sustainable outcomes. By addressing technical and societal challenges, these technologies can pave the way for transformative solutions to some of the world's most pressing issues.

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