



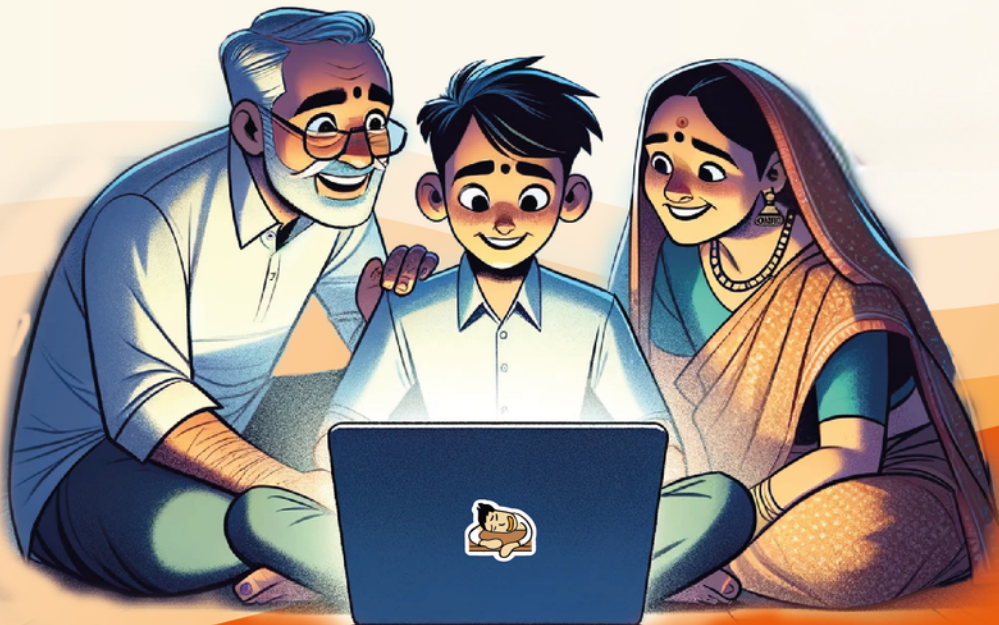
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UPSC MAINS

Solved PYQs

2022

General Studies Paper 3



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How to Maximize Your UPSC Mains Score Using These PYQs

Transform Your Preparation into Your Success Strategy

✗ "I solve PYQs but still struggle in mock exam"

Your Problem: You're treating PYQs like MCQs - solving for the sake of solving without strategic analysis.

Strategic Solution: After solving each question, spend 10 minutes analyzing: What was the examiner testing? Which keywords were crucial? How can I improve my answer structure? Create a "mistakes point list" to track recurring weaknesses.



"I can't finish questions within time limits"

Your Problem: You know the content but struggle with time management and answer structuring under pressure.

Time-Bound Practice: Set strict timers - 7 minutes for 10-mark questions, 12 minutes for 15-mark questions. Practice writing concise, impactful answers. Use bullet points and subheadings to save time while maintaining clarity.



"My answers lack depth and examples"

Your Problem: Your answers are generic and don't stand out among thousands of similar responses.

Content Enhancement: For each PYQ, create a "example bank" - collect 2-3 specific case studies, data points, or contemporary examples. Practice weaving these naturally into your answers to demonstrate comprehensive understanding.



"I don't know which topics to prioritize"

Your Problem: Without pattern analysis, you're studying everything equally instead of focusing on high-weightage areas.

Smart Analysis: Create a frequency chart of topics from last 7 years. Identify recurring themes and question patterns. Allocate 60% of your time to high-frequency topics, 40% to emerging trends. Also Sleepy Classes has a video on complete pattern analysis of UPSC mains.

⚠ Critical Mistake to Avoid

Don't just read solved answers and move on. The real learning happens when YOU attempt the question first, then compare with model answers to identify gaps.



Remember: PYQs are your blueprint, not just practice material

Every question tells you exactly what UPSC expects. Use this collection to decode the examiner's mindset, not just to test your knowledge. Your success lies in understanding the 'why' behind each question.

FREE - GS Mains PYQs Discussion

Date	Day	Topic	Year
02 June 2025	Monday	General Studies Paper 1	2024
03 June 2025	Tuesday	General Studies Paper 2	2024
04 June 2025	Wednesday	General Studies Paper 3	2024
05 June 2025	Thursday	General Studies Paper 4	2024
15 June 2025	Sunday	General Studies Paper 1 to 4	2023
22 June 2025	Sunday	General Studies Paper 1 to 4	2022
29 June 2025	Sunday	General Studies Paper 1 to 4	2021
06 July 2025	Sunday	General Studies Paper 1 to 4	2020



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Economy

1) Why is Public Private Partnership (PPP) required in infrastructural projects? Examine the role of PPP model in the redevelopment of Railway Stations in India.

Approach:

- Introduction: Define Public Private Partnership (PPP)
- Body: Explain the need for Public Private Partnership (PPP) in infrastructure projects
 - Examine the role of Public Private Partnership (PPP) in redevelopment of railway stations
- Conclusion: Give appropriate conclusion in this regard

Introduction:

- Public-Private Partnership (PPP) has emerged as a vital mechanism for developing infrastructure projects worldwide, including in India. The PPP model leverages the strengths of both the public and private sectors to enhance efficiency, innovation, and funding availability for large-scale projects.
- In the 2025-26 Budget, the government emphasized reviving PPPs, particularly in sectors like highways and railways, to leverage private capital and expertise

Importance of Public-Private Partnership in Infrastructure Projects

Funding and Financial Stability

- **Capital Mobilization:** Infrastructure projects require substantial capital investments. PPP allows for pooling financial resources from private entities, thereby reducing the fiscal burden on the government.
- **Risk Sharing:** By involving private players, financial and operational risks are shared, mitigating the potential impact on public finances.

The Hyderabad Metro Rail Ltd (HMRL), the largest Metro project in the world to be implemented in the public-private partnership (PPP).

PPP has helped NHAI clock 29.81 Km/day (in 2014-15, the rate was 16.61 km/day).

- **Technical Expertise:** Private sector participation brings advanced technologies and management practices, enhancing project efficiency and quality.
- **Operational Efficiency:** Private entities often operate with greater efficiency, reducing costs and ensuring timely project completion.
- **Innovative Solutions:** The private sector is driven by competition and innovation, which can lead to more creative and effective solutions for infrastructure development.
- **Modern Amenities:** PPP projects often introduce modern amenities and services that improve the overall user experience.

- The port sector was constrained by limited capacity, traditional infrastructure and poor equipment levels. These were resolved by roping in the private sector to make ports globally competitive
- The Jawaharlal Nehru Port completed 25 years of public-private partnership (PPP) in 2022

Economic Growth and Job Creation

- **Boosting Economy:** Infrastructure development through PPP can stimulate economic growth by improving connectivity and accessibility.
- **Employment Generation:** Large-scale infrastructure projects create numerous job opportunities, both during the construction phase and in ongoing operations.

Role of PPP in Redevelopment of Railway Stations in India

- **Developing railways is a costly affair:** The development of railway infrastructure is costly while the railway sector in India faces a shortage of funds along with a backlog of maintenance and modernization projects. PPPs can help by providing access to private sector capital and technology.
- **Improve operating ratio:** Currently Indian Railways suffers from a very poor operating ratio of about 98. The PPP model can bring opportunities for investment to improve operating efficiency by introducing modern and clean technology along with management expertise.
- **Increased revenue source:** PPP railway projects provide for shared use of rail tracks. This would lead to efficiency and an increased revenue source for states and reduced cost basis for private investors.
- **Better services:** Stations would be equipped with services like Wifi, well maintained restrooms, lounges, etc. This would act as a revenue source to private players while people get the benefit of quality service.
- **Increased competition:** Entry of private sector would introduce competition in a sector that was earlier a monopoly. This would improve the service and allow for modernization of railway infrastructure.

Conclusion

- Public-Private Partnerships are essential for the sustainable development of infrastructure projects in India, offering financial, technical, and operational advantages. The successful implementation of PPP in the redevelopment of railway stations demonstrates its potential to transform India's transportation infrastructure, providing better services and amenities for passengers.
- With the right policies and collaborative efforts, PPP can significantly contribute to the modernization and efficiency of Indian Railways.

2) Is inclusive growth possible under market economy? State the significance of financial inclusion in achieving economic growth in India.

Approach:

- **Introduction:** Define Market economy
- **Body:** Explain how inclusive growth is possible in market economy
 - Write about significance of financial inclusion in achieving economic growth in India.
- **Conclusion:** Give appropriate conclusion in this regard (whatever we have discussed in the body)

Introduction

- A market economy relies on the forces of demand and supply, private enterprise, and limited government intervention. While it promotes efficiency and innovation, it may also lead to inequality if left unchecked. Therefore, inclusive growth, which ensures participation and benefit-sharing across all sections of society, requires proactive state policies and robust institutional mechanisms.
- This concept is crucial for fostering social stability, reducing poverty, and enhancing overall economic resilience. In a market economy, where resource allocation is primarily determined by supply and demand, achieving inclusive growth can be challenging.

Inclusive Growth in a Market Economy

- Market economies are based on the principles of efficiency and competition, which can drive innovation and productivity. A market economy, with proper regulations and policies, can foster conditions for inclusive growth by providing opportunities for all segments of society to participate and benefit from economic activities.
- Women-centric economic development programmes have helped Bangladesh rank 34th in the World Economic Forum's Inclusive Development Index's list of emerging economies, way ahead of South Asian competitors India (62), Pakistan and Sri Lanka.

Significance of Financial Inclusion in Achieving Economic Growth in India

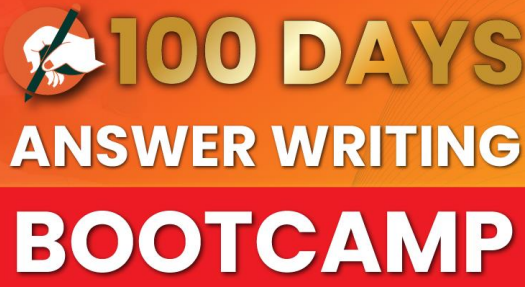
- Financial Inclusion refers to the process of ensuring access to financial services like banking, credit, insurance, and digital payment systems for all individuals, especially the underserved and unbanked populations.
- By providing financial services to the poor, financial inclusion empowers individuals to save, invest, and improve their livelihoods, thereby contributing to economic growth.

Impact on Economic Growth

- Access to banking services encourages savings and investments, which are critical for economic growth. **For example, PMJDY accounts have mobilized substantial savings from the poor.**
- Microfinance and small loans enable entrepreneurs to start and expand businesses, creating jobs and boosting local economies. **Studies have shown that microfinance has had a positive impact on income generation and poverty reduction.**
- Access to insurance products helps individuals and businesses mitigate risks, leading to greater economic stability and resilience.

Conclusion

- Inclusive growth within a market economy is challenging but achievable with the right mix of government policies, financial inclusion efforts, and targeted interventions. Financial inclusion is a cornerstone of this endeavour, as it empowers individuals, promotes economic stability, and fosters overall economic growth. By continuing to expand financial access and literacy, and addressing infrastructure and regulatory challenges, India can achieve a more inclusive and robust economic growth trajectory.



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3) What are the major challenges of Public Distribution System (PDS) in India? How can it be made effective and transparent?

Approach:

- Introduction: Give a brief idea about the Public Distribution System (PDS) and its objectives.
- Body: Mention the challenges of PDS
 - Mention how PDS can be made effective and transparent.
- Conclusion: Give appropriate conclusion in this regard (whatever we have discussed in the body)

Introduction:

- The Public Distribution System (PDS) in India is a critical component of the government's strategy to ensure food security and mitigate hunger and malnutrition among the country's vulnerable populations.
- Through a network of fair price shops, the PDS distributes subsidized food grains and essential commodities to millions of households.
- **PDS is being implemented under the National Food Security Act (NFSA), 2013 in all States/UTs. The Act provides for coverage of up to 75% of the rural population and up to 50% of the urban population for receiving food grains (rice, wheat & coarse grains) at highly subsidized rates i.e. Rs. 3/2/1 per kg respectively.**

Major Challenges of the Public Distribution System

- **Leakages and Diversion:** A significant portion of the subsidized food grains intended for the poor is siphoned off due to corruption and inefficiencies. These leakages occur at various stages, from procurement to distribution, with some estimates suggesting that up to 36% of the food grains are diverted to the open market or lost during transit.
- **Identification and Targeting Issues:** The process of identifying and targeting eligible beneficiaries is fraught with errors and exclusions. Many deserving households, particularly among the rural poor and marginalized communities, do not possess ration cards or are wrongly excluded from the beneficiary lists.
 - A report by Global call to Action against poverty found that more than 90 million eligible people have been excluded from legal entitlements under the Targeted Public Distribution System (TDPS).
- **Inadequate Infrastructure:** Many fair price shops, particularly in remote and rural areas, suffer from poor infrastructure, including lack of proper storage facilities, irregular supply, and inadequate staffing.
 - In 2020-21, the buffer stocks amounted to 97.2 million tonnes, 143 per cent higher than the norm. This leading to inadequate storage facilities, highlighted by CAG audits time and again

Measures to Make PDS Effective and Transparent

- **Decrease subsidy burden on government:** In order to increase the effectiveness of PDS, the Economic Survey suggested limiting the scope of PDS to the bottom 40% of the population and decreasing the subsidy burden on the government.
- **One Nation One Ration Card Scheme:** This would help the migrant population access the benefits of PDS and reduce the exclusion errors.
- **Digitalisation:** States such as Chhattisgarh and Madhya Pradesh have implemented IT measures to streamline TPDS, through the digitisation of ration cards, the use of GPS tracking of delivery, and the use of SMS based monitoring by citizens. Use of Aadhaar helps prevent duplication and provides for better authentication.

The Justice Wadhwa Committee Report for PDS (2011) recommended computerization to prevent diversion and to allow for safe identification at ration stores.

- **Direct Cash Transfers:** The Government is asking States/UTs to choose Direct Benefit Transfer (DBT) in order to check leakage and diversions.
- **Universal PDS:** Tamil Nadu implements a universal PDS, such that every household is entitled to subsidised food grains. This way, inclusion and exclusion errors are reduced.
- **Improving storage capacities:** Shanta Kumar Committee recommended private participation in storage and distribution to make the system effective. In line with this recommendation, storages are built by private investors and contracted by FCI for a guaranteed duration of 10 years under the Private Entrepreneur Guarantee (PEG) Scheme.

Conclusion

- The Public Distribution System in India faces significant challenges that undermine its effectiveness in ensuring food security for the poor. By implementing measures such as Direct cash transfer, computerization, improved infrastructure, and robust grievance redressal mechanisms, the PDS can be made more effective and transparent. These reforms are essential to enhance the credibility and efficiency of the system, ensuring that the benefits reach those who need them the most.

4) Elaborate the scope and significance of the food processing industry in India.

Structure:

- Introduction: Role of Food Processing Industry
- Scope of the Food Processing Industry
- Significance of the Food Processing Industry
- Conclusion

Introduction

- The food processing industry plays a pivotal role in the economic landscape of India, contributing significantly to agricultural development, employment generation, and the overall growth of the nation's economy. With its vast agricultural resources and diverse culinary heritage, India presents a promising landscape for food processing activities.
- It serves as a vital link between farm and fork, with the potential to generate employment, reduce wastage, enhance farmer income, and promote exports.
- The Indian food sector ranks fifth in terms of scale, contributing almost 6% of GDP, 13% of Indian exports, and 6% of overall industrial investment in the country.
- The Indian food and grocery market is the world's sixth largest, with retail contributing 70 per cent of the sales.

Scope of the Food Processing Industry

- **Agricultural Inputs:** India's agricultural sector serves as the backbone of the food processing industry, providing a rich and diverse range of raw materials. The country is one of the world's largest producers of grains, fruits, vegetables, dairy products, and spices. For instance, India is the largest producer of milk, pulses, and spices globally and ranks among the top producers of fruits and vegetables.
- According to the Ministry of Agriculture & Farmers' Welfare, Government of India, the **total food grain production in the country during the 2020-21 crop year stood at 305.44 million tonnes**, with significant contributions from crops like rice, wheat, maize, and pulses.
- **Processing Technologies:** Advancements in processing technologies have revolutionized the food processing industry, enabling efficient handling, preservation, and transformation of agricultural produce. Modern techniques such as cold storage, dehydration, canning, and freeze-drying have extended the shelf life of perishable commodities and expanded the range of value-added products.
 - **Example:** The adoption of solar-powered cold storage units in rural areas has facilitated the preservation of fruits and vegetables, reduced post-harvest losses and improved market access for farmers.

- **Product Diversification:** The food processing industry in India offers a wide array of processed foods to cater to diverse consumer preferences. From traditional staples like rice and wheat products to innovative snacks, beverages, and ready-to-eat meals, the market encompasses a vast range of products.
 - **Example:** Companies like Haldiram's, Britannia Industries, and Nestlé India have introduced innovative products tailored to Indian tastes, such as flavoured milk, ethnic snacks, and fortified cereals.
- **Value Addition:** Food processing adds significant value to agricultural commodities by enhancing their quality, nutritional content, and marketability. Value-added products command higher prices in domestic and international markets, thereby increasing farmers' incomes and contributing to rural development.
 - **Example:** The production of branded and packaged dairy products like cheese, yogurt, and flavoured milk has created new market opportunities for dairy farmers, encouraging investment in dairy infrastructure and technology.
- **Export Potential:** Processed food products from India have substantial export potential, driven by the country's rich culinary heritage and the growing demand for ethnic and organic foods in global markets. Indian food products are known for their unique flavours, aromas, and nutritional profiles, making them popular among international consumers.
- According to the Agricultural and Processed Food Products Export Development Authority (APEDA), India's exports of processed food products during the fiscal year 2020-21 amounted to USD 26.51 billion, with major export items including marine products, basmati rice, spices, and processed fruits and vegetables.

Significance of the Food Processing Industry

- **Employment Generation:** The food processing industry is a significant source of employment, particularly in rural areas where agricultural activities are predominant. It provides opportunities for skilled and unskilled labour across various stages of food production, processing, and distribution, thus contributing to poverty alleviation and inclusive growth.
- According to the National Statistical Office (NSO), the food processing sector employed over 7.68 million people in 2019-20, accounting for approximately 9% of total manufacturing employment in the country.
- **Value Chain Integration:** By linking farmers to consumers through processing and distribution networks, the food processing industry facilitates value chain integration. This integration ensures fair prices for farmers' produce, reduces post-harvest losses, improves supply chain efficiency, and enhances food security and availability.
- Initiatives like the Pradhan Mantri Kisan SAMPADA Yojana aim to strengthen the agri-food value chain by investing in infrastructure, technology, and logistics, thereby benefiting farmers, processors, and consumers alike.

- Foreign Direct Investment (FDI): India's liberalized policy framework and favourable investment climate have attracted significant FDI inflows into the food processing sector. Foreign investments contribute to technology transfer, infrastructure development, and capacity building, fostering innovation and competitiveness within the industry.
- According to the Department for Promotion of Industry and Internal Trade (DPIIT), cumulative FDI inflows into the food processing sector from April 2000 to September 2021 amounted to USD 12.73 billion.
- **Nutritional Security:** Processed food products play a crucial role in addressing nutritional deficiencies and promoting public health. Fortification, enrichment, and diversification of food products enhance their nutritional quality and contribute to dietary diversity, thereby improving the nutritional status of the population.
- The government's Integrated Child Development Services (ICDS) program includes the provision of nutrient-rich supplementary foods to pregnant women and children, emphasizing the importance of fortified foods in combating malnutrition.
- **Environmental Sustainability:** Sustainable practices in food processing, such as waste minimization, energy efficiency, and eco-friendly packaging, contribute to environmental conservation and resource optimization. The adoption of green technologies and eco-certifications enhances the industry's sustainability credentials and aligns with global trends towards responsible consumption and production.
 - **Example:** The use of biodegradable packaging materials, energy-efficient processing equipment, and waste-to-energy technologies in food processing plants reduces environmental impact and promotes sustainable development.

Conclusion

- The food processing industry in India plays a multifaceted role in driving economic growth, promoting rural development, ensuring food security, and enhancing nutritional outcomes. With its vast scope, diverse product range, and significant contributions to employment generation and value addition, the industry occupies a central position in India's agrifood system.
- By harnessing its strengths and addressing its limitations, India can leverage the transformative power of the food processing industry to build a resilient and inclusive food system that meets the evolving needs of its population while contributing to global food security and sustainable development goals.

5) Economic growth in the recent past has been led by increase in labour productivity. Explain this statement. Suggest the growth pattern that will lead to creation of more jobs without compromising labour productivity.

Structure:

- Introduction: Labour productivity
- Body:
 - Economic Growth Led by Labor Activity
 - Suggested Growth Pattern for Job Creation and Labor Productivity
- Conclusion

Introduction

- Labour productivity, defined as output per worker or per hour worked, is a key driver of economic growth. In the past few years, especially post-COVID recovery phase (2021–2024), India has witnessed economic growth that was disproportionately driven by increased labour productivity rather than employment expansion.

Economic Growth Led by Labor Activity:

- **Service Sector Dominance:** The services sector, which includes IT, retail, hospitality, and logistics, has been a major contributor to India's GDP growth. As of 2023, the services sector accounted for around 54% of India's GDP and employed about 31% of the workforce. The sector's growth has been driven by high labor participation, particularly in areas like retail and hospitality, which are labor-intensive.
- **Manufacturing Sector:** The manufacturing sector, which contributes about 16-17% of GDP, has also seen growth through labor-intensive industries like textiles, apparel, and food processing. The "Make in India" initiative has aimed to boost manufacturing and create jobs, leading to increased labor activity in this sector.
- **Increased Participation:** India's labor force participation rate (LFPR) has shown signs of recovery, reaching around 42.5% in 2023, up from 40.3% in 2020. This increase has been driven by the gradual recovery of the economy post-pandemic and the expansion of employment opportunities in labor-intensive sectors.
- **Employment Growth:** According to the Periodic Labour Force Survey (PLFS) 2022-23, the unemployment rate dropped to 7.2%, indicating an improvement in job creation. However, a significant portion of this employment has been in the informal sector, where productivity and wages are typically lower.

Suggested Growth Pattern for Job Creation and Labor Productivity:

- **Enhancing Skills for High-Productivity Jobs:** To improve labor productivity, India must invest in skill development, particularly in emerging sectors such as technology, renewable energy, and advanced manufacturing. The Skill India Mission, which aims to train 400 million people by 2024, is crucial in this regard.
- **Vocational Training and Education:** Expanding vocational training and education can help workers transition from low-productivity jobs to higher-productivity sectors. This requires collaboration between industry and educational institutions to align curricula with market needs.
- **Digital Economy:** The expansion of the digital economy offers opportunities for job creation in high-productivity sectors like IT services, e-commerce, and fintech. As of 2023, India's digital economy was valued at \$300 billion, with the potential to grow further with supportive policies and infrastructure.
- **Reducing Informality:** Formalizing the labor market by extending social security, improving labor laws, and encouraging formal employment contracts can help enhance labor productivity and job quality. The implementation of the Code on Wages 2019 and other labor reforms are steps in this direction.
- **Rural and Agricultural Development:** Enhancing productivity in agriculture through better technology, irrigation, and market access can lead to higher incomes and job creation in rural areas, reducing migration to cities and balancing economic growth

Conclusion:

- India's recent economic growth has been significantly driven by increased labor activity, particularly in labor-intensive sectors. However, this growth pattern has also highlighted challenges such as low productivity, income inequality, and the dominance of informal employment. To create more jobs without compromising labor productivity, India needs to focus on skill development, technological innovation, formalization of the labor market, and sectoral diversification.
- By adopting this balanced growth pattern, India can ensure sustainable and inclusive economic growth, benefiting all sections of society

6) Do you think India will meet 50 percent of its energy needs from renewable energy by 2030? Justify your answer. How will the shift of subsidies from fossil fuels to renewables help achieve the above objective? Explain.

Structure:

- Introduction: Introduce with renewable energy goals
- Body:
 - Feasibility of India Meeting Renewable Energy Target
 - Role of Shifting Subsidies from Fossil Fuels to Renewables
- Conclusion

Introduction

- India's ambitious target of meeting 50 percent of its energy needs from renewable sources by 2030 underscores the country's commitment to sustainable development and combating climate change.
- Achieving this goal requires a comprehensive strategy that addresses the challenges of renewable energy deployment while leveraging the benefits of shifting subsidies from fossil fuels to renewables.
- India has set an ambitious target of reaching the net zero emission levels by 2070. India has also proposed a five-point strategy (**PanchAmrit**), which includes meeting 50% of its yearly energy demand, which is 500 GW, from renewable resources by 2030. This is the world's largest expansion plan in renewable energy.

Feasibility of India Meeting Renewable Energy Targets

Current Progress

- India stands 4th globally in Renewable Energy Installed Capacity (including Large Hydro), 4th in Wind Power capacity & 4th in Solar Power capacity (as per REN21 Renewables 2022 Global Status Report). The country has set an enhanced target at the COP26 of 500 GW of non-fossil fuel-based energy by 2030.
- India has 424 GW of power generation capacity which includes around 180 GW from non-fossil fuels and another 88 GW is in the works. The country has a target of 500 GW of renewable energy capacity by 2030. "
- The Central Electricity Authority forecasts the country's reliance on coal to drop from 53% of installed capacity in 2021 to 33% in 2030, whereas solar and wind together make up 51% by then, up from 23% in 2021.

Policy Support:

- The Indian government has implemented various policies and initiatives to promote renewable energy development and achieve its targets. These include the National Solar Mission, National Wind Energy Mission, and various state-level renewable energy policies and incentives.
- The Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM-KUSUM) scheme aims to promote solar energy adoption among farmers by providing subsidies for solar pump installations, solarization of grid-connected pumps, and solar power plants on barren or fallow land.
- **Technological Advancements:** Technological advancements in renewable energy technologies, particularly solar and wind power, have significantly reduced costs and improved efficiency. India has emerged as a global leader in renewable energy auctions, with record-low tariffs for solar and wind power projects.
- The Rewa Solar Park in Madhya Pradesh, one of the world's largest solar parks, achieved a record-low tariff of INR 2.97 per kWh in 2017, demonstrating the competitiveness of solar energy in India.
- **Grid Integration and Infrastructure:** Grid integration remains a challenge for renewable energy deployment due to intermittency and variability of renewable energy sources. However, India has made significant investments in grid infrastructure, including the Green Energy Corridors project, to facilitate the integration of renewable energy into the grid.
 - **Example:** The Green Energy Corridors project aims to strengthen interstate transmission infrastructure and establish renewable energy management centres to facilitate the smooth integration of renewable energy into the grid.

Role of Shifting Subsidies from Fossil Fuels to Renewables

- **Alignment with Climate Goals:** Shifting subsidies from fossil fuels to renewables is essential to align India's energy policies with its climate goals and commitments under the Paris Agreement. Fossil fuel subsidies perpetuate dependence on polluting energy sources and hinder the transition to clean and sustainable energy systems.
 - **Example:** The Kerosene Subsidy Reforms initiated by the Indian government aim to reduce kerosene subsidies and promote the adoption of cleaner cooking fuels such as liquefied petroleum gas (LPG) and biogas.
- **Promotion of Renewable Energy Deployment:** Redirecting subsidies from fossil fuels to renewables can stimulate investment, deployment, and adoption of renewable energy technologies. Subsidy support for renewable energy projects can reduce investment risks, lower financing costs, and enhance market competitiveness.
 - **Example:** The Accelerated Depreciation (AD) benefit and Generation-Based Incentive (GBI) schemes introduced by the Indian government provide tax incentives and financial support to promote investment in renewable energy projects.



- **Economic and Social Benefits:** Shifting subsidies to renewables can generate significant economic and social benefits, including job creation, improved energy access, and enhanced economic competitiveness. Renewable energy industries have the potential to create millions of jobs across the value chain, from manufacturing and installation to operation and maintenance. **Example:** The Atal Jyoti Yojana (AJAY) scheme aims to provide solar-powered LED lanterns to rural households without access to electricity, thereby promoting energy access and reducing reliance on fossil fuels for lighting.
- **Environmental Sustainability:** Redirecting subsidies to renewables can contribute to environmental sustainability by reducing greenhouse gas emissions, air pollution, and environmental degradation associated with fossil fuel combustion. Renewable energy sources such as solar, wind, and hydropower produce minimal emissions and pollutants. **Example:** The Pradhan Mantri Ujjwala Yojana (PMUY) scheme aims to provide clean cooking fuel (LPG) to poor households, thereby reducing indoor air pollution, respiratory diseases, and deforestation associated with traditional biomass cooking fuels.

Conclusion

- India's target of meeting 50 percent of its energy needs from renewable sources by 2030 is ambitious but achievable with the right policies, investments, and incentives. The country has made significant progress in renewable energy deployment, driven by favourable government policies, technological advancements, and declining costs of renewable technologies.
- Shifting subsidies from fossil fuels to renewables is crucial to accelerate India's transition to a clean, sustainable, and resilient energy system. Redirecting subsidies can align energy policies with climate goals, promote renewable energy deployment, stimulate economic growth, and enhance environmental sustainability. Government policies and initiatives play a vital role in facilitating this transition and ensuring a sustainable energy future for India.

7) What are the main bottlenecks in upstream and downstream process of marketing of agricultural products in India?

Structure:

- Introduction- Define agri-marketing and the meaning of upstream and downstream processes.
- Body: - Mention main bottlenecks (issues) in both the upstream and downstream agricultural marketing.
- Conclusion- summary of the answer

Introduction

- The marketing of agricultural products in India faces significant challenges in both upstream (pre-production and production) and downstream (post-production and distribution) processes.
- These bottlenecks hinder the efficient flow of goods from farms to consumers, affecting farmers' incomes and market stability. Addressing these issues is crucial for enhancing the agricultural sector's performance and ensuring better returns for farmers.

Bottlenecks in the upstream process of marketing of agricultural products in India

- **Inadequate Infrastructure:** The lack of **proper storage facilities, cold chains, and transportation infrastructure** leads to significant **post-harvest losses, estimated at around 16% of total produce annually**. This affects the quality and marketability of agricultural products.
- **Limited Access to Quality Inputs:** Farmers often face difficulties in accessing **high-quality seeds, fertilizers, and pesticides, affecting crop productivity and quality**. Additionally, the high cost of inputs can be prohibitive for small and marginal farmers.
- **Financial Constraints:** Limited access to credit and financial services hampers farmers' ability to invest in modern technologies and practices. **High-interest rates and complex loan processes further exacerbate this issue.**
- **Lack of Extension Services:** Insufficient agricultural extension services result in a knowledge gap among farmers regarding **best practices, pest management, and market trends**. This reduces their ability to produce high-quality, market-ready products.
- **Presence of Middlemen:** The involvement of a large number of intermediaries in the agricultural supply chain reduces the share of farmers in the final price of their produce and leads to inefficiencies.

Bottlenecks in the downstream process of marketing of agricultural products in India

- **Market Access and Information:** Farmers often lack direct access to markets and reliable market information, leading to dependence on intermediaries who capture a significant share of profits. This reduces farmers' bargaining power and earnings.
- **Inefficient Supply Chains:** Fragmented and inefficient supply chains increase transaction costs and reduce the profitability of agricultural marketing. Multiple intermediaries and poor logistics contribute to delays and spoilage.
- **Market Infrastructure:** The absence of well-developed market infrastructure, such as wholesale markets, grading and sorting facilities, and digital platforms, limits farmers' ability to sell directly to consumers or processors.
- **Price Volatility:** Frequent price fluctuations due to demand-supply mismatches, inadequate market linkages, and speculative trading impact farmers' incomes and market stability. For example, tomato prices have fluctuated wildly in recent years, impacting both producers and consumers.

According to a 2023 report by the National Bank for Agriculture and Rural Development (NABARD), post-harvest losses in India are estimated to be worth over ₹90,000 crore annually due to inadequate infrastructure. The e-NAM (National Agriculture Market) initiative aims to address some of these issues by creating a unified national market for agricultural commodities. However, its implementation has faced challenges due to lack of awareness and infrastructure gaps at the local level.

Conclusion

- Addressing the bottlenecks in the upstream and downstream processes of agricultural marketing in India requires a multifaceted approach, including infrastructure development, policy reforms, and enhanced market access. By tackling these challenges, India can ensure better returns for farmers, reduce post-harvest losses, and create a more efficient and resilient agricultural sector.

8) What is Integrated Farming System? How is it helpful to small and marginal farmers in India?

Structure:

- Introduction-Define Integrated Farming System
- Body- Mention some of the features of Integrated Farming System and Give pointers as to how it is helpful specifically to small and marginal farmers.
- Conclusion-summary of the answer

Introduction

- Integrated Farming System (IFS) is a holistic agricultural approach that combines different agricultural activities like cropping, livestock, aquaculture, agroforestry, and horticulture to achieve sustainable and profitable farming. By integrating various components, IFS aims to optimize resource use, improve productivity, and ensure environmental sustainability.
- This approach is particularly beneficial for small and marginal farmers in India, who often face challenges like limited land, water scarcity, and financial constraints.

Advantages Of Integrated Farming System (IFS) to small and marginal farmers in India:

- **Better yields:** Studies have shown that adoption of IFS has maintained high yields or increased yields in most of the components involved when compared to a single-siloed approach. **For example**, beekeeping can increase pollination and yield some crops, such as mustard.
- **Higher remuneration for farmers:** IFS offers better remuneration for farmers on the same land size. For example, when a farmer grows a crop along with the integration of fish and goats, he stands to gain as much as three times the remuneration he would have gotten when the crop alone is grown. Hence, IFS can help double farmers' income.
- **Ensuring food security along with nutritional security:** IFS can not only ensure food security by maintaining high yields and increased calories produced per hectare but also contribute towards nutritional security by offering many diverse dietary options such as **meat, fish, milk, and grains**.
- **Recycling and reduction of waste:** It can reduce overall waste at the farm level as waste is recycled and put to use for other components. This forms a cycle where very little waste is generated.
- **Use of waste land:** For IFS, fallow waste land can be utilised by choosing appropriate components such as **fish + poultry + livestock** etc. that do not require fertile land to operate.

- **Employment generation:** an integrated system such as IFS can generate gainful employment for the local unemployed population, as three or more components can require more man-days of work. Thus, improving the standard of living not only for the landholders but also for the surrounding community.
- **Environment protection and climate change mitigation:** With effective waste recycling, nutrients in the soil can be restored and thus help in maintaining soil fertility. Reduced usage of chemical fertilisers and other farm inputs eliminates associated pollution, thus helping preserve the environment. **Also, the overall system produces fewer Greenhouse Gases (GHGs) and a smaller carbon footprint. Hence, IFS can be important for Climate Change mitigation.**

Government Schemes for Promotion of Integrated Farming System

- **National Mission for Sustainable Agriculture:** It is part of the **Sustainable Agriculture Mission**, one of the eight missions under the **National Action Plan on Climate Change (NAPCC)**. It promotes sustainable agriculture through its various key dimensions. The Integrated Farming System is promoted through this Mission by offering assistance and subsidies to set up Crop-based IFS or Livestock-based IFS. NMSA has the following components:
 - **Rainfed Area Development (RAD):** It promotes IFS by encouraging multi-cropping, inter cropping, rotational cropping, etc.
 - **Soil Health Management (SHM):** Promotes sustainable soil health management that is crop and location specific.
- **National Horticulture Mission (NHM) and Horticulture Mission for Northeast and Himalayan States (HMNEH):** Both are sub-scheme of **Mission Integrated Development of Horticulture (MIDH)**. They provide various support and assistance for setting up orchards, beekeeping, bamboo farms, etc. under various sub-missions. **MIDH is a centrally sponsored scheme with 60:40 fund sharing between the central and state governments. (90:10 split for Northeastern and Himalayan states)**
- **Pradhan Mantri Matsya Sampada Yojna:** promotion of sustainable fisheries for enhancing farmers income. It promotes modern fishing technologies such as **recirculatory aquaculture systems, biofloc, aquaponics, cage farming etc.**

Conclusion

- Integrated Farming System offers a viable solution for small and marginal farmers in India by optimizing resource use, diversifying income sources, promoting sustainability, and ensuring financial and food security. Through successful examples and government initiatives, IFS demonstrates its potential to transform the agricultural landscape, making farming more resilient and profitable for those with limited means.

Science & Tech

9) The increase in life expectancy in the country has led to newer health challenges in the community. What are those challenges and what steps need to be taken to meet them?

Introduction

- The global increase in life expectancy is one of the most significant achievements of modern society, driven by advancements in **healthcare, sanitation, and living standards**. However, this demographic shift brings forth a new set of health challenges, particularly in countries like India, where the population is aging rapidly.

Life expectancy rate, also known as life expectancy at birth, is a statistical measure that represents the average number of years a person is expected to live from birth based on current mortality rates. It is an important indicator of the overall health and well-being of a population.

According to the United Nations Population Division, global life expectancy at birth for both sexes has improved from 46.5 years in 1950 to 71.7 years in 2022 and is expected to rise to 77.3 by 2050.

The life expectancy for India in 2023 was 70.42 years, a 0.33% increase from 2022.

UN estimate- India's life expectancy in 1950 was 35.21 and it will be 81.96 in the year 2100

Challenges Arising from Increased Life Expectancy

Non-Communicable Diseases (NCDs)

- With longer life expectancy, there is a higher prevalence of non-communicable diseases (NCDs) such as cardiovascular diseases, **cancer, diabetes, and chronic respiratory diseases**.
- According to the World Health Organization (WHO), **NCDs account for approximately 63% of all deaths in India**. For instance, the incidence of diabetes has been steadily rising, with an estimated **77 million diabetic individuals in India as of 2019**.
- **Age-Related Health Conditions**
- Aging is often accompanied by a range of age-related health conditions, including **dementia, osteoporosis, arthritis, and sensory impairments**. The prevalence of these conditions increases with age, leading to greater healthcare needs and challenges in providing long-term care and support.

Mental Health Issue

- Longer life expectancy also correlates with an increased risk of mental health issues among the elderly population. **Depression, anxiety, and cognitive decline are common mental health challenges faced by older adults.**
- The National Mental Health Survey of India 2015-16 reported a high prevalence of depression among the elderly, with rates ranging from 14.4% to 26.3%.
- **Social Isolation and Loneliness**
- Aging populations are vulnerable to social isolation and loneliness, particularly as they face life transitions such as retirement, loss of spouse, or physical limitations.
- A study conducted by **HelpAge India** found that **35% of elderly respondents reported feeling lonely often or always, highlighting the need for social support and community engagement initiatives.**

Steps to Address These Challenge

Strengthen Geriatric Healthcare:

- Expand programs like National Programme for Health Care of the Elderly (NPHCE).
- Establish geriatric OPDs, wards, and mobile health units in all districts.

Training and Human Resource Development:

- Train more **geriatric specialists**, nurses, and ASHA workers in elderly care.
- Integrate geriatric care modules in **medical and nursing education.**

Mental Health Integration:

- Mainstream elderly mental health in District Mental Health Programme (DMHP).
- Promote social engagement through community centers and day-care services.

Financial and Social Support:

- Strengthen pension schemes like National Social Assistance Programme (NSAP).
- Introduce long-term care insurance for chronic illness and disability.

Conclusion

- The increase in life expectancy presents both opportunities and challenges for societies worldwide, requiring comprehensive strategies to address the diverse health and social needs of aging populations.

- By prioritizing preventive healthcare, strengthening healthcare systems, promoting social inclusion, and enhancing financial security for the elderly, governments, communities, and healthcare providers can effectively mitigate the adverse effects of aging and ensure a dignified and fulfilling life for older adults. Through collaborative efforts and targeted interventions, we can build age-friendly societies that celebrate the contributions and resilience of older individuals while safeguarding their health, well-being, and rights.

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10) Launched on 25th December, 2021, James Webb Space Telescope has been much in the news since then. What are its unique features which make it superior to its predecessor Space Telescopes? What are the key goals of this mission? What potential benefits does it hold for the human race?

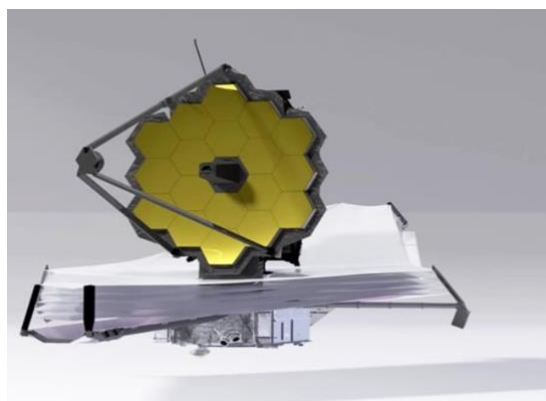
Approach:

- **Introduction:** Introduce James Webb telescope.
- **Body:**
 - Discuss features of James Webb vis-à-vis Hubble telescope (its predecessor).
 - Stress on the utility of these features of JWST
 - Mention key goals of JWST.
 - Highlight the potential benefits it holds for the human race.
- **Conclusion:** Summarise the answer.

Answer:

Introduction:

- The James Webb Space Telescope (JWST) is a powerful infrared space telescope that was launched in 2021. It is the largest and most powerful telescope ever built, and it is expected to revolutionize our understanding of the universe.



Unique Features of JWST Compared to Earlier Space Telescopes:

Infrared Vision

- Unlike Hubble, which observes primarily in visible and ultraviolet light, JWST is optimized for the infrared spectrum.
- Allows it to see distant galaxies, exoplanets, and stellar nurseries through cosmic dust clouds.

Advanced Cooling System

- Operates at -233°C using a large sunshield and active cooling.

- This is essential for detecting faint heat signatures from deep space, especially in infrared astronomy.

Larger Mirror Size

- JWST has a 6.5-meter segmented gold-coated mirror, compared to Hubble's 2.4-meter mirror.
- Collects more light, enabling it to observe fainter and more distant objects.

Greater Look-Back Time

- JWST can observe light from galaxies formed just 200 million years after the Big Bang.
- Enables exploration of early universe formation and evolution.

Location at L2 Lagrange Point

- Positioned about 1.5 million km from Earth at the L2 point, reducing interference from Earth's light and heat.
- Provides a stable, cold environment for deep-space observation.

Key Goals of the JWST Mission:

- **Observing the Early Universe:** It will study the universe's infancy around 13.5 billion years ago and probe the formation of the first galaxies, stars and planetary systems.
- **Studying Exoplanets:** It will also investigate the atmospheres of exoplanets and search for signs of habitability or even life beyond our solar system.
- **Understanding Star Formation and Stellar Evolution:** It will shed light on the processes of star formation and the life cycles of stars, enhancing our understanding of how stars and planetary systems come into being and evolve.
- **Probing Galaxy Evolution:** It will provide insights into the evolution of galaxies over cosmic time, aiding in unravelling the complex processes that have shaped our universe over billions of years.

Potential Benefits for Humanity:

- **Scientific Discoveries** in various fields of astronomy and astrophysics which will push the boundaries of our knowledge about the universe.
- **Advancements in technological and engineering fields** that can find applications in other scientific domains and industries.
- As a successor to the Hubble Space Telescope, it will **inspire future generations** of scientists, engineers, and the general public. It will foster their **interest in STEM fields** and space exploration.
- It will **boost confidence** in the capabilities of large-scale space observatories, setting the stage for future space telescopes and planetary exploration missions.

Conclusion:

- The James Webb Space Telescope's unique features, scientific objectives, and potential benefits for humanity position it as a game-changing observatory. Its ability to peer into the universe's infrared realms promise to revolutionize our understanding of the cosmos. India should also actively participate in such international partnerships to position itself as a prospective space player in the years to come.

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11) What is the basic principle behind vaccine development? How do vaccines work? What approaches were adopted by the Indian vaccine manufacturers to produce COVID-19 vaccines?

Approach

- Introduction- give brief explanation of vaccine and its significance
- Body- discuss about the working of vaccine and approach adopted by India along with examples
- Conclusion- Conclude by highlighting the importance and effectiveness of vaccines in controlling and preventing infectious diseases, with a special emphasis on the role of Indian vaccine manufacturers during the COVID-19 pandemic.

Introduction

- The basic principle of vaccination is "memory" of the immune system. Vaccines let the immune system to learn how to fight the future onslaught of that pathogen for which vaccine is being given.
- The body prepares antibodies in response to vaccination and remembers this act. When the related pathogen attacks in the future, the immune system uses its "memory" to fight the infection.

Working

- Vaccines contain **weakened or inactive parts of a particular organism (antigen)** that **triggers an immune response within the body**. Newer vaccines contain the **blueprint for producing antigens rather than the antigen itself**. Regardless of whether the vaccine is made up of the antigen itself or the blueprint so that the body will produce the antigen, this weakened version will not cause the disease in the person receiving the vaccine, but it will prompt their immune system to respond much as it would have on its first reaction to the actual pathogen.
- Some vaccines require multiple doses, given weeks or months apart. This is sometimes needed to allow for the **production of long-lived antibodies and development of memory cells**. In this way, the body is trained to fight the specific disease-causing organism, building up memory of the pathogen so as to rapidly fight it if and when exposed in the future.

Approaches were adopted by the Indian vaccine manufacturers

During the COVID-19 pandemic, Indian pharmaceutical companies adopted various strategies to develop vaccines using both global and indigenous technologies.

- **Covaxin**, developed by Bharat Biotech in collaboration with ICMR, is an **inactivated virus vaccine**. It uses a killed SARS-CoV-2 virus that cannot cause disease but can still trigger an immune response. It follows a traditional and time-tested method and is stored at 2–8°C.
- **Covishield**, produced by the Serum Institute of India in partnership with Oxford-AstraZeneca, is a **viral vector vaccine**. It uses a modified chimpanzee adenovirus (ChAdOx1) to deliver the genetic code for the SARS-CoV-2 spike protein, prompting the body to generate an immune response. It also requires storage at 2–8°C.
- **ZyCoV-D**, developed by Zydus Cadila, is India's first **DNA-based vaccine**. It introduces plasmid DNA encoding the spike protein into the body, which cells then use to produce the protein and trigger immunity. It is also notable for being the world's first **needle-free DNA vaccine**, with storage requirements of 2–8°C.
- **Sputnik V**, manufactured under license in India by Dr. Reddy's Laboratories, is a **viral vector vaccine** that uses two different human adenoviruses (Ad26 and Ad5) in two separate doses to deliver the spike protein gene. Initially, it required ultra-cold storage at -18°C, but later formulations allowed storage at 2–8°C.
- **Corbevax**, produced by Biological E Ltd., is a **protein subunit vaccine** that contains recombinant spike protein fragments. This approach trains the immune system without exposing it to the entire virus and is also stored at 2–8°C.

Environment

12) Each year a large amount of plant material, cellulose, is deposited on the surface of Planet Earth. What are the natural processes this cellulose undergoes before yielding carbon dioxide, water and other end products?

Introduction

- Cellulose, a complex organic compound, is the most abundant biomass component, **making up approximately 50% of plant cell walls**.
- Annually, a vast amount of cellulose is deposited on Earth's surface through **plant litter**, accounting for **around 60 billion metric tons of carbon** (Huang et al., 2018).
- This cellulose **undergoes natural processes**, ultimately yielding carbon dioxide, water, and other end products.

Natural Processes

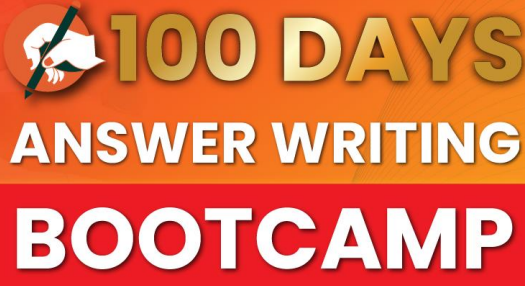
- **Fragmentation**
 - Physical breakdown of cellulose into smaller particles occurs through **weathering (e.g., wind, water, temperature fluctuations)**.
 - Animals like **insects, rodents, and decomposer organisms** like earthworms contribute to fragmentation.
 - Microbial activity also plays a role in breaking down cellulose.
- **Hydrolysis**
 - Microorganisms like **bacteria (e.g., Cellulomonas, Clostridium) and fungi (e.g., Trichoderma, Aspergillus)** secrete enzymes called cellulases.
 - Cellulases break down cellulose into simpler sugars like **glucose, cellobiose, and cellotriase**.
 - Hydrolysis occurs extracellularly, with enzymes breaking down cellulose outside the microbial cells.
- **Fermentation**
 - Microbes convert sugars from hydrolysis into volatile fatty acids (VFAs), alcohols, and gases like CO₂ and CH₄.
 - Fermentation occurs in anaerobic environments, like soil, sediments, or the guts of animals.
 - Microbes **like Ruminococcus, Fibrobacter, and Clostridium dominate fermentation processes**.
- **Humification**
 - Residual organic matter is transformed into humus, a stable and complex organic substance.
 - Humus is rich in aromatic compounds, fulvic and humic acids, and other recalcitrant molecules.

- **Humification** occurs through abiotic and biotic processes, like oxidation, condensation, and microbial activity.
- **Mineralization**
 - Microbes ultimately convert humus into **CO₂**, water (**H₂O**), and nutrients like **nitrogen (N)**, **phosphorus (P)**, and **potassium (K)**.
 - Mineralization occurs in both aerobic and anaerobic environments.
 - Nutrients are released back into the ecosystem, available for plant uptake and microbial growth.

These processes are **interconnected and influenced** by factors like temperature, moisture, oxygen availability, and microbial community composition.

Conclusion

- The decomposition of cellulose is a crucial part of the global carbon cycle.
- It ensures:
 - Nutrient recycling
 - Soil fertility
- **Atmospheric carbon balance**



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13) Discuss in detail the photochemical smog emphasizing its formation, effects and mitigation. Explain the 1999 Gothenburg protocol.

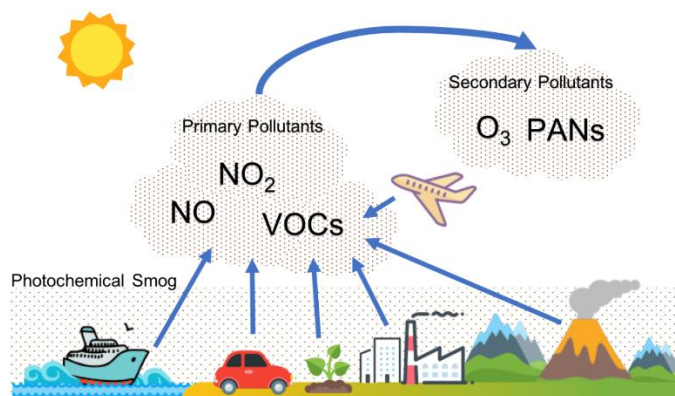
Introduction

- Photochemical smog, commonly referred to as "**summer smog**," is a significant air pollution issue resulting from the chemical reactions between **sunlight** and pollutants such as **nitrogen oxides (NO_x)** and **volatile organic compounds (VOCs)**.
- It is characterised by a **hazy, brownish-grey colour** and primarily affects urban areas with **high traffic** and industrial activities.

Formation

Conditions Favouring Smog Formation:

- **High temperatures:** Accelerate the chemical reactions.
- **Stagnant air:** Lack of wind allows pollutants to accumulate.
- **Urban areas:** High traffic and industrial activities increase the concentration of primary pollutants.



Effects

Health Impacts

- **Respiratory Problems:** Causes irritation of the respiratory system, exacerbates asthma, bronchitis, and other lung diseases.
- **Eye Irritation:** Leads to burning and irritation of the eyes.
- **Potential Long-term Health Effects:** Chronic respiratory diseases, reduced lung function, and cardiovascular issues

Environmental Impacts

- **Plant Damage:** Reduces photosynthesis, damages leaves, and affects crop yields. Ozone, a key component of photochemical smog, can penetrate plant leaves through the stomata and interfere with the photosynthetic process. This reduces the ability of plants to produce food and grow.



- In California's Central Valley, ozone pollution has been shown to reduce the growth and yield of crops like soybean, wheat, and cotton.
- **Ecosystem Disruption:** Harmful effects on wildlife, particularly in water bodies where ozone can dissolve. It can also effect wildlife, particularly those that rely on sensitive habitats or have specific respiratory and metabolic needs.
 - Amphibians, such as frogs and salamanders, are particularly vulnerable to ozone pollution as it can impair their respiratory systems and reduce their reproductive success.

Mitigation

- **Emission Control**
 - Vehicle Emission Standards
 - Industrial Emission Regulations
- **Alternative Fuels and Energy Sources**
 - Promotion of Electric Vehicles
 - Renewable Energy Sources
 - Cleaner Fuels
- **Urban Planning**
 - Public Transportation Systems
 - Green Spaces and Urban Forests
- **Public Awareness and Policies**

Gothenburg Protocol

- The 1999 Gothenburg Protocol was an environmental agreement aimed at **reducing air pollution and its transboundary effects** in Europe.
- It aimed to **abate acidification, eutrophication, and ground-level ozone** by controlling emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds (VOCs).
- It was adopted under the Convention on Long-Range Transboundary Air Pollution (LRTAP) of the United Nations Economic Commission for Europe and entered into force in May 2005.
- However, the **protocol was amended in 2012** by Executive Body to include national emission reduction commitments to be achieved by 2020 and beyond.
- The revised protocol also includes emission reduction commitments for **fine particulate matter**.
- The amended protocol entered into force in 2019 and currently 26 parties in Europe have accepted the amended protocol.

14) Explain the mechanism and occurrence of cloudburst in the context of the Indian subcontinent. Discuss two recent examples.

Cloudburst

- Intense weather events, especially when more than **10 centimeters (3.94 inches)** of rainfall occurs within a **10 square kilometers (3.86 square miles)** region within an hour, are called cloudbursts.
- They have the potential to wreak havoc, causing **intense flooding, landslides, mudflows and land cavings** that affect thousands of people in mountainous regions.

Two recent examples

- **Amarnath Cloudburst (July 2022) in Jammu and Kashmir**, which caused flash floods near the holy cave shrine, leading to the death of 16 pilgrims and extensive damage to infrastructure.
- **Kullu Cloudburst (July 2023) in Himachal Pradesh**, which triggered flash floods and landslides, severely affecting villages and causing loss of lives and property and significant damage to infrastructure and deaths.

Amarnath Cloudburst

- The Amarnath cloudburst was a result of a **localized, intense weather event**, driven by orographic uplift and monsoonal moisture.
- The Amarnath shrine is located at **3,900 meters in the Himalayas**.
- **Moist monsoon winds from the Bay of Bengal** hit the steep slopes of the mountains.
- These winds are **forced upward**, rapidly cooling and condensing into storm clouds.
- Within a **span of 15–30 minutes**, an estimated **30–40 mm of rain** fell over a very small area.
- The terrain being rocky and steep, water could not percolate into the ground and instead rushed down in the form of a flash flood.

15) Discuss global warming and mention its effects on the global climate. Explain the control measures to bring down the level of greenhouse gases which cause global warming, in the light of the Kyoto Protocol, 1997.

Global Warming

- Global warming refers to the **long-term rise in the average temperature** of the Earth's climate system.
- This warming primarily stems from **human activities** that increase the concentration of greenhouse gases (GHGs) in the atmosphere.

Effects

- **Rising temperatures:** Average global temperatures have been increasing, leading to heatwaves becoming more frequent and intense.
 - For instance: In 2019, Europe experienced a record-breaking heatwave, with temperatures soaring well above normal levels for an extended period, causing heat-related illnesses and deaths.
- **Changes in precipitation patterns:** Global warming alters rainfall patterns, leading to more intense rainfall in some regions and droughts in others.
 - For instance: In 2021, Odisha witnessed a dramatic shift in weather patterns. Just weeks after experiencing drought-like conditions in 24 of its 30 districts, the state faced severe flooding due to a low-pressure system in the Bay of Bengal. Major rivers overflowed, exceeding danger marks and inundating previously parched land
- **Melting ice and rising sea levels:** Warming temperatures cause polar ice caps and glaciers to melt, contributing to rising sea levels. This phenomenon threatens coastal communities and low-lying islands.
 - For instance: Greenland's ice sheet is melting at an accelerating rate, contributing to rising sea levels. An estimated 28,707 sq. kilometres of Greenland's ice sheet and glaciers have already melted over the last three decades.
- **Ocean acidification:** Increased carbon dioxide levels in the atmosphere lead to higher levels of CO₂ dissolving into the oceans, resulting in ocean acidification. This has detrimental effects on marine life, especially organisms with calcium carbonate shells or skeletons, such as corals and shellfish.
 - For instance: Recent aerial surveys conducted by Australian authorities confirmed the 6th widespread coral bleaching across two-thirds of the Great Barrier Reef (GBR).
- **Shifts in ecosystems and biodiversity loss:** Global warming disrupts ecosystems and habitats, causing shifts in the distribution and behaviour of plant and animal species. Some species may struggle to adapt to rapidly changing conditions, leading to biodiversity loss and extinction.

- For instance: Polar bears are facing habitat loss as the Arctic Sea ice melts, impacting their ability to hunt ringed seals for food and reproduce.
- **Extreme weather events:** Global warming increases the frequency and intensity of extreme weather events such as hurricanes, cyclones, and wildfires. These events can cause widespread destruction of infrastructure, loss of lives, and displacement of communities.
 - For example: Massive wildfires caused due to global warming in 2019-20 devastated Australia. Millions of hectares of forests, bushlands, and national parks were burned, destroying critical habitat for a diverse range of flora and fauna.

Control Measures

- The Kyoto Protocol, adopted in 1997 was a landmark agreement which aimed at addressing global climate change by reducing greenhouse gas emissions.
- The control measures outlined in the Kyoto Protocol include:
- **Emission reduction targets:** It set specific emission reduction targets for each Annex I country, aiming to reduce their emissions by an average of 5.2% below 1990 levels.
 - Cap-and-trade system
 - Clean Development Mechanism (CDM)
 - Joint Implementation (JI)
- **Compliance and reporting:** It established mechanisms for monitoring, reporting, and verifying countries' emissions and compliance with their targets. This included regular reporting of emissions data and compliance with emission reduction commitments.
- **Adaptation and flexibility:** Recognizing the diverse circumstances and capabilities of countries, it provided flexibility in how countries could achieve their emission reduction targets. It also emphasized the importance of adaptation to the impacts of climate change, particularly for vulnerable countries and communities.

Issues

- **Limited Participation**
 - The protocol bound only developed (Annex I) countries, excluding developing nations like China, India, and Brazil from emission reduction targets.
 - Yet by the mid-2000s, developing countries had become major emitters, especially China – the world's largest emitter – with no binding obligations.
- **Withdrawal of Major Emitters**
 - The United States, which accounted for over 20% of global emissions, never ratified the protocol.
 - Canada withdrew in 2011, citing unfair economic burdens and the absence of obligations for major developing emitters.
- **Modest Emission Targets** - Only 5.2% below 1990 levels by 2012
- **Ineffective Market Mechanisms** - Lack of transparency and poor monitoring
- **Absence of Enforcement** - No stringent penalties

- Did not account for **the rapid economic rise of developing countries.**

Also

- **Transitioning to Renewable Energy:** Shifting from fossil fuels to renewable sources like solar, wind, geothermal, and hydropower significantly reduces GHG emissions.
- **Energy Efficiency:** Implementing energy-saving practices in homes, industries, and transportation sectors lowers overall energy consumption and associated emissions.
- **Afforestation and Forest Conservation:** Forests act as carbon sinks by absorbing CO₂, so promoting afforestation and sustainable forest management plays a crucial role.
- **Technological Advancements:** Investing in research and development of cleaner technologies like carbon capture and storage offers long-term solutions.

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16) Explain the causes and effects of coastal erosion in India. What are the available coastal management techniques for combating the hazard?

Introduction

- Coastal erosion is the **wearing away of land** by action of waves, currents and wind.
- It is accompanied with **landward recession** of the shoreline and loss of land area.
- It is a common problem faced in almost **all coastal areas**.
- Only the **magnitude and nature of erosion changes** from place to place.
 - According to a new study published in the Indian Academy of Science's journal Current Science as much as 45% of India's coastline is facing erosion.
 - The Indian coast has lost a net area of about 73 sq. km over the past 15 years to coastal erosion as per the same study.
 - The Andaman and Nicobar Islands face the most erosion, with close to 89% of the shoreline eaten away by the Bay of Bengal.

Causes - Natural

- **Wave Action** - The famous Puri Beach in Odisha has been experiencing erosion due to constant wave action.
- **Tidal Currents** - Vypin Island, Kerala faces severe erosion due to the tidal currents of the Arabian Sea.
- **Storm Surges and Cyclones** - Cyclone Fani in 2019 caused severe erosion along the Odisha coast.
- **Sea Level Rise** - The Sundarbans delta, due to its low-lying mangrove forest with an average elevation of less than one meter above sea level, is highly vulnerable to sea level rise.
- **Geological Factors** - Sandy beaches, which consist of loose, unconsolidated materials, are more prone to erosion compared to rocky cliffs, which are more resistant to wave action and weathering. Known for its unique "disappearing beach" phenomenon, where the sea recedes up to 5 kilometers during low tide, Chandipur in Odisha is highly susceptible to erosion.

Causes - Anthropogeni

- **Sand Mining** - In Karnataka, rampant sand mining has led to coastal erosion.
- **Construction Activities** - In Podampetta, in Odisha, massive damage has been done to the shoreline after a minor port came into existence.
- **Deforestation** - According to Union ministry of earth sciences, close to 20% of Goa's shore along its 139-km-long coastline has been eroded due factors such as deforestation.
- **Dams and River Regulation** - Aswan High Dam in Nile delta reduced the amount of sediment reaching the delta. As a result, the coastline is eroding by up to 125-175 m/yr.

Impacts

- **Loss of Land** - The state of Odisha has experienced significant coastal erosion, particularly in the Kendrapara and Jagatsinghpur districts. Valuable agricultural land is lost to the advancing sea, impacting the livelihoods of farmers and reducing arable land availability.
- **Damage to Infrastructure** - Gopalpur, a coastal town in Odisha, has seen severe erosion that has damaged roads, bridges, and buildings close to the shore. The erosion threatens the infrastructure of the town, including tourist facilities and local businesses.
- **Economic Impacts** - Marina Beach in Chennai, one of the longest urban beaches in the world, faces severe erosion issues. The loss of the beach area has had a significant economic impact on tourism, reducing the number of visitors and affecting local businesses that depend on tourist traffic.
- **Environmental Impacts** - The Sundarbans, a UNESCO World Heritage Site, is facing severe erosion that affects its extensive mangrove forests. The destruction of these mangroves has a profound impact on local biodiversity, including endangered species like the Bengal tiger and various fish and bird species.
- **Displacement of Communities** - Shanghumugham, a coastal village in south Kerala, which is rapidly losing beaches to erosion has affected fishers, their homes and livelihood.

Management

Hard Engineering Solutions:

- **Seawalls:** Built parallel to the shore to protect the coast from wave action.
- **Groynes:** Structures built perpendicular to the shore to trap sand and reduce erosion.
- **Breakwaters:** Offshore structures that absorb wave energy and reduce the impact on the shore.
- **Revetments:** Sloping structures placed on banks or cliffs to absorb wave energy.

Soft Engineering Solutions:

- **Beach Nourishment:** Adding sand or sediment to beaches to replace what has been eroded as has been done through Sand bypassing at Visakhapatnam, Paradip.
- **Dune Stabilization:** Planting vegetation or using barriers to stabilize sand dunes and prevent erosion.
- **Mangrove Restoration:** Replanting mangroves to provide a natural barrier against waves and storm surges.

Policy and Legislation:

- **Coastal Regulation Zone Notification, 2019:** Provides for No Development Zones (NDZ) along various categories of coastal areas to protect the coastline from encroachment and erosion.

Conclusion

- Coastal erosion is a significant challenge for India, driven by both natural and human factors.
- The effects of erosion are far-reaching, impacting the environment, economy, and communities.
- Effective coastal management techniques, ranging from engineering solutions to integrated management approaches, are crucial for mitigating the such hazards.
- Implementing these measures requires coordinated efforts from government bodies, local communities and stakeholders to ensure the sustainable development of India's coastal regions.

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Internal Security

17) Discuss the types of organised crimes. Describe the linkages between terrorists and organised crime that exist at the national and transnational levels.

CRIME Framework

- The **CRIME** framework structures the answer into five key areas:
- **Categories:** Outline the main types of organised crimes.
- **Relationships:** Explain the general linkages between organised crime and terrorism.
- **Impact at National Level:** Describe how these linkages operate within countries.
- **Motives and Methods:** Highlight shared motives and operational methods.
- **Examples at Transnational Level:** Provide global examples of linkages.

Introduction

- Define organised crime and its linkage with terrorism.
- Example: “Organised crime, driven by profit, fuels terrorism through shared resources, destabilizing nations and global security. These linkages thrive at national and transnational levels.”

CRIME Framework- Body

- **Categories:** Organised crimes include drug and human trafficking, arms smuggling, money laundering, cybercrime, and extortion. Structured groups execute these for profit or power across borders.
- **Relationships:** Terrorists and organised crime groups form symbiotic ties, with criminals supplying funds and arms, and terrorists offering ideological cover. Both exploit weak governance and porous borders for mutual gain.
- **Impact at National Level:** In India, D-Company’s drug and arms smuggling funded the 1993 Mumbai blasts, while Northeast insurgents use extortion to finance operations. Corruption enables these linkages, eroding national security.
- **Motives and Methods:** Driven by profit and power, both use smuggling routes, hawala, and cyber networks for coordination. They recruit from marginalized groups, employing violence to maintain control.
 - **Examples at Transnational Level:** Globally, the Taliban’s \$4 billion opium trade funds Al Qaeda’s operations, while ISIS profits from oil smuggling in Syria-Iraq. Southeast Asia’s Golden Triangle cartels support regional insurgents via drug trafficking.

Conclusion

- Linkages between organised crime and terrorism threaten stability at national and global levels.
- Robust counter-strategies, like intelligence sharing and border security, are critical to disrupt these networks

18) What are the maritime security challenges in India ? Discuss the organisational, technical and procedural initiatives taken to improve the maritime security.

WAVE Framework

The WAVE framework structures the answer into four key areas:

- **Widespread Threats:** Identify key maritime security challenges facing India.
- **Agencies Involved:** Discuss organisational initiatives to strengthen maritime security.
- **Vigilance through Technology:** Highlight technical measures to enhance surveillance and response.
- **Enforcement Procedures:** Outline procedural steps to improve coordination and enforcement.

Introduction

- Highlight India's maritime vulnerabilities and the need for robust initiatives.
- Example: "India's 7,517 km coastline, vital for 95% of its trade, faces multifaceted maritime threats. Organisational, technical, and procedural initiatives have strengthened its security framework."

Body- WAVE Framework

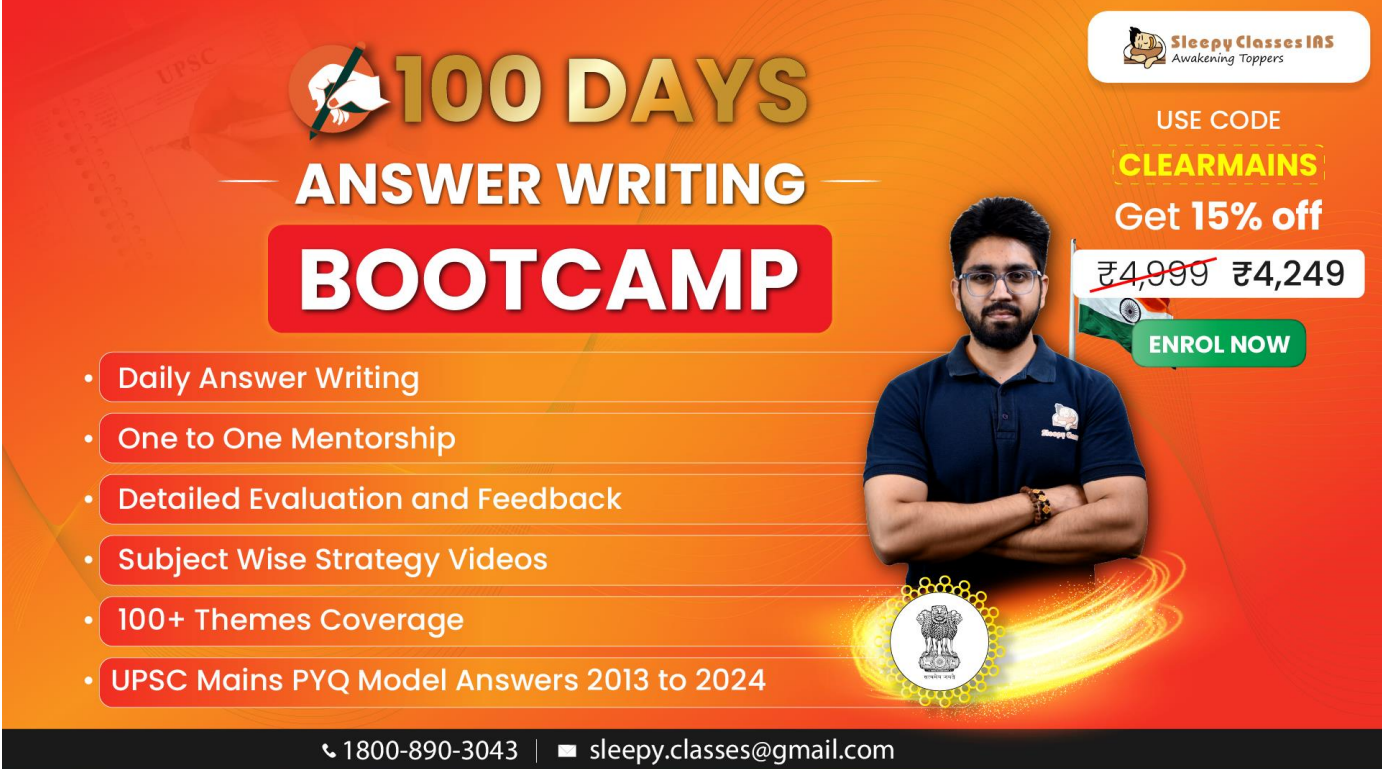
- **Widespread Threats:** India's maritime domain is threatened by terrorism (e.g., 26/11), piracy in the Gulf of Aden, smuggling in the Sundarbans, illegal fishing, Chinese naval expansion, and environmental disasters. These challenges jeopardize trade, energy security, and regional stability.
- **Agencies Involved:** The NCSMCS, led by the Cabinet Secretary, and the NMSC under the NSA coordinate the Indian Navy, Coast Guard, and State Marine Police. IMAC and JOCs in Mumbai and Kochi ensure seamless inter-agency action.

Body- WAVE Framework

- **Vigilance through Technology:** The Coastal Surveillance Network's 46 radars and 74 AIS receivers, paired with ISRO's GSAT-7A satellites, provide gapless monitoring. The NC3I network, upgraded in 2024, and ICG's 2025 patrol boat acquisitions enhance response capabilities.
- **Enforcement Procedures:** Post-26/11 SOPs, coastal security drills like Malabar 2023, and IFC-IOR's data sharing with 40 countries strengthen coordination. The Maritime Zones Act and ISPS Code ensure robust port security.

Conclusion

- India's integrated maritime security approach effectively counters terrorism, piracy, and geopolitical threats. Continued technological upgrades and global cooperation are essential for sustained stability in the Indian Ocean.



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19) What are the different elements of cyber security ? Keeping in view the challenges in cyber security, examine the extent to which India has successfully developed a comprehensive National Cyber Security Strategy.

Introduction

- Define cybersecurity elements and India's strategic need amid rising threats. Example: "Cybersecurity, vital for India's digital economy, comprises network, application, and information security. Rising cyberattacks necessitate a robust National Cyber Security Strategy, which India has partially achieved."

SHIELD Framework

- **Safeguards:** Cybersecurity encompasses network security (firewalls), application security (patches), information security (encryption), IAM (authentication), operational security, and disaster recovery. These elements protect systems from unauthorized access and data breaches.
- **Hazards:** India faces 13 lakh annual cyberattacks, state-sponsored threats from groups like Red Echo, a 70% cybersecurity workforce shortage, fragmented agency coordination, and weak legal frameworks. These challenges threaten critical infrastructure and economic stability.
- **Initiatives:** The 2020 Strategy, supported by the 2013 Policy, CERT-In, NCIIPC, I4C, and programs like Cyber Swachhta Kendra, aims to secure digital infrastructure. The 2023 DPDP Act strengthens data privacy and resilience.
- **Evaluation:** India's strategy has reduced cybercrime response times via CERT-In and neutralized botnets through Cyber Swachhta Kendra. Global partnerships with the UK and NCIIPC's infrastructure protection bolster its cybersecurity posture.
- **Limitations:** The unimplemented 2020 Strategy, overlapping agency roles, resource shortages, and an outdated IT Act limit effectiveness against AI and 5G threats. Coordination inefficiencies further hamper progress.
- **Direction:** India must enact a Cybersecurity Act, centralize coordination under a single agency, train professionals, and join global frameworks like the Budapest Convention. These steps will fortify its digital defenses.

Conclusion

- India's cybersecurity strategy shows progress but requires implementation and modernization. A unified, resource-rich approach will secure its digital future.

20) Naxalism is a social, economic and developmental issue manifesting as a violent internal security threat. In this context, discuss the emerging issues and suggest a multilayered strategy to tackle the menace of Naxalism

Introduction

- Define Naxalism as a socio-economic and security issue and outline the approach. Example: "Naxalism, rooted in socio-economic disparities, fuels violent unrest in India's tribal regions. Addressing emerging issues requires a multilayered strategy, as outlined by the GROW framework."

GROW Framework

- The **GROW** framework structures the answer into four key areas:
 - **Grievances:** Identify the social, economic, and developmental issues fueling Naxalism.
 - **Risks:** Highlight emerging operational and ideological risks posing security threats.
 - **Operations:** Discuss Naxalism's evolving tactics and their impact.
 - **Way Forward:** Propose a multilayered strategy to address root causes and security challenges.

Grievances (G)

- **Economic Deprivation:** Poverty and unemployment in Red Corridor; 50% villages lack amenities.
- **Land Alienation:** Mining displaces tribals, violating Forest Rights Act (2006).
- **Social Exclusion:** Lack of education and healthcare fuels resentment.
- **Governance Gaps:** Corruption and poor scheme implementation alienate communities.

Risks (R)

- **Urban Naxalism:** Ideological spread to cities via social media.
- **External Linkages:** Ties with Nepal Maoists and arms smuggling.
- **Radicalization:** Online propaganda targets youth.
- **Economic Impact:** ₹15 billion annual losses from disrupted projects.

Operations (O)

- **Guerrilla Warfare:** Ambushes and IEDs (e.g., 2023 Sukma attack).
- **Technology Use:** Drones and encrypted communication.
- **Forced Recruitment:** Coercion of tribal youth.
- **Extortion:** Levies on mining firms fund operations.

Way Forward (W)

- **Development:** Expand roads, schools via Aspirational Districts.
- **Security:** Strengthen CAPF operations like Operation Prahhaar.
- **Dialogue:** Promote surrender policies (e.g., Niyad Nellanar).
- **Counter-Propaganda:** Use media to build trust and debunk narratives.

Conclusion

- “Naxalism cannot be eliminated through the barrel of a gun alone. It must be addressed through a compassionate state that ensures justice, dignity, and development for the most marginalized. Only then can we win the hearts and minds of those misled into violence.”

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