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MONTHLY MAGAZINE
APRIL 2026
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1447 / C, 3rd Floor,
15th Main Road, H Block,
Anna Nagar West,
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+91 9445132221
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044 4232 3192
www.plrajiasacademy.com
info@plrajiasacademy.com

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APRIL YOJANA 2026

GS Paper: General Studies III (GS-3)
Subject: Science and Technology; Economic Development; Environment; Disaster Management
Topic & Sub-Topics:

1. IT & Computers: Artificial Intelligence (AI) and Digital Public Infrastructure (DPI).
2. Cyber Security: Cyber threats, data privacy, and digital trust architectures.
3. Space & Deep-Tech: Indigenous technology, private sector participation, and frontier computing.
4. Disaster Management: Disaster Risk Reduction (DRR), institutional frameworks, and climate resilience.
5. Environment & Infrastructure: Green technology, renewable energy transition, and circular economy.

1. Artificial Intelligence at Population Scale

Introduction

Artificial Intelligence (AI) is evolving into India's next frontier of Digital Public Infrastructure (DPI), building upon the foundational triumphs of Aadhaar, UPI, and Digi Locker. By unifying data ecosystems, compute infrastructure, and public governance, India is pioneering a unique model of population-scale digital innovation engineered to drive economic growth, maximize social inclusion, and uplift human development.

AI as a Tool for Public Good (Sectoral Transformation): India's focus centers strictly on real-world deployment across foundational sectors rather than restricted, experimental research labs:

Agriculture: Deploying AI-enabled voice-based assistants to help farmers effortlessly navigate welfare schemes, carry out automated crop surveys, and receive localized weather advisories in regional languages, eliminating critical information asymmetry.

Healthcare: Scaling AI-powered diagnostic tools to assist frontline healthcare workers in early, rapid detection of critical diseases like tuberculosis and diabetic retinopathy, substantially boosting public health outcomes.

Fintech: Integrating AI with UPI systems to enable voice-activated digital payments, driving financial inclusion deep into low-literacy and rural demographics.

Governance & Judiciary: Deploying AI-driven, real-time translation and transcription systems to enhance administrative efficiency and streamline access to justice across a linguistically diverse country.

India AI Impact Summit 2026 & Global Leadership: This landmark event shifted the international narrative away from basic AI risk and regulation toward harnessing AI for development and public good. The globally endorsed New Delhi Declaration (signed by 90+ nations) focused heavily on:

1. Democratizing universal access to AI infrastructure.
2. Promoting inclusive, ethical, and human-centric AI ecosystems.
3. Developing highly secure, trusted architectures while building AI-ready human capital and resilient infrastructure.
4. Positioning India as a primary architect for Global South-centric AI governance frameworks.

The IndiaAI Mission (Foundational Infrastructure): An initiative aimed at completely democratizing core AI resources through a three-tiered structural framework:

1. **Compute Infrastructure:** Setting up shared Graphic Processing Unit (GPU) clusters available to startups, researchers, and public labs at heavily subsidized rates ($\approx$ ₹65 to ₹100 per hour).
2. **Data Ecosystem (AIKosh Platform):** Constructing a central repository hosting over 10,000+ distinct datasets and 286+ pre-trained AI models tailored specifically to solve Indian socio-economic challenges.

3. **Application Layer (Governance Integration):** Actively applying a whole-of-government approach to deploy AI for direct public utility, including crop monitoring, real-time disaster prediction (floods, landslides), beneficiary verification, and healthcare diagnostics.

Building an Inclusive AI Innovation Ecosystem: Focuses on shifting innovation away from Tier-1 metros by setting up dedicated AI labs and training centers in Tier-2 and Tier-3 cities.

1. Massive literacy drives like YUVA AI for ALL are integrated across public platforms like DIKSHA and iGOT Karmayogi.
2. Comprehensive startup support is provided through strategic funding, mentorship, and international collaborations.
3. Ensuring data safety and transparency by introducing robust deepfake detection, digital AI watermarking, and model evaluation frameworks.

Significance: Extends the standard DPI philosophy to AI-driven governance, improves service delivery, minimizes linguistic barriers, bridges the digital divide, and functions as an affordable, scalable blueprint for developing countries.

Challenges: Stubborn digital divides regarding infrastructure access; pervasive concerns surrounding data privacy, system security, and ethical deployment; a prominent skill gap in the workforce; and a pressing need for stronger inter-institutional coordination.

Way Forward:

Expand inclusive digital networks, deepen AI literacy, establish robust data governance and ethical AI regulations, and actively champion public-private partnerships (PPPs) alongside global tech collaborations.

2. Cyber Security and Digital Trust

Introduction

In an era shaped by hyper-digital transformation, cybersecurity has transitioned from a backend technical requirement to the ultimate cornerstone of digital trust, national sovereignty, and economic stability. As the massive convergence of Biotechnology, Robotics, Artificial Intelligence, and Nanotechnology (BRAIN) accelerates, modern systems—ranging from smart vehicles to national governance networks—are becoming deeply interconnected, rapidly expanding the cyberattack surface. Consequently, future cyber readiness relies heavily on systemic resilience and trust-based ecosystems.

Evolving Cyber Threat Landscape: Operating within a highly volatile, uncertain, complex, and ambiguous (**VUCA**) environment, modern systems integrate physical machinery, digital software (AI networks), and unpredictable human interfaces. This cross-convergence exposes vulnerabilities across multiple vectors:

1. Supply Chain Risks: Compromised or malicious hardware components.
2. Network Threats: GPS spoofing, satellite disruptions, or attacks on critical undersea cables.
3. Software Flaws: Malicious software updates and crippling ransomware.
4. Application Vulnerabilities: Data theft and illicit remote control of critical infrastructure.
5. Human Elements: Sophisticated social engineering and phishing campaigns.

Key Cyber Frauds Active in the Ecosystem:

As highlighted by the Enforcement Directorate, prominent frauds target various vulnerable points:

Pig Butchering: Scammers lure victims into fake romantic relationships or job offers, build emotional trust, and subsequently defraud them via fake investment schemes.

Phantom Hacking: Fraudsters masquerade as government officials or tech support, falsely claim the victim's bank account or device is compromised, and trick them into transferring funds to a "safe account" controlled by the attacker.

Online Betting and Gambling: Illicit, unauthorized platforms draw users into rigging games with false promises of massive financial returns.

Instant Loan Apps: Rogue apps offer quick, document-free micro-loans, exploit personal user data from devices, and blackmail victims for exorbitant repayments through threats without ever disbursing the actual loan amounts.

The Multi-Layered Cybersecurity Architecture: Effective defense requires enforcing rigorous security standards across six distinct, interconnected layers simultaneously:

1. Material & Communication Layer: Securing hardware supply chains, satellite uplinks, and physical telecom networks.
2. Hardware & Systems Layer: Countering dangerous backdoor implants and the manipulation of core control systems.
3. Operating System & Network Layer: Mitigating unpatched OS update bugs, broken network protocols, and ransomware.
4. Application Layer: Securing vulnerable APIs, untrusted applications, and cloud storage breaches.
5. Task/Functional Layer: Defending against algorithmic manipulation and malicious system operation overrides.
6. Human Layer: Addressing the weakest link by building behavioural resilience against social engineering.

Digital Trust & Cyber Resilience: Moving beyond mere threat prevention, current policies champion **cyber resilience**. This focuses on real-time threat detection, rapid recovery mechanisms, and maintaining continuous operational workflows even during an active attack. Digital trust is reinforced by deploying **Public Key Infrastructure (PKI)** to manage bulletproof authentication, data encryption, and systemic integrity.

Stakeholder Responsibilities:

1. Government: Standardizing robust regulatory legal frameworks, investing heavily in dedicated cyber-talent, and sharing real-time global threat intelligence.
2. Industry: Practicing "security-by-design" product development, continuous network auditing, and responsible data management.
3. Citizens: Practicing basic everyday cyber hygiene and upgrading general digital awareness.

Challenges & Vulnerabilities: The rapidly increasing sophistication of attacks, an acute domestic shortage of skilled cybersecurity professionals, complex data privacy governance issues, and systemic dependence on foreign digital assets (like satellites and undersea fiber paths).

3. India's Space and Deep-Tech Ecosystem

Introduction

In the contemporary global dynamic, national power is measured by technological depth and sovereignty rather than basic industrial manufacturing capacity. India's space and deep-tech ecosystem reflect a strategic transformation from a basic technology service provider to a pioneering frontier technology creator, directly feeding into the national vision of Viksit Bharat @2047.

Evolutionary Context: Rooted originally in pure socio-economic development under Dr. Vikram Sarabhai, ISRO successfully established core capabilities across satellite communications, remote sensing, indigenous planetary navigation (NavIC), and deep space exploration. Highly cost-effective landmark triumphs—including the Mars Orbiter Mission (MOM), the Chandrayaan Programme, and the Aditya-L1 solar probe—have permanently secured India's position among elite spacefaring powers.

The Paradigm Shift to a Public-Private Ecosystem: Recent reforms have broken the traditional state-driven monopoly, introducing an expansive commercial startup environment. The regulatory body IN-SPACe has successfully enabled this change by:

1. Opening the space sector to direct private capital and independent corporate participation.
2. Empowering private firms to build proprietary satellites, operate custom launch vehicles, and market downstream space services.
3. Transforming domestic industry players from simple component sub-contractors into independent end-to-end aerospace market leaders.
4. Private Space Sector Innovations: High-tech startups are capturing critical points across the aerospace value chain:

5. Launch Systems: Ventures like Sky root Aerospace and Agnikul Cosmos are actively engineering customized, highly flexible small satellite launch vehicles to satisfy the global demand for immediate small-satellite constellations.
6. Satellite & Data Economy: Enterprises like Pixel are putting advanced hyperspectral satellites into orbit to harvest rich data analytics for precision agriculture monitoring, urban development, and global climate analysis.
7. Deep-Tech as a Strategic Stack Enabler: The space ecosystem is heavily reinforced by a cluster of foundational, sovereign deep technologies:
    1. AI & Analytics: Automating the processing of massive satellite telemetry and climate tracking maps.
    2. Semiconductors: Domestic fabrication of specialized, radiation-hardened microchips designed to survive extreme cosmic rays.
    3. Quantum Tech: Engineering un-hackable, quantum-encrypted secure satellite communication links.
    4. Robotics & Automation: Optimizing high-precision automated spacecraft assembly and surface exploration rovers.
    5. Policy Pillars: This tech stack is driven by government initiatives like the National Quantum Mission, the India Semiconductor Mission, and the proposed National Deep Tech Startup Policy.

Societal Applications for Public Welfare: India's advanced tech remains dedicated to grassroots development. For instance, the Bharat-VISTAAR platform seamlessly merges real-time satellite imagery, AI models, and weather data to provide hyper-local agricultural advisories, optimize crop productivity, assess environmental risks, and handle regional disaster mitigation.

Strategic Autonomy & Future Trajectory: Cultivating an indigenous semiconductor system and scaling NavIC significantly limits reliance on unpredictable foreign frameworks, reinforcing national security. Simultaneously, India is acting as a reliable technology partner by supplying cost-effective space solutions across the Global South. The road to 2047 remains defined by the Gaganyaan human spaceflight mission, plans for a permanent indigenous space station, deep lunar surface exploration, and expanding deep-tech research labs.

4. From Relief to Resilience (Disaster Risk Reduction)

Introduction

India's current developmental path dictates that economic expansion cannot be sustained without building safe, resilient infrastructure. With the intensifying frequencies of multi-hazard heatwaves, urban deluges, and acute health emergencies, disasters are treated as complex, systemic risks rather than isolated incidents. Thus, public policy has engineered a major structural shift from old-school, reactive, relief-centric compensation to proactive, risk-informed, asset-resilient governance.

The Changing Risk Landscape: Driven heavily by three key structural shifts:

1. Climate-Induced Intensification: Pervasive, severe weather extremes like sudden cloudbursts, high-intensity cyclones, and extended heatwaves.
2. Cascading and Interconnected Risks: A singular hazard now triggers systemic failures across multiple overlapping sectors simultaneously (e.g., paralyzing transport, grids, health centers, and supply lines).
3. Rising Urban Vulnerabilities: Rapid, unplanned urbanization sprawling directly over hazard-prone zones, requiring future-projection planning over historical data.

Institutional Architecture: Mainstreaming Disaster Risk Reduction (DRR) directly into standard urban planning via the legal mandate of the Disaster Management Act, 2005 (establishing 3-tier national, state, and district networks), the policy execution of the NDMA, and the National Disaster Management Plan (NDMP), which is aligned with the global Sendai Framework.

The Aswal Model (Risk-Informed Governance): This model integrates rigid quality-assurance metrics into civic governance, emphasizing that resilience must be engineered into public infrastructure during the design phase rather than added after a failure. It functions via 4 interlinked stages:

1. Risk Knowledge: Mapping scientific vulnerability utilizing geospatial software, AI models, and real-time data.
2. Decision Support: Translating raw data maps into strict localized building codes and zoning laws.
3. Implementation: Ensuring institutional execution, active bureaucratic regulation, and local training.
4. Learning & Adaptation: Conducting analytical post-disaster audits to upgrade future defensive systems.

Empirical Analysis of the Indian Experience:

Risk Area / Hazard	**What Science & Data Provide**	**What Governance Does**	**Visible Outcome**
Cyclones (East Coast)	Accurate tracking, storm surge modelling.	Automated early warning, mass evacuations, cyclone shelters.	Sharp, historic reductions in the loss of human lives.
Heat Waves	Precise temperature forecasts, health risk analytics.	Executing localized Heat Action Plans, hospital preparedness.	Minimizing heat-related public mortality rates.
Urban Floods	Rainfall modelling, drainage mapping.	Flash alerts, traffic redirections, stormwater upgrades.	Accelerated post-flood recovery (though execution gaps persist).
Earthquakes	Seismic zoning maps, structural design standards.	Implementing building codes, structural retrofitting.	Reduced building collapses where codes are enforced.
Landslides	Rainfall threshold markers, remote sensing terrain maps.	Safe route planning, slope protection infrastructure.	Reduced vulnerability across hill highways and settlements.
Industrial Risks	Exposure analysis, rigorous safety audits.	Strict safety inspections, emergency management plans.	Noticeable improvements in industrial crisis prevention.

Systemic Gaps & Challenges: Persistent weaknesses in integrating scientific risk data into everyday municipal planning; weak enforcement of localized structural codes; severe resource and capacity constraints across local urban bodies (ULBs); and poor inter-agency data sharing.
Way Forward: Mandate risk-informed structural engineering across all public infrastructure, deploy AI-backed district risk dashboards, upgrade local municipal funding, and foster community-led participatory disaster response networks.

5. Green Technologies for India's Sustainable Future

Introduction

India’s developmental blueprint toward Viksit Bharat @2047 balances economic growth with environmental stewardship by transitioning toward a low-carbon, highly resource-efficient circular economy. This green transformation combines traditional ecological values with cutting-edge modern clean technology.

Conceptual Distinctions in Sustainable Tech:

Green Tech: Employs science and technology to safeguard the planet's natural resources and limit human environmental degradation (e.g., sustainable farming, eco-friendly goods).
Clean Tech: Specifically optimizes performance and operational efficiency while reducing waste and negative environmental impacts (e.g., solar panels, wind turbines, wastewater treatment).
Climate Tech: Focuses directly on mitigating greenhouse gas emissions and countering human-induced climate change (e.g., carbon capture systems, electric vehicles).

Energy Transition and Renewable Growth Metrics:

India is the 4th largest producer of renewable energy globally. As of January 2026, the energy architecture stands as follows:

1. Total Non-Fossil Capacity: $\approx$ 272 GW, making up roughly 51.5% of India's total installed power capacity.
2. Solar Leadership: Dominating with 107+ GW from ground-mounted commercial stations and 24+ GW from rooftop setups.
3. The Storage Target: To sustain grid stability during peak variations, India requires 16.13 GW / 82.37 GWh of energy storage by 2026-27, driven by pumped hydro and Battery Energy Storage Systems (BESS) funded via Viability Gap Funding (VGF).

Power Capacity Share Analysis (As of October 2025 Data):

1. Coal: 218.3 GW (43.2%)
2. Solar: 129.9 GW (25.7%)
3. Hydro: 55.5 GW (11.0%)
4. Wind: 53.6 GW (10.6%)
5. Gas: 20.1 GW (4.0%)
6. Biomass: 10.8 GW (2.1%)
7. Nuclear: 8.8 GW (1.7%)
8. Lignite & Diesel: 7.2 GW (1.4%)
9. Waste to Energy: 0.0 GW (0.2%)

Green Mobility Framework: Accelerating mass EV adoption across public transit, two-wheelers, and three-wheelers via fiscal schemes like FAME-II and PM E-DRIVE. Long-term success relies heavily on cleanly generated charging electricity, closed-loop lithium battery recycling, and a highly skilled mechanical workforce.

Circular Economy & Waste-to-Wealth: Transitioning away from linear models by enforcing strict Extended Producer Responsibility (EPR) under the E-Waste Management Rules 2022 and Battery Waste Management Rules. Notably, 60% of **legacy urban waste has been processed as of 2026**. Furthermore, the Gobardhan initiative converts rustic organic waste into Compressed Biogas (CBG) and organic manure.

Sustainable Agriculture & Water Management: Integrating climate resilience with resource optimization:

1. Micro-Irrigation: "Per Drop More Crop" protocols now span 95+ lakh hectares.
2. PM-KUSUM: Targeting 34,800 MW of solar capacity dedicated entirely to agricultural water pumping.
3. Water Security: Driven by the Jal Jeevan Mission (rural tap access), AMRUT (urban wastewater treatment), and the Atal Bhujal Yojana (groundwater table replenishment).

Industrial Decarbonization and Green Hydrogen: Targeting hard-to-abate core industrial sectors (steel, cement, chemicals) via market-driven instruments:

1. Perform Achieve and Trade (PAT): Generated 27.07 MTOE in direct energy savings.
2. Carbon Credit Trading Scheme (CCTS): Introducing market-driven compliance mechanisms for carbon reduction.
3. National Green Hydrogen Mission: Displacing fossil fuels in heavy manufacturing.

Nuclear Energy Paradigm Shift: The SHANTI Act 2025 marks a regulatory transformation by opening the historically state-controlled nuclear energy sector to private corporate participation and Foreign Direct Investment (FDI up to 49%), repositioning nuclear power as a clean, reliable baseline source to achieve Net-Zero targets.

Challenges: High capital financing constraints for urban/rural green grids; lack of large-scale energy storage capacity; implementation gaps at the local municipality level; and keeping green technologies affordable and inclusive for lower-income groups.

Way Forward: Classify battery storage as critical national grid infrastructure, strengthen financing avenues for Urban Local Bodies (ULBs), enforce energy-efficient green building codes, and integrate grassroots MSMEs into the clean-tech manufacturing supply chain.

KURUKSHETRA

1. Digital Transformation — Digital Pathways for Rural India

Introduction

Digital empowerment stands as the structural anchor for inclusive growth in rural India. Over the last decade, the expansion of broadband networks, unified public digital data architectures, and frontier conversational Artificial Intelligence (AI) has fundamentally transformed rural socio-economic institutions. By narrowing the urban-rural technological divide, the state is pulling isolated village economies into the formalized, mainstream digital economy.

Drivers and Scale of the Rural Digital Footprint:

Macro Scale Optimization: India's digital ecosystem encompasses nearly 958 million active internet users, with projections firmly on track to hit 1.03 billion by 2026.

Rural-Led Expansion: Rural pockets account for approximately 548 million users (57% of the national aggregate). Notably, rural data adoption is growing four times faster than urban equivalents.

Telecom Infrastructure Cover: Deep penetration is driven by widespread 4G networks covering 95% of the population, a progressive nationwide 5G rollout, and intuitive voice-search AI tools used by 44% of rural internet users to bypass text-literacy barriers.

Policy Framework: This shift is anchored by the Digital India Programme, aimed at transitioning the nation into a digitally empowered knowledge economy.

Digital Infrastructure & Last-Mile Delivery Networks:

Bharat Net Architecture: Serving as the core optical fiber backhaul, it connects over 2.15 lakh Gram Panchayats across the nation, with more than 2.18 lakh Panchayats verified as fully service-ready.

Common Service Centres (CSCs): A distributed retail delivery network of nearly 6 lakh CSC nodes is operational, with 79% explicitly situated in rural landscapes.

Village Level Entrepreneurs (VLEs): Operated locally by VLEs, CSCs function as single-window service hubs providing friction-free access to e-governance, micro-banking, health platforms, and digital literacy portals directly to the grassroots.

Digital Governance, Financial Inclusion, and Leakage-Free Welfare Infrastructure:

Direct Benefit Transfer (DBT) Efficiency: Linking biometric Aadhaar verification with state welfare distribution has minimized structural leakages. By 2025, the framework securely routed over ₹34 lakh crore across 370+ union and state welfare programs, directly benefiting more than 50 crore citizens.

Universal Welfare Linkages: Flagship agrarian and rural job schemes have achieved near-universal Aadhaar integration, explicitly led by PM-KISAN (disbursing funds to $\approx$ 11.65 crore farmers) and MGNREGA.

The JAM Trinity Effect: The synergy between Jan Dhan bank accounts, Aadhaar validation, and Mobile connectivity cut’s identity duplication, reducing the incidence of fake or ghost beneficiaries by 20% to 30% across core programs.

UPI Financial Formalization: The Unified Payments Interface (UPI) has restructured everyday rural commerce. Approximately 86.7% of rural youth use UPI platforms daily. Furthermore, 55% of all national UPI transactions originate from rural and semi-urban territories, driving the rapid formalization of the rural economy.

Digital Agriculture and Intelligent Agronomic Technology Stack:

Agri Stack Core Foundation: Digital integration is anchored by Agri Stack alongside the unified Kisan ID network (targeting 20 crore farmers). This infrastructure links farmer identities, land registries, and crop data to support targeted state subsidies and direct credit appraisal.

Precision Farming Applications: Integrating AI algorithms, IoT field sensors, and satellite remote imaging enables precision input application, predictive pest tracking, and crop health mapping. This data-driven model has triggered a 10% to 30% reduction in farmer input costs while optimizing crop yields.

Intermediary-Free Market Access: Platforms like the e-NAM digital marketplace provide transparent price discovery and direct market access, minimizing farmer dependence on exploitative local intermediaries.

Socio-Economic Development and Structural Diversification:

Telemedicine Delivery: The Ayushman Bharat Digital Mission (ABDM) enables portable digital health records and direct telemedicine consultations, bringing healthcare to remote areas.

Grassroots E-Education: Open-access portals like DIKSHA and e-Vidya distribute interactive digital learning resources to compensate for local school infrastructure gaps.

E-Commerce Market Integration: The ONDC (Open Network for Digital Commerce) allows rural artisans, small-scale producers, and micro-enterprises to sell directly to national consumer markets, boosting rural entrepreneurship.

Systemic Challenges & Constraints: Pervasive connectivity gaps across remote and tribal areas; low digital literacy levels among elderly and marginalized populations; and rising cybersecurity vulnerabilities alongside data privacy risks.

Way Forward: Expand broadband fiber and 5G cellular infrastructure to underserved areas; strengthen targeted digital capacity-building drives; increase public-private partnerships (PPPs) in Agri-tech; and implement robust data governance and cybersecurity frameworks.

2. Food Safety in the Digital India Era

Introduction

Food safety constitutes an uncompromisable pillar of public health, consumer protection, and macro-economic development. Managing food safety in India is an immensely complex challenge, given its large population, highly diverse food sub-cultures, and a massive network of over 6 million Food Business Operators (FBOs). Fast-paced urbanization, an expanding food processing sector, the growth of food delivery apps, and rising consumer awareness necessitate a highly modern regulatory model. Under the Digital India framework, technology-driven governance has modernized the national food safety regulatory architecture.

Structural Shift in Governance (Traditional vs. Digital Ecosystem): The Food Safety and Standards Authority of India (FSSAI), operating under the Food Safety and Standards Act, 2006, has transitioned national food safety from a slow, reactive mechanism into a preventive, data-backed model:

Regulatory Metric	**Traditional Food Safety Framework**	**Modern Digital Food Safety Framework**
Licensing & Registration	Slow, paper-based physical applications.	Unified online tracking via **FoSCOS**.
Enforcement Inspection	Subjective, manual physical inspections.	Mobile-based, real-time digital inspections.
Data Management	Fragmented, isolated paper records.	Centralized national databases.
Market Monitoring	Reactive, post-incident approach.	Real-time tracking and predictive monitoring.
Grievance Redressal	Opaque, limited consumer grievance options.	Transparent, direct online grievance platforms.
Ecosystem Transparency	Low structural transparency.	High transparency with trackable workflows.
Response Velocity	Slow, bureaucratic delayed responses.	Fast, immediate data-backed mitigation.

FSSAI's Core Integrated Digital Initiatives:

FoSCOS (Food Safety Compliance System): A single-window cloud architecture that enables online licensing, registration, and compliance tracking. It maintains a centralized national database of food businesses, enhancing regulatory oversight and supporting the Ease of Doing Business.

InFoLNet (Indian Food Laboratory Network): This platform fully digitizes sample testing, lab reporting, and inter-lab data sharing. It seamlessly connects national, state, and private labs into a single network, providing empirical data to support evidence-based policymaking.
Food Import Clearance System (FICS): An online platform providing risk-based, real-time clearance for imported food shipments. Integrated with the customs network ICEGATE-SWIFT, it ensures strict quality control on all food imports without bottlenecking trade velocity.
FoSTaC (Food Safety Training & Certification): A digital portal focused on large-scale capacity building for food handlers. It has trained over 16 lakh food safety supervisors and nearly 3 lakh street food vendors, embedding a culture of food hygiene across the country.
Food Safety Connect App & Eat Right India: Consumer-facing digital applications designed for immediate grievance redressal, food violation reporting, and promoting public awareness regarding nutrition, labelling, and safe practices.

The Role of Frontier Technologies in Predictive Governance:

Artificial Intelligence (AI): Machine learning models parse historical compliance records to identify high-risk food establishments and predict potential sanitation violations before they occur.
Internet of Things (IoT): Smart, connected cold-chain sensors log real-time temperature, humidity, and storage variations during transit, eliminating food spoilage.
Blockchain Traceability: Distributed ledgers secure end-to-end "farm-to-fork" traceability, enabling near-instantaneous tracking and isolation of contamination sources during public health recalls.
Significance & Regulatory Impact: This digital ecosystem strengthens public health outcomes by reducing food-borne diseases, boosts export competitiveness by aligning with global quality benchmarks, enhances the ease of doing business for food firms, and fosters consumer trust.
Systemic Challenges: A persistent digital divide affecting small-scale rural vendors; low digital literacy levels among informal street food handlers; and rising concerns regarding data privacy and cybersecurity.
Way Forward: Expand basic digital infrastructure and last-mile connectivity for vendors; strengthen localized training and capacity-building programs; promote deep integration of AI-IoT-Blockchain architectures; and implement robust data protection frameworks.

3. Digitising Cooperatives — PACS In Transition & Rural Governance Reform

Introduction

The digital transformation of rural institutions serves as a vital pathway for inclusive governance in modern India. Among these, Primary Agricultural Credit Cooperative Societies (PACS)—which historically relied on manual accounting and paper ledgers—are undergoing a massive structural reorganization through centralized computerization. This transition extends beyond simple administrative reform; it modernizes the entire rural financial landscape to build a transparent, highly efficient, and accountable cooperative ecosystem.

The Macro Context of Rural Governance Re-Engineering:

1. Driven by expanded internet connectivity (over 100 crore subscribers) and deep mobile penetration, rural governance has experienced rapid digitization.
2. Modern systems like e-Gram Swaraj, SVAMITVA, Bharat Net, and the digitized Public Distribution System (PDS) have collectively improved service delivery, transparency, and accountability at the grassroots level.
3. Aadhaar-based authentication and online tracking platforms have addressed historical administrative challenges—such as delays, poor record-keeping, and leakages—while cutting the incidence of fake beneficiaries by establishing targeted service delivery channels.
4. This foundational digital shift has paved the way for the modernization of cooperative institutions, including PACS, cooperative banks, and dairy cooperatives.

The Strategic Role and Vulnerabilities of Manual PACS:

Credit Backbone: PACS form the baseline of the national rural cooperative credit structure, accounting for nearly 14% of all institutional agricultural credit.

Farmer-Centric Operations: As member-driven institutions, they provide short- and medium-term agricultural credit, supply critical inputs (seeds, fertilizers, pesticides), and offer accessible financial services directly at the village level.

The Manual Bottleneck: Despite their local accessibility and high community trust, their traditional reliance on manual accounting led to operational inefficiencies, loan processing delays, and risks of financial irregularities or lack of transparency.

The PACS Computerization Project (Features & Technical Objectives):

Institutional Mandate: Launched following the creation of the dedicated union Ministry of Cooperation (2021), the landmark PACS Computerization Project is designed to fully digitize roughly 63,000 functional PACS over a five-year timeline.

ERP Cloud Integration: The project introduces a unified Enterprise Resource Planning (ERP) software platform, linking local PACS with District Central Cooperative Banks (DCCBs), State Cooperative Banks (StCBs), and NABARD.

Hardware Support: The software transition is reinforced by the nationwide deployment of physical computers, biometric authentication devices, and handheld printers.

End-to-End Functional Digitization: The platform automates:

1. Core membership registries and loan portfolio management.
2. Deposit accounts, input procurement, and warehouse inventory tracking.
3. Local PDS operations and seamless Direct Benefit Transfer (DBT) routing.
4. Direct Kisan Credit Card (KCC) integration and RuPay card linkages.
5. Standardized cybersecurity protocols and data management.

Multi-Dimensional Structural Impacts:

Credit Velocity Optimization: Digital records of landholdings and loan histories enable accurate credit appraisal and faster loan disbursement, aligning with agricultural cycles. Automated calculations reduce errors and delays.

Governance Transparency: A common national accounting platform reduces malpractices such as duplicate or fraudulent loans, ensures real-time transaction visibility, and strengthens audit mechanisms. This builds trust among farmers in cooperative institutions.

Multi-Service Transition: Digitization allows PACS to function as multi-functional service nodes. They can operate Common Service Centres (CSCs), Fair Price Shops, and Kisan Samriddhi Kendras, generating employment and improving village service delivery.

Democratic Deepening: Real-time record updates improve the accountability of management committees, reinforcing the cooperative ethos.

Systemic Challenges: Significant digital literacy gaps persist among older cooperative society members and local staff; rural power and connectivity issues challenge remote regions; and data security concerns complicate large-scale system integration.

Way Forward: Establish continuous capacity-building and digital training bootcamps for PACS personnel; expand localized connectivity infrastructure; implement strict data protection standards to ensure interoperability across the cooperative banking sector.

4. Smart Panchayats — Grassroots Digital Governance

Introduction

The emergence of Smart Panchayats reflects the modernization of grassroots rural governance through digital technology. Managing over 2.68 lakh Gram Panchayats, Panchayati Raj Institutions (PRIs) constitute the foundational backbone of democratic decentralization in India. Long constrained by manual workflows, poor record keeping, and opaque fund tracking, PRIs are adopting integrated digital architectures. This shift is transitioning local self-governance from a slow bureaucratic structure into a highly transparent, accountable, and citizen-centric democratic model.

Key Digital Initiatives Driving the Smart Panchayat Architecture:

eGramSwaraj & PFMS Integration: A single unified interface combining the eGramSwaraj planning portal with the Public Financial Management System (PFMS). It enables end-to-end digital planning, standardized accounting, and continuous monitoring of local development works alongside real-time bank transfers, minimizing administrative delays and fiscal leakages.

Meri Panchayat App & Panchayat NIRNAY: Mobile-first user applications that provide citizens direct access to local financial files, allocated budgets, ongoing asset spending, and historical minutes of council decisions, driving participatory democracy.

SabhaSaar (AI-powered Tool): An advanced Artificial Intelligence tool that records local Gram Sabha proceedings via automatic speech-to-text, generating instant bilingual summaries and official transcripts. By 2026, 1.15 lakh Panchayats (approx 43%) have deployed SabhaSaar, with states like Tamil Nadu and Odisha achieving near-universal implementation.

SVAMITVA Scheme: A landmark initiative utilizing high-resolution drone mapping to survey rural inhabited land parcels. It generates legal property ownership cards, reducing property disputes, streamlining local tax planning, and unlocking asset-backed credit access for rural homeowners.

Gram Manchitra (GIS Platform): A comprehensive Geo-Spatial Information System (GIS) application that allows Panchayats to practice scientific spatial planning for infrastructure projects (roads, schools, clinics) using precise satellite layers.

AuditOnline Platform: A system designed for digital financial auditing of Panchayat accounts. It minimizes the misuse of public funds by enforcing strict financial discipline and ensuring public accountability.

BharatNet & PM-WANI: High-speed broadband fiber backhauls coupled with PM-WANI public Wi-Fi access points provide the essential telecom infrastructure needed to run digital governance services across rural communities.

Core Functional Modules of Panchayat Digitization: As standardized by the Ministry of Panchayati Raj, digitization transforms six core functional areas:

1. Finance and Accounting: Automatically organizes and displays all Panchayat income streams and asset expenditures in a clear, standardized format.
2. Panchayat Profiling: Electronically records and stores local election data, elected representative details, and active planning committees in a single profile.
3. Geo-Tagging of Assets: Mandates the use of mobile GPS applications to map and photograph local infrastructure works, verifying project implementation.
4. Action Plan Creation: Employs automated budgeting systems to help draft realistic annual village action plans based on available funds.
5. Progress Tracking and Reporting: Provides live dashboard updates on whether an approved public project is actively running, completed, or halted.
6. Activity Output Integration: Links transaction data across distinct functional modules to ensure continuous progress tracking.

Systemic Challenges: Persistent connectivity gaps disrupt operations across remote and tribal borderlands; a gender digital divide limits the active participation of women representatives; and language barriers on portals restrict accessibility for marginalized groups.

Way Forward: Ensure reliable broadband up-time to all villages; promote regional language user interfaces; implement gender-inclusive digital policies to empower women within PRIs; and improve the accessibility of devices.

5. Agritech and The Data-Driven Rural Economy

Introduction

Agriculture remains the core economic driver of rural India, directly supporting nearly half of the national workforce. However, traditional agricultural systems face structural challenges, including fragmented landholdings, climate volatility, and limited market access, which suppress crop yields and lead to unstable farm incomes. Powered by expanding digital infrastructure, the rapid rise of the Agri Tech sector is driving a structural transition toward a modern, data-driven rural economy.

Agri Tech as a Driver of Macro Rural Transformation:

1. Agri Tech integrates Artificial Intelligence, specialized drone hardware, satellite remote sensing, IoT arrays, and open digital marketplaces to support data-backed farming decisions.
2. These systems bridge traditional information gaps between isolated farmers, buyers, banks, and agronomic research centers.
3. Widespread adoption has shown the potential to increase average farmer net incomes by 25% to 35%**,** contributing directly to UN Sustainable Development Goals.

Core Technological Vectors and Their Direct Impact:

AI-Backed Agrometeorological Advisory Systems: Machine learning models analyse real-time soil data, short-range weather patterns, satellite indexes, and historical pest migrations to deliver location-specific crop advisories.

Kisan e-Mitra: A multilingual, voice-enabled AI chatbot that handles thousands of daily complex queries regarding agricultural schemes and troubleshooting.

National Pest Surveillance System (NPSS): An automated imaging system that enables early pest detection and automated treatment advisories across 65+ crops and 400+ pest species, reducing information asymmetry.

Drones and Precision Farming Infrastructure: Replaces uniform, wasteful farming methods with targeted input application. Drones provide detailed multispectral crop monitoring and precision chemical spraying, cutting input use and lowering labor costs.

Namo Drone Didi Scheme: Backed by an allocation of ₹1,261 crore, this initiative provides specialized agricultural drones directly to women Self-Help Groups (SHGs), driving rural employment opportunities for youth and women.

Sovereign Digital Ecosystems (Agri Stack): A unified national data architecture that integrates verified farmer databases, digitized land records, and crop maps. It supports targeted subsidy delivery, index-based crop insurance, and fast-tracked access to institutional credit while minimizing financial inclusion bottlenecks.

The AgriTech Value Chain (Key Interlocking Components): The shift toward smart agriculture relies on eight technical nodes:

1. GPS & GIS: Maps exact plot boundaries and soil type variations.
2. Auto-Steer Machinery: Automates tractor pathways to prevent overlapping rows and save fuel.
3. Variable Rate Technology (VRT): Automatically alters fertilizer and water discharge rates based on localized soil needs.
4. Remote Sensing: Utilizes satellite bands to track localized chlorophyll levels and water stress.
5. Yield Monitors: Measures crop volume in real time during harvest to pinpoint underperforming plot sections.
6. Wireless Telematics: Connects field equipment with central farm management databases.
7. Artificial Intelligence: Diagnoses crop diseases instantly from smartphone images.
8. Data Collection & Analysis: Aggregates multi-year statistics to support evidence-based policymaking.

Policy and Institutional Backing:

Digital Agriculture Mission: Backed by an allocation of ₹32,817 crore, this mission funds the foundational development of Agri Stack and the complete digitization of land registries.

State Initiatives: Tailored regional networks—such as Karnataka's Krishi Sanjeevani mobile testing laboratories and Kerala's K-FON fiber highway—deliver digital governance directly to the field.

Systemic Challenges: High upfront procurement costs for drones and sensors challenge smallholder farmers; highly fragmented landholdings limit the scalability of heavy mechanical technologies; and data ownership and privacy concerns complicate large-scale data integration.

Way Forward: Leverage Farmer Producer Organizations (FPOs) to support the collective adoption of high-cost drone services; design clear data governance frameworks that safeguard individual farmer privacy rights; expand broadband connectivity; and increase public-private partnerships to scale aggrotech innovation across rural India.

DOWN-TO-EARTH APRIL 2026

1. Food In the Age of Climate Change

Context

1. Food systems today are at the intersection of climate change, livelihoods, nutrition, and ecology.
2. As modern agriculture contributes significantly to greenhouse gas emissions, the emerging paradigm is climate-smart agriculture, which integrates livelihood security, nutritional outcomes, and ecological sustainability.

About Food System & Climate Change

1. Food systems today are both victims and drivers of climate change. Agriculture contributes significantly to greenhouse gas emissions, while climate change threatens crop productivity, water availability, and farmer livelihoods.
2. Thus, the challenge is to redesign agriculture to ensure livelihood security, nutritional adequacy, and ecological sustainability simultaneously.

Low-Input and Climate-Resilient Agriculture

Reduce dependence on costly external inputs (fertilisers, pesticides). Key rationale are:

1. High-input agriculture increases costs and farmer vulnerability.
2. Smallholders lack economies of scale.
3. Low-input systems can maintain productivity via soil and water management.

Water and Soil as Core Inputs

Shift focus from chemical inputs to natural resource management. Key measures include:

1. Rainwater harvesting (traditional Indian practices)
2. Improving irrigation efficiency
3. Enhancing soil organic matter

Risk Minimisation through Diversification

The key idea is to adopt multi-cropping and mixed farming systems. It benefits:

1. Reduces climate risk (pests, droughts)
2. Ensures multiple income streams
3. Enhances biodiversity

Climate-Smart Crop Choices (Millets Focus)

Promote crops suited to local ecology and nutrition needs.

Why Millets?

1. Drought-resistant, climate-resilient
2. High nutritional value (iron, fibre)
3. Suitable for marginal soils

Food, Nutrition, and Gut Health

Key Idea: Food choices influence human health via gut microbiome.

1. Soil Health → Crop Diversity → Dietary Diversity → Gut Health
2. Gut hosts trillions of microbes that are critical for immunity and metabolism
3. Diverse, fibre-rich diets support healthy microbiota

Conclusion: Towards Sustainable Food Systems

Food must be reimagined as a system that supports farmers' livelihoods, ensures nutritional security, and protects ecological balance. The future lies in climate-resilient, low-input, biodiversity-based agriculture, supported by policy reforms and conscious consumption. As research shows, crops like millets can act as a bridge between climate adaptation, nutrition, and sustainability, making them central to India's agricultural transformation.

2. Sanitary Waste Management in India

Context

1. Women in rural areas of Himalayan states adopt reusable menstrual hygiene products, reducing sanitary waste.

About Sanitary Waste

1. It comprises used menstrual pads and diapers that remains an under-recognized component of India's solid waste management system.
2. Its environmental, financial, and social impacts are disproportionately high, making it a critical governance and public health issue, despite forming a small fraction of total waste.

Case Study: Dehradun

Key Issues: Mixed with dry waste or concealed in packaging.

1. Disposal methods: Open dumping, burial, and flushing in toilets.
2. Handled manually by sanitation workers, exposing them to health risks (infection, odour), social stigma and indignity.

Economic Burden:

3. Incineration cost: ₹1.75 lakh/month for 10 tonnes
4. Estimated cost for Dehradun city: ₹1.86 crore/month

Environmental and Public Health Concerns

Non-biodegradability: Over 90% of sanitary pads contain plastic.

Pollution: Improper disposal contaminates soil and water.

Health risks: Pathogen exposure for waste workers.

Infrastructure gaps: Lack of disposal systems in India.

Poor menstrual waste management is now recognized as a global environmental and public health challenge.

Emerging Solution: Reusable Menstrual Products

Waste Warriors Initiative: Active since 2022 in Uttarakhand & Himachal Pradesh.

Strategy includes awareness workshops, demonstrations of reusable pads & menstrual cups; community engagement via SHGs, schools, Anganwadi's.

Adoption Trends:

1. Cloth pads: Higher acceptance (cultural familiarity)
2. Menstrual cups: Adopted more by younger women

Long-term benefits:

3. Cost-effective (cup lasts ~5 years)
4. Eliminates disposal challenges

Why Reusables Matter

Reusable products significantly reduce waste burden.

1. Cloth pads are less polluting and sustainable.
2. Promote circular economy in waste management.
3. Reduce pressure on municipal systems.

Challenges in Sanitary Waste Management

Behavioural Issues: Social stigma around menstruation; and concealment of waste.

Policy Gaps: Limited implementation of Solid Waste Management Rules, 2016; and lack of segregation at source.

Technological Constraints: Incineration is costly and polluting; and limited eco-friendly alternatives.

Equity Concerns: Burden falls on informal sanitation workers.

Way Forward

Promote Sustainable Alternatives: Scale up reusable pads and menstrual cups; and encourage biodegradable sanitary products.

Strengthen Waste Segregation: Mandatory separate collection of sanitary waste; and provide labelled disposal bags/bins.
Behavioural Change: Awareness campaigns under Swachh Bharat Mission; and menstrual hygiene education in schools.
Protect Sanitation Workers: Mechanization of waste sorting, and provide PPE and dignified working conditions.
Policy Integration: Include sanitary waste in Extended Producer Responsibility (EPR); and incentivize eco-friendly product innovation.

3. E20 Ethanol Blending in India

Context

1. From April 2026, India has mandated 20% ethanol blending (E20) in petrol to reduce crude oil imports, enhance energy security, and lower carbon emissions.
2. However, emerging evidence suggests that E20 is a transitional solution with mixed outcomes, raising concerns about its long-term sustainability.

About Ethanol Blending

1. It is the process of mixing ethanol (a biofuel made from crops like sugarcane or corn) with petrol to be used as fuel in vehicles.
2. **Example:**
    1. E10: 10% ethanol & 90% petrol
    2. E20: 20% ethanol & 80% petrol
3. It is mainly done to reduce dependence on crude oil, lower pollution and emissions, and promote renewable energy sources.

Rationale Behind Ethanol Blending

India imports ~85% of its crude oil. Ethanol blending helps save foreign exchange, support farm incomes, and reduce GHG emissions (partially).

Impact on Vehicles and Fuel Economy

Lower Energy Efficiency: Ethanol has lower calorific value, leading to higher fuel consumption, and reduced mileage.
Compatibility Issues: Older vehicles (pre-2023) are not designed for E20, that face corrosion risks, and material degradation.
Fuel System Concerns: Ethanol is hygroscopic (absorbs water), and corrosive in nature, that can damage fuel lines, and rubber seals.

Environmental Implications

Positive Effects: Better combustion due to oxygen content, that reduces carbon monoxide (CO), hydrocarbons (HC), and particulate emissions.
Negative Effects:
Increase in NOx Emissions: E20 can increase nitrogen oxides (NOx)
Toxic Aldehyde Emissions: Higher emissions of acetaldehyde, and formaldehyde.
Higher Evaporative Emissions: Ethanol increases fuel volatility leads to VOC emissions, and contributes to ground-level ozone.
Regulatory Gap: India lacks adequate monitoring of aldehydes, and strong evaporative emission norms, compared to US, EU, Brazil.

Economic and Agricultural Concerns

Food vs Fuel Debate: Rising ethanol demand increases demand for corn and sugarcane. It leads to food inflation, and stress on the livestock sector.
Import Paradox: India is importing industrial ethanol, and corn that undermines the goal of self-reliance.
Water Stress: Sugarcane-based ethanol highly water-intensive impacting groundwater levels.

Policy Paradox: Transitional vs Long-Term Solution

1. E20 is a transitional fuel, not a clean end-state. It risks diverting focus from Electric Vehicles (EVs), and hydrogen-based mobility.

Global trend:

1. EU: Focus on electrification (90% CO_2 reduction target)
2. US: Limits blending to ~10–15%

Need for Strategic Reorientation

Promote 2G Ethanol: From crop residues, and municipal waste. It reduces food-fuel conflict.

Shift Towards Industrial Use: Ethanol as chemical feedstock, green solvent, bio-plastic input.

Global examples: USA, Germany, EU

Strengthen Regulations: Introduce aldehyde emission norms, and evaporative emission standards.

Accelerate Clean Mobility: Focus on electric mobility, and renewable energy integration.

4. A Warmer, Shorter Winter in India

Context

1. India's winter of 2026 stands out as an anomaly, marked by a near absence of cold extremes and a premature transition to summer-like conditions.
2. Analysis of IMD data reveals it as part of a broader climatological shift, characterised by declining cold waves, rising temperatures, and increasing variability in seasonal patterns.

IMD Classification

Cold Day: Maximum temperature 4.5°C–6.4°C below normal

Severe Cold Day: >6.4°C below normal

Cold Wave: Minimum temperature 4.5°C–6.4°C below normal

Severe Cold Wave: >6.4°C below normal

Decline of Cold Waves: Key Trends

February 2026: No cold day or cold wave recorded; first such February in five years.

1. Comparison: 6 cold-wave days in 2022; 1 in 2023; 7 in 2024 and 5 in 2025.
2. It indicates a sharp weakening of winter intensity.

Seasonal Trend (Jan–Feb Combined)

3. 24 events in 2026 (second lowest in 5 years); 21 in 2023 (lowest); 38 in 2024 (peak).
4. It suggests high inter-annual variability, but overall declining severity.

Changing Geography of Cold Waves

Core Pattern: Concentrated in North, Northwest, Central India

Emerging Shifts: Limited southern penetration

1. 2023: Telangana & Karnataka affected
2. 2025: Only Telangana (1 day)
3. 2026: Only Karnataka

Spatial Variability:

4. 2023: Widest spread (17 states)
5. 2025: Narrowest (9 states)
6. 2026: Expanded again (15 states)

It reflects unstable spatial behaviour of cold extremes.

Warming Trend Across Cities

Major Observations: 34 cities analysed:

1. 23 cities: Above-normal maximum temperatures
2. 30 cities: Above-normal minimum temperatures

Key Pattern: "Normal" temperatures becoming rare

3. Pan-India trend: From Himalayas (Shimla, Srinagar) to coastal regions (Panjim)

Himalayan Anomalies: Warmer nights than days (relative to normal)

4. Extreme spikes:

    1. Shimla: Up to 10°C above normal
    2. Itanagar: Night temp ~8°C above normal
5. It suggests elevation-dependent warming, a critical climate signal

Scientific Evidence: Long-Term Climate Trends

The observed 2026 anomalies align with broader research findings:

1. Declining cold waves and increasing heatwaves across India
2. Rising minimum temperatures (warmer nights)
3. Increasing temperature anomalies and variability

Conclusion

India's winter of 2026 reflects a clear climatic transition i.e. weaker winters, earlier summers, and erratic spatial spread of cold events.

These trends align with long-term scientific evidence pointing to climate change-driven restructuring of seasonal cycles, rather than isolated anomalies.

5. Energy Warfare in The Strait of Hormuz: Implications for India and The World

Context

1. The recent naval escort of Indian LPG tankers through the Strait of Hormuz signals a structural shift in global energy trade.
2. What was once largely commercial is now deeply geopolitical, resembling a zero-sum strategic contest.
3. Control over energy flows has become a tool of coercion, reflecting the growing weaponisation of trade and supply chains.

Strategic Importance of the Strait of Hormuz

1. A critical maritime chokepoint, only ~33 km wide.
2. It handles a significant share of global energy flows:
    1. ~35% of seaborne crude oil
    2. ~29% of LPG
    3. ~19% of LNG and refined products
3. Nearly 20% of global oil trade passes through it.
4. Around 100 ships transit daily under normal conditions.
5. Maritime chokepoints like Hormuz are 'systemic vulnerabilities' where disruptions can trigger global economic shocks and energy insecurity.

From Conflict to Energy War (2026 Crisis)

1. Conflict triggered by US–Israel strikes on Iran, and Iran's retaliation led to closure of the Strait, causing 97% drop in shipping traffic, and ~3,000 ships stranded.
2. Escalation: Israeli strike on South Pars gas field; and Iranian strike on Qatar's Ras Laffan LNG hub.
3. It resulted in a full-fledged energy war, targeting production and transit infrastructure.

Global Economic Impact

1. Oil prices surged:
    1. Touched $120/barrel, stabilizing above $100
    2. Possible rise to $150 if disruption continues
2. LNG, LPG, fertilisers, helium prices increased
3. IEA released 400 million barrels (record reserve release)
4. Energy shocks from chokepoint disruptions resemble 1970s oil crises, with cascading effects across sectors.

Impact on Asia: Maximum Vulnerability

1. Asia consumes ~80% of Hormuz oil flows; Major dependents are China, India, Japan, South Korea.
2. Severe impacts on developing nations:
    1. Nepal: LPG rationing

2. Sri Lanka: Weekly shutdowns
3. Pakistan: LNG crisis leads to school closures.
3. It highlights energy inequality and vulnerability of import-dependent economies.

India's Energy Vulnerability

High Import Dependence:

1. Crude oil: 88–90% imported, in which ~50% via Hormuz.
2. LPG: 60% imported (90% via Hormuz)
3. LNG: 68% from Gulf.

India's Response

1. Invoked Essential Commodities Act, 1955
2. **4-tier rationing system:**
   1. Priority: households, CNG
   2. Cuts: industry (50%), fertilisers (70%)
3. Increased domestic LPG production by 38%
4. Diversified imports: US, Russia, Norway, Algeria
5. Push for PNG (piped natural gas) expansion

Broader Geopolitical Lessons

Energy Security & National Security: Naval escorts and diplomacy show militarisation of trade routes
Chokepoint Vulnerability: Hormuz exemplifies how geography shapes geopolitics
Weaponisation of Energy: States increasingly using energy supply as leverage.
Control over chokepoints gives states outsized geopolitical power, making global trade fragile.

Way Forward for India

1. Diversification of energy sources (Africa, Americas)
2. Strategic petroleum reserves expansion
3. Accelerate renewables & green hydrogen
4. Strengthen naval presence in IOR
5. Promote regional energy cooperation

OIL SHOCKS

1973 Crisis (First Oil Shock): It was triggered by the Yom Kippur War (1973) between Israel and a coalition of Arab states.

1. OPEC, particularly Arab members, imposed an oil embargo on countries supporting Israel (primarily the US, Western Europe and Japan).
2. Oil prices quadrupled from US $3 per barrel to $12.
3. Global economic recession and inflation followed ('stagflation').

1979 Crisis: Triggered by Iranian Revolution that toppled the Shah of Iran.

4. Production in Iran collapsed and exports fell sharply.
5. Oil prices doubled from $15 per barrel to $39, renewed global inflation and economic slowdown.

1990 Oil Price Spike: Caused by Iraq invasion of Kuwait or Gulf War in 1990.

6. Oil prices jumped from $20 per barrel to over $40 temporarily and stabilised after coalition forces liberated Kuwait in early 1991.

2008 Oil Price Spike: Caused by strong global demand, especially from China and emerging economies.

7. Geopolitical tensions (West Asia) and limited spare capacity resulted in tight supply.
8. Oil prices hit a record high of $147 per barrel in July 2008.

2020 Oil Price Collapse: Triggered by global demand collapse due to COVID-19 lockdowns and price war between Russia and Saudi Arabia in early 2020 exacerbated oversupply.

9. West Texas Intermediate (WTI) crude futures briefly went negative in 2020.

2026 Oil Price Spike: The US–Iran tensions have driven Brent crude prices up from $80 per barrel to $120 within a week.

6. India's Fertiliser Dependence

Context

Recent conflicts in West Asia and past disruptions (Russia–Ukraine war, China's export restrictions) highlight how fertilizer security is directly linked to food security, fiscal stability, and geopolitical strategy.

Scale of India's Fertiliser Dependence

High Import Dependence: India is the 2nd largest fertiliser importer globally (FAO data).

Demand vs Production (2024–25):

1. Demand: ~64.9 million tonnes
2. Production: ~46.5 million tonnes
3. Imports: ~16 million tonnes

Import Concentration Risks:

4. Urea imports: ~70% from Gulf (Oman, Qatar, Saudi Arabia, UAE)
5. DAP imports: More than 40% from Saudi Arabia
6. Heavy reliance on Strait of Hormuz (critical chokepoint)

Hidden Dependence (Raw Materials):

7. 85% natural gas (urea feedstock) imported
8. 90–95% rock phosphate imported
9. ~50% phosphoric acid imported

Effective dependence rises to ~68–70%, making India structurally vulnerable.

Link Between Fertiliser and Food Security

1. Fertilisers are essential for high crop yields and Green Revolution sustainability.
2. Supply disruptions leading to lower yields, inflation, food insecurity.

Recent Geopolitical Shocks

West Asia Conflict (2025–26): Disruption in Gulf supply routes;

1. Gas supply restrictions → fertiliser plants running below capacity;
2. Likely price rise and subsidy burden increase;

Past Examples:

3. Russia–Ukraine War (2022): Fertiliser prices doubled
4. China export restrictions (2025): Forced costly imports

Every disruption leads to reactive scrambling rather than strategic planning.

Key Challenges

Supply Chain Concentration: Overdependence on a few regions (Gulf, China, Russia)

Fiscal Burden:

1. Fertiliser subsidy: ₹1.77 lakh crore (2024–25)
2. Urea heavily subsidised leading to market distortion.

Imbalanced Usage: Excessive urea use leading to soil degradation & environmental damage.

Domestic Constraints: Limited reserves of potash and phosphate; and high dependence on imported feedstock.

Strategies to Reduce Dependence

Diversification of Imports: Shift sourcing to Southeast Asia (Indonesia, Malaysia, Vietnam); Africa, Central Asia, Latin America

1. Reduce geopolitical concentration risks

Overseas Investments: Expand models like Oman India Fertiliser Company (OMIFCO)

2. Invest in rock phosphate (Morocco – 70% reserves); and potash mines abroad

Boost Domestic Production: Improve plant efficiency; use low-grade domestic resources; and integrate with the energy sector (green ammonia).

Strategic Fertiliser Reserve: Maintain buffer stocks for crisis situations

Reforming Fertiliser Subsidy

Current Issues: Urea price fixed since 2018 leading to overuse; and government bears 85–90% of cost.

Suggested Reforms:

1. Direct income transfers to farmers (per acre basis)
2. Rationalise urea pricing
3. Promote balanced nutrient use (NPK mix)

Way Forward

Treat fertiliser as a strategic sector like energy security; and build resilient and diversified supply chains.

Biofertilisers & Organic Inputs: Compost from agricultural waste; and microbial nitrogen fixation

Government Initiatives: PM-PRANAM scheme

7. Ecocide: Environmental Harm in Warfare

Context

1. Recent geopolitical conflicts in West Asia highlight a growing but under-recognised dimension of warfare i.e. environmental destruction.
2. Incidents involving incendiary weapons, toxic chemicals, and attacks on energy infrastructure demonstrate that ecological damage is no longer incidental but increasingly systemic and strategic.

Recent Evidence of Environmental Damage in Conflict

Use of Hazardous Substances: Reports indicate use of white phosphorus over civilian areas in southern Lebanon, and alleged aerial spraying of glyphosate.

1. **White phosphorus** Is highly incendiary; causes severe burns, fires, and long-term soil contamination.
2. **Glyphosate** is an herbicide that can contaminate soil, crops, and water systems at high concentrations.

According to environmental monitoring groups, over 120 incidents of ecological harm have been recorded in the ongoing conflict.

Destruction of Energy Infrastructure

1. Airstrikes on oil depots and refineries triggered massive fires releasing soot, hydrocarbons, sulphur and nitrogen compounds.
2. Reports of 'black rain' (acid precipitation) affecting human health and agriculture.

Climate Impact of War

Initial weeks of bombardment were estimated to emit ~5 million tonnes CO_2 equivalent, exceeding annual emissions of some countries (e.g., Iceland).

Emissions drivers: Burning oil facilities, military mobilization, and weapon production and deployment

When Does Environmental Harm Become a War Crime?

Traditionally, environmental damage in war is treated as collateral, not primary harm. However, current conflicts challenge this assumption.

Historical Precedent:

Agent Orange (Vietnam War): Long-term ecological and human health damage, and triggered global debate on environmental protection in warfare.

Existing Legal Frameworks

Additional Protocol I (1977): Prohibits warfare causing 'widespread, long-term, and severe' environmental damage.

Rio Declaration (1992): Warfare is inherently destructive to sustainable development (Principle 24).

Rome Statute, 1998 (ICC): Environmental damage is a war crime if it is intentional, causes widespread, long-term, severe harm, and is disproportionate to military advantage.

Concept of Ecocide

It was proposed in 2021 as 'Unlawful or wanton acts committed with knowledge of causing severe and widespread or long-term environmental damage'.

Recent Developments: 2024 proposal by Vanuatu, Fiji, Samoa to include ecocide as the 5th international crime under the Rome Statute.

Ecology as a Tool of Conflict

Slow Environmental Transformation: Afforestation policies replacing native ecosystems:

1. Example: Replacement of Mediterranean vegetation with European pines
2. Impacts: Biodiversity loss; Soil degradation; Altered fire regimes

War–Environment Nexus: Environmental damage is now a by-product of conflict.

A strategic instrument (e.g., targeting infrastructure, altering landscapes)

Way Forward

1. Codify Ecocide as an international crime with clearer thresholds
2. Strengthen monitoring mechanisms (e.g., satellite-based environmental tracking)
3. Integrate environmental norms into military doctrines
4. Promote universal participation in ICC frameworks
5. Enhance role of non-state actors and civil society in documentation and advocacy

8. West Asia War: Impact On India's Pharmaceuticals Sector

Context

1. Recent geopolitical conflicts have exposed the fragility of global pharmaceutical supply chains.
2. Disruptions in the supply of critical raw materials and rising input costs pose a serious threat to global public health, especially for developing nations dependent on affordable medicines from India.

About Geopolitics and the Changing Nature of 'Collateral Damage'

1. Modern conflicts increasingly extend beyond battlefields to disrupt essential civilian infrastructure, including healthcare systems.
2. Geopolitical tensions and wars significantly affect pharmaceutical supply chains by interrupting logistics, increasing trade barriers, and creating uncertainty in global markets.
3. Such disruptions disproportionately affect vulnerable populations, especially children, by limiting access to essential medicines and vaccines.

India as the 'Pharmacy of the World'

1. India plays a central role in global health:
    1. Supplies generic medicines to ~200 countries
    2. Major provider of vaccines (DPT, BCG, measles) to UNICEF and WHO
    3. Accounts for a significant share of low-cost drugs globally
2. India's pharmaceutical sector is deeply integrated into global health systems, particularly in developing regions.

Structural Weakness: Dependence on Imported Raw Materials

Heavy Import Dependence: 70–75% of APIs and intermediates sourced from China.

1. Dependence spans Key Starting Materials (KSMs), drug intermediates, and Active Pharmaceutical Ingredients (APIs).
2. India's dominance in generics is underpinned by reliance on Chinese raw materials, making it vulnerable to external shocks.

Impact of War on Pharma Supply Chains

Supply Chain Disruptions: Damage to air transit hubs and shipping routes, delays in temperature-sensitive drugs (e.g., cancer medicines) and increased logistics costs and rerouting.

1. Pharmaceutical supply chains are highly sensitive to geopolitical disruptions due to their complexity and just-in-time nature.

Rising Input Costs: Increased cost of APIs and intermediates; currency volatility and insurance costs; and impact on drug prices across the distribution chain.

2. Rising trade pressures and tariffs significantly increase pharmaceutical costs, especially for generic manufacturers.

Medicines at Risk: Shortages and price increases are expected in Paracetamol (fever management), antibiotics (routine infections), diabetes medicines, and cancer drugs (temperature-sensitive).

3. These medicines form the backbone of primary healthcare, amplifying the crisis.

Global Implications

Impact on Developing Countries: Africa and low-income countries rely heavily on Indian generics.

1. Disruptions may cripple public health programs

Vaccine Supply Risks: India supplies bulk vaccines globally;

2. ~70% of vaccine raw materials are imported → potential bottlenecks

Threat to Global Health Security: Disruptions in pharmaceutical supply chains can undermine global health systems and pandemic preparedness.

Policy Responses and Gaps

Government Measures: Production Linked Incentive (PLI) scheme to boost domestic API production; and increase in API exports.

Limitations:

1. Continued high import dependence;
2. Rising share of imports from China;
3. Insufficient domestic capacity in KSMs and intermediates;

Onshoring and diversification are necessary but require long-term investment and policy coherence.

Way Forward

Short-Term Measures: Strategic stockpiling of critical drugs and APIs; diversification of import sources; and strengthening logistics and cold-chain infrastructure.

Long-Term Measures: Promote domestic API and KSM manufacturing; invest in R&D and innovation; build resilient supply chains (multi-country sourcing); and enhance global cooperation in health security.

9. Fuelwood Resurgence Amid LPG Crisis: Energy Security Lessons For India

Context

Amid West Asia conflict, fuelwood has re-emerged as a critical fallback energy source, as it disrupted global energy supply chains, exposing India's dependence on imported liquefied petroleum gas (LPG).

Return to Fuelwood

Across India, reports indicate a sharp surge in fuelwood demand:

1. Chhattisgarh, Jharkhand, Odisha, Kerala: Households reverting to fuelwood despite earlier LPG adoption
2. Urban spillover: Even city dwellers are sourcing fuelwood from outskirts

Informal markets booming

3. Fuelwood bundles being sold near Raipur
4. Ranchi witnessing increased roadside trade
5. Balangir (Odisha) seeing LPG users shift to wood

It reflects a 'distress-driven reverse transition' in cooking energy use.

Historical Perspective: Echoes of the 1970s Oil Crisis

1. The 1974 oil crisis triggered LPG shortages in India
2. That decade marked the beginning of the transition from fuelwood to LPG
3. However, the transition remains incomplete even after five decades

Fuelwood continues to function as a parallel energy system.

Current Energy Mix

NSO (2021): ~33% households use fuelwood; and ~50% rural households depend on it

NFHS-5: ~41% population uses biomass fuels (fuelwood, dung cakes)

Urban India: 89% households use LPG

Regional disparity: 11 states have more than 50% households using solid fuels

These Indicate energy inequality and rural-urban divide.

Fuelwood Economy

Fuelwood is not merely a traditional fuel—it is an organized informal economy:

1. Global market size: $37.04 billion (2024) and further projected ~$46 billion by 2030 (Grand View Research)
2. Livelihood dependence: Millions of rural households engaged in collection and trade.
3. Commercial circulation: ~18% of fuelwood collected is sold in towns and cities.

These demonstrate that fuelwood is a market-driven energy commodity, not just subsistence use.

Why Fuelwood Persists

Structural Reasons

1. Affordability: Minimal or zero monetary cost
2. Accessibility: Locally available
3. Supply reliability: Not dependent on imports or logistics
4. Cultural familiarity: Traditional cooking practices

The current LPG shortage reinforces these advantages.

Concerns and Challenges

Health Impacts: Indoor air pollution leads to respiratory diseases; and disproportionate burden on women and children.

Environmental Costs: Deforestation and forest degradation, and carbon emissions (though sometimes considered carbon-neutral locally).

Energy Poverty: Indicates lack of sustained access to clean energy; and reflects gaps in schemes like PM Ujjwala Yojana.

Policy Implications

Strengthen Clean Energy Access: Ensure continuous LPG supply chains; and improve refill affordability (subsidies, DBT efficiency).

Diversified Energy Basket: Promote alternatives like biogas, electric cooking, and solar-based solutions.

Sustainable Fuelwood Management: Agroforestry and community forestry, and efficient cookstoves to reduce emissions.

Focus on Energy Justice: Address rural-urban disparities, and target vulnerable populations.

10. Declining Camel Population in Rajasthan

Context

Recently, the Rajasthan High Court observed a sharp decline in camel population despite a protection law.

Trend in Camel Population

1. India's Camel population has declined by more than 75% since the 1970s, a decline driven by economic transitions, shrinking rangelands, legal constraints, and declining institutional support
   - ~7.5 lakh in 2004, ~3.2 lakh (year of enactment of protection law) in 2015 and ~1.5 lakh in 2021.
2. It indicates a continuous and steep decline, even after legal protection.

Legal Framework

Rajasthan Camel Act, 2015: Rajasthan Camel (Prohibition of Slaughter and Regulation of Temporary Migration or Export) Act, 2015.

Key Provisions:

1. Ban on slaughter of camels
2. Restriction on transport/export outside the state
3. Regulation of migration of camels

Camel declared as the State Animal of Rajasthan.

About Camels

They are exceptionally suited to dryland ecosystems, and deeply embedded in the cultural lives of pastoral communities such as the Raika, Rabari, and Fakirani Jat.

Key Camel Breeds in India

Dromedary Camels (Rajasthan and Gujarat):

1. **Bikaneri (Rajasthan):** Commonly used for cart pulling and heavy draught work.
2. **Jaisalmeri (Rajasthan):** Primarily used for riding, camel safaris, and long-distance travel, especially in the Thar Desert.
3. **Mewari (Southern Rajasthan):** This is a dual-purpose breed, utilized for both milk production and draught.
4. **Kachchhi (Gujarat):** It is commonly used for ploughing and carting in the Rann of Kachchh and surrounding regions.
5. **Kharai (Gujarat):** Adapted to coastal and mangrove ecosystems. It is an excellent swimmer, capable of crossing creeks and feeding on mangroves.

Bactrian (Camelus bactrianus), Ladakh: The double-humped camel, or Bactrian camel, is found exclusively in the high-altitude cold desert of Ladakh.

6. Critically Endangered on the IUCN Red List of Threatened Species.
7. Gobi and Gashun Gobi deserts of northwest China and Mongolia.

11. Illegal Sand Mining in National Chambal Wildlife Sanctuary

Context

A Supreme Court-appointed Central Empowered Committee (CEC) has flagged rampant illegal sand mining in the National Chambal Wildlife Sanctuary (NCWS). The issue highlights governance failures across Rajasthan, Madhya Pradesh, and Uttar Pradesh.

About National Chambal Wildlife Sanctuary

1. It is a tri-state protected area (Rajasthan, Madhya Pradesh, Uttar Pradesh).
2. It is notified for conservation of critically endangered species like Gharial (Gavialis gangeticus); Gangetic River dolphin; and Indian skimmer.
3. It is recognized as an Important Bird Area (IBA).
4. It features a fragile riverine ecosystem with sandbanks crucial for breeding.

Key Findings of the CEC

Continuous illegal mining: Sand extraction, transportation, and storage ongoing inside sanctuary limits.
Weak coordination: Poor inter-state and inter-departmental cooperation.
Denotification concerns: States have denotified forest areas without central approval, facilitating mining.
Regulatory failure: Ineffective enforcement of environmental laws and court orders.

Environmental Impacts

Threat to Biodiversity: Destruction of nesting sites of gharials and turtles. Disturbance to river dolphins and bird habitats.
River Ecology Degradation: Alteration of river flow and sediment balance. Increased erosion and habitat fragmentation.
Pollution and Noise: Mining machinery leads to noise pollution, affecting aquatic fauna.

Legal and Governance Issues

1. Violations of Wildlife Protection Act, 1972; and Environment Protection Act, 1986
2. Weak implementation of Eco-Sensitive Zone (ESZ) norms.
3. Federal governance gap: lack of coordinated action among states.

CEC Recommendations

1. Immediate ban on mining, extraction, transportation, storage of sand in sanctuary and ESZ.
2. Strengthening inter-state coordination mechanisms.
3. Strict enforcement of forest and wildlife laws.

Way Forward

1. Establish a joint inter-state task force.
2. Use technology (drones, GIS) for monitoring.
3. Ensure community participation in conservation.
4. Strengthen accountability of state authorities.

12. Global Energy Crisis Amid Conflict in West Asia

Context

The ongoing geopolitical conflict involving the US, Israel, and Iran has triggered a global energy crisis.

About

1. Disruptions in critical supply routes, especially maritime chokepoints like the Strait of Hormuz have historically posed major risks to global oil flows, affecting nearly one-fifth of global petroleum trade.
2. It has led to acute shortages of fuel (petrol, diesel, LPG), rising inflation and trade deficits, and long queues and rationing in several countries.

The crisis is not merely economic but humanitarian, disproportionately affecting vulnerable populations.

Socio-Economic Impacts

Energy Poverty and Inequality: Over 700 million people lack reliable energy access, making them highly vulnerable.

1. Rising LPG and fuel prices strain household incomes, especially in developing countries.

Impact on Agriculture and Food Security: Fertilizer supply disruptions (linked to natural gas) threaten agricultural productivity.

2. Combined with climate change, this may intensify global food insecurity.

Macroeconomic Stress: Increased oil import bills worsen current account deficits.

3. Developing economies face currency depreciation and fiscal instability.

Pre-existing Energy Transition Trends

1. Even before the crisis, the world was transitioning toward clean energy: Renewables accounted for ~50% of installed electricity capacity by 2025.
2. Around 85% of new capacity additions were solar and wind.
3. This transition is driven not only by climate goals but also by cost-effectiveness and technological advancements.

Role of Developing Countries in Energy Transition

1. Low and middle-income countries are leading adoption:
   1. Countries like Namibia and Togo (solar);
   2. Jordan and Kyrgyzstan (battery systems);
   3. Nepal and Sri Lanka (electric vehicles)
2. These trends are supported by falling costs of solar panels and batteries, flexibility to bypass legacy fossil fuel infrastructure, dependence on energy imports, and pushing energy independence.

War-Induced Structural Shifts in Energy

Short-Term Responses: Diversification of suppliers: US, Russia, Nigeria, Guyana;

1. Increased reliance on domestic fossil fuels (coal, charcoal)

Long-Term Structural Changes: Possible end of cheap fossil fuel era; acceleration of energy nationalism and protectionism; and supply chain restructuring for energy technologies.

Energy systems are becoming more geopolitically fragmented.

Clean Energy: From Climate Imperative to Security Necessity

1. The crisis reframes renewable energy as a tool for energy security, a hedge against geopolitical shocks, and a pathway to economic resilience.
2. Crises often accelerate energy transitions, as seen in Europe post-Ukraine war.

Challenges Ahead

1. Infrastructure damage in conflict zones delays supply recovery; fragmented global cooperation weakens climate action; and risk of reverting to polluting fuels in the short term.
2. The global order governing energy and climate is increasingly unstable.

Way Forward

1. Diversification of energy mix: renewables, storage, and green hydrogen
2. Strengthening strategic reserves
3. Decentralized energy systems (mini-grids, rooftop solar)
4. International cooperation despite geopolitical tensions
5. Domestic manufacturing of clean technologies

13. Maternal Mortality in India and The World

Context

Recent findings from the Global Burden of Disease (GBD) 2023 Study highlight a significant decline in maternal mortality globally and in India. However, progress remains uneven, with major challenges persisting in high-burden countries.

About Maternal Mortality

1. It refers to the death of a woman during pregnancy, childbirth, or within 42 days after termination of pregnancy, from causes related to or aggravated by the pregnancy or its management (excluding accidental or incidental causes).
2. It is a critical indicator of women's health and healthcare delivery. It is included in SDG Goal 3 (Good Health and Well-being).
3. Maternal Mortality Ratio (MMR) is the key indicator used to measure maternal mortality.
4. It reflects the quality of the healthcare system, access to maternal services, and socio-economic conditions.

India's Progress

1. India has reduced its Maternal Mortality Ratio (MMR) by nearly 80%, from 508 (1990) to 116 (2023). It reflects improvements in institutional deliveries, access to antenatal care, and government schemes (e.g., JSY, JSSK).
2. Despite this progress:
    1. India recorded 24,700 maternal deaths in 2023, making it the second-highest globally after Nigeria.
    2. Indicates that absolute burden remains high due to population size and regional disparities.

Global Scenario

1. Total maternal deaths worldwide (2023): ~240,000
2. Global MMR: 190.5 per 100,000 live births
3. This is ~3 times higher than the SDG target (≤70 by 2030)
4. **High-Burden Countries:** Five countries account for 36% of global maternal deaths: Nigeria, India, Ethiopia, Pakistan, and Cameroon.
5. These countries face weak health systems, inequitable access, and socio-economic barriers.

Major Medical Causes of Maternal Deaths

Haemorrhage (Severe Bleeding): Leading cause globally; especially postpartum haemorrhage; and requires timely emergency obstetric care.

Hypertensive Disorders: Includes preeclampsia/eclampsia; share increased from 16.6% to 20.1%; and reflects rising non-communicable disease burden.

These two causes account for over 40% of maternal deaths globally.

Emerging Concern: Late Maternal Deaths

1. Defined as deaths 43 days to 1 year after childbirth
2. Increased from 1.3% (1990) to 3.2% (2023)
3. It indicates gaps in postnatal care, and need for continuum of care beyond delivery.

Key Challenges

Structural Issues: Regional disparities (e.g., BIMARU states); rural-urban divide; and shortage of skilled birth attendants.

Health System Gaps: Inadequate emergency obstetric care. weak referral systems, and poor postnatal follow-up.

Social Determinants: Early marriage and pregnancy, malnutrition and anemia, and gender inequality.

Way Forward

Policy Measures: Strengthen primary healthcare (Ayushman Bharat, HWCs); and improve maternal death surveillance systems

Clinical Interventions: Timely management of haemorrhage & hypertension, and scale up skilled birth attendance.

Social Interventions: Delay age of marriage, and improve female education and nutrition.

14. India's Updated Climate Commitments (NDCS) For 2035

Context

1. Recently, India has updated its Nationally Determined Contributions (NDCs) under the Paris Agreement (2015), marking its third submission to the UNFCCC.
2. These commitments reflect a balanced approach between development and decarbonisation, especially in a global context of geopolitical tensions and supply-chain disruptions.
3. The update follows the first Global Stocktake (2023), which highlighted that the world is off track to limit warming to 1.5°C.

Key Targets for 2035

Emissions Intensity Reduction: Reduce emissions intensity of GDP by 47% from 2005 levels

Clean Energy Transition: Achieve 60% of installed power capacity from non-fossil fuel sources

Carbon Sink Expansion: Create 3.5–4 billion tonnes CO_2 equivalent carbon sink through forests and tree cover.

Qualitative Targets

1. Climate-friendly economic pathways
2. Climate-resilient infrastructure
3. Mobilisation of low-cost finance (domestic & international)
4. Capacity building and R&D
5. Promotion of Lifestyle for Environment (LiFE)
6. These aim to embed sustainability into governance and ensure a just and inclusive transition.

Significance of the Updated NDCs

- Aligns with India's net-zero targets by 2070
- Reflects commitment to climate multilateralism
- India differs from developed nations by focusing on emissions intensity, not absolute cuts
- Positions India among 130+ countries submitting updated NDCs.

Analysis

Incremental but Cautious Approach: Targets represent a gradual increase, not a major leap

1. **Concerns:** Lack of sector-specific pathways; and weak integration of existing decarbonisation roadmaps.

Energy Transition Challenges (Installed Capacity vs Actual Generation): More than 50% installed capacity from non-fossil fuels (~283 GW), but only about 29% actual electricity generation is non-fossil.

2. **Key Issues:** Structural inefficiencies in the energy system; grid constraints and transmission bottlenecks; renewable energy curtailment (e.g., 2.3 TWh solar curtailed in 2025); coal plants not flexible enough.

Strategic Shift in Energy Policy: Renewables now seen as a climate necessity and energy security tool, and reduces dependence on imported fossil fuels.

3. However, risk of new dependency on Lithium, and solar components supply chains.

Role of Technology: Key sectors (cement, aluminium, MSMEs) rely on energy efficiency improvements, and Carbon Capture, Utilisation and Storage (CCUS)

4. **Concern:** Pace of technological scaling may be insufficient.

Climate Finance Challenge: Estimated $8 trillion (2025–2050) required, and $5 trillion for the power sector alone.

5. **Constraints:** Global climate finance inadequate; $300 billion/year vs $1.3 trillion demand (COP29); and heavy reliance on domestic funding, and debt financing.

15. Artemis II And the New Lunar Race

Context

Half a century after Apollo, NASA's Artemis II aims to open a new chapter in deep-space exploration.

About Artemis Programme

Return to the Moon: NASA's Artemis programme aims to return humans to the Moon after the Apollo missions (ended in 1972). Artemis II is a crewed lunar flyby mission, paving the way for Artemis III (planned landing mission).

Focus on Lunar South Pole: The south pole region is the primary target due to presence of Permanently Shadowed Regions (PSRs), high possibility of water ice deposits, and geological diversity useful for scientific study.

Gateway to Mars: The Moon is envisioned as a launch base for deep-space missions, especially Mars. Artemis aligns with NASA's long-term goal of interplanetary exploration.

Importance of Lunar Far Side Observation

1. The far side of the Moon is less explored due to lack of direct communication with Earth.
2. Artemis II observations under partial illumination enhance detection of crater rims, ridges, slopes, and understanding of lunar geology and evolution.

Global Lunar Competition

United States (NASA): Artemis missions aim for human landing, lunar base establishment, and sample return missions.

China:

1. Target: Crewed Moon landing by 2030
2. Achievements: First landing on far side (2019); and sample return missions (2020, 2024)
3. Plans: International Lunar Research Station (ILRS) with Russia by 2035, and possible landing sites near equatorial volcanic regions (e.g., Rimae Bode)

India:

4. Chandrayaan-3 (2023): Successful south pole landing
5. Chandrayaan-4 (2027 planned): Sample collection and return; focus on south pole exploration

Strategic and Geopolitical Dimensions

Resource Competition: Key lunar resources like Helium-3 (potential fusion fuel), water ice raises concerns about resource control, and economic exploitation

Military Concerns vs Scientific Cooperation:

1. Moon could become a strategic control point (Earth-Moon gravity well concept) & risk of militarization of space.
2. Moon is too distant and costly for effective military use; and limited direct strategic advantage.

International Space Law: Governed by the Outer Space Treaty (1967), prohibits weapons of mass destruction in space, and promotes peaceful use of outer space.

16. Land Consolidation in India: Key to Agrarian Reform and Productivity

Context

1. Land consolidation has become more relevant than ever for sustainable agriculture and rural development with rising land fragmentation due to demographic and economic pressures.
2. Implementation of land consolidation in India remains uneven and incomplete, despite early adoption and proven benefits.

About Land Consolidation in India

It refers to the reorganization of fragmented agricultural landholdings into compact blocks to improve efficiency, reduce costs, and enhance productivity.

Two Approaches:

1. **Voluntary Approach:** Based on consent of all landowners; more democratic and sustainable
2. **Majority-Based Approach:** Implemented with majority approval; faster but may lead to disputes.

Historical Evolution in India

Pre-Independence: Introduced in Punjab (1920) on an experimental basis; supported by cooperative societies

Post-Independence: Became a key component of land reforms (Kumarappa Committee); Adopted alongside Zamindari abolition, Tenancy reforms, and Land ceiling laws.

Legal Provisions

Constitutional Position:

1. Land is a State Subject (Entry 18, State List)
2. States are responsible for enacting and implementing consolidation laws

Central Support:

3. Department of Land Resources (DoLR), Ministry of Rural Development
4. Provides policy guidance and promotes best practices
5. Supports Digital India Land Records Modernization Programme (DILRMP)

Major State Laws:

6. Uttar Pradesh Consolidation of Holdings Act, 1953

Uttar Pradesh Model: Initiated in 1954 (Muzaffarnagar, Sultanpur); expanded statewide in 1958; and covered over 100,000 villages (Phase I).

7. Punjab Consolidation of Holdings Act, 1948
8. Haryana Consolidation of Holdings Act, 1948 (adapted)
9. Madhya Pradesh Land Revenue Code, 1959 (Sections 205–221)
10. Himachal Pradesh Holdings (Consolidation and Prevention of Fragmentation) Act, 1971

Objectives of Land Consolidation | Process of Land Consolidation

1. Reduce fragmentation of holdings | Notification of Area by state government
2. Promote economies of scale | Updating Land Records
3. Enable mechanization and irrigation efficiency | Valuation of Land Parcels
4. Improve land records and tenure security | Preparation of Consolidation Scheme
5. Facilitate rural infrastructure development (roads, irrigation channels) | Reallocation of Land (Chakbandi) into contiguous plots | Provision for Compensation (if value differs) | Creation of New Land Records (Jamabandi)

Evidence of Effectiveness

Empirical Findings: Fragmentation reduces productivity significantly; even a 10% reduction in fragmentation can boost output per acre.

1. **Field Study (Rajasthan, 2025):** Cultivation cost reduced by more than 30%; Labour days reduced from 220 to 140; and tractor use reduced by almost 50%.

Regional Success: Punjab, Haryana, Western UP have better irrigation systems, higher mechanization, and strong foundation for Green Revolution

2. **Lagging States (e.g., Bihar, Odisha)** lack of consolidation linked to lower agricultural development.

Global Perspective

1. FAO (2020) identifies land consolidation as a key tool for rural development
2. Contributes to SDGs: SDG 1 (No Poverty); & SDG 2 (Zero Hunger)

Challenge of Land Fragmentation

Rising fragmentation: 86.2% of India's operational holdings are small and marginal (<2 ha) (Agriculture Census 2021–22).

1. Average landholding declined from 1.08 ha (2016–17) to 0.74 ha (2021–22) (NABARD).
2. **Causes:** Population growth, inheritance laws leading to subdivision, economic compulsions
3. **Impacts:** Increased cost of cultivation, reduced mechanization efficiency, higher labour and time costs, lower agricultural productivity and incomes

Administrative & Governance Issues: Corruption and lack of transparency, weak land records and mapping systems, and revenue department-led process lacks local accountability.

Social Resistance: Disputes over land valuation and allocation, and lack of consent (e.g., cases from Uttar Pradesh villages).

Legal and Policy Gaps: Excessive exemptions in laws, and irregular implementation across states.

Infrastructure Issues: Missing access roads; and loss of trees, wells without compensation.

Policy Innovations & Suggestions

Strengthen Institutional Mechanisms: Involve Gram Panchayats for transparency; digitize land records (SVAMITVA, DLRS initiatives).

Ensure Farmer Participation: Minimum 75% consent rule (as suggested in UP)

Periodic Consolidation: Repeat exercise every 10–15 years

Integrate with Rural Development: Align with irrigation, roads, and livestock policies.

Protect Common Lands: Ensure proper demarcation of grazing and community lands.

Way Forward

Land consolidation is not merely a technical reform but a structural transformation tool for Indian agriculture. It improves productivity, reduces costs, and enhances rural livelihoods. However, its success depends on transparent governance, community participation, and periodic updates.