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FINANCIAL ASYMMETRY IN POLITICAL FUNDING IN INDIA

Context

- Ahead of successive electoral cycles, concerns have intensified regarding transparency in India's political funding framework, with unequal access to private donations distorting electoral competition.

Political Funding in India

- **Individual Donations:** Section 29B of the Representation of the People Act (RPA) 1951, permits political parties to accept donations from individual persons.
  - The Election Commission of India's Transparency Guidelines require the disclosure of donations over **₹20,000** under the Act.
- **State/Public Funding:** State funding of elections in India involves the government providing financial support to political parties and candidates.
  - **Direct Funding:** Monetary assistance directly to parties/candidates for campaign expenses.
  - **Indirect Funding:** Includes subsidized media access, tax benefits, free public spaces for campaigns, and support for utilities, transport, and security.
- **Corporate Funding:** Governed under **Section 182 of the Companies Act, 2013.** Corporate donations were banned in India from **1969 until 1985.** Key conditions for Donation are as;
  - Companies must be at least **three years old.**
  - Donations are capped at **7.5%** of the average net profits made during the three immediately preceding financial years.
  - Contributions must be disclosed in the company's profit and loss account.

Challenges in the Existing Funding Framework

- **Concentration of political finance:** Political funding is **heavily skewed** in favour of a few dominant parties, leading to an uneven distribution of financial resources and weakening electoral competition.
- **Weak transparency:** Disclosure requirements are inadequately enforced, and key information on **donor–party linkages** remains outside the public domain, limiting meaningful citizen scrutiny.
- **Lack of internal party accountability:** Most political parties function without enforceable norms of internal democracy, transparent decision-making, or rigorous financial auditing.
- **Unlimited party spending** on more ambitious, sophisticated and professional campaigns has resulted in increasing costs of elections.

Electoral Trust Scheme

- **Electoral Trust Scheme:** The electoral trust scheme was introduced by the government in **2013.**
- Electoral trusts are one of the **funding channels for political parties.**
  - They became a preferred source of political donation for companies in 2024-25 after the SC scrapped the **electoral bonds scheme in 2024.**
  - **Both schemes** are meant to facilitate donations to political parties by corporations and individuals.
- **Eligibility:** Any company registered under the Companies Act can form an electoral trust.
  - Any citizen of India, a company registered in India, or a **firm or Hindu Undivided Family** or association of persons living in India, can donate to an electoral trust.
- **Three trusts**, Prudent Electoral Trust, Progressive Electoral Trust and New Democratic Electoral Trust, accounted for **98 percent** of all contributions in **2024-25.**

How do These Trusts Function?

- **Renewal Requirement:** Electoral trusts must apply for renewal every three financial years to continue operating.
- **Eligible Beneficiaries:** Donations can be made only to political parties registered under Section 29A of the Representation of the People Act, 1951.
- **Mandatory Disbursement Rule:** At least 95% of total contributions received in a financial year must be donated to eligible political parties.
  - The remaining 5% may be used only for administrative expenses.
- **Disclosure of Donor Identity:** PAN is mandatory for resident Indian contributors.
  - Passport number is required for NRIs at the time of contribution.
- **Accounting & Oversight:** Trusts must maintain audited accounts, disclosing donors, recipients, and disbursements to the CBDT and the Election Commission of India (ECI).

Recommendations on State Funding

- **Constituent Assembly debate:** The earliest discussions on the cost of elections were held in the Constituent Assembly in **1948.**

- They argued in favour of the need for the state/public treasury to bear election expenditure in a regulated, least expensive and organised manner.

- **Indrajit Gupta Committee (1998):** Supported state funding to level the playing field for all parties.
- **Law Commission of India (1999):** Advocated for total state funding, conditional on parties not accepting other funds.
- **Second Administrative Reforms Commission (2008):** Recommended partial state funding to reduce undue financial influence.

Reforms needed in political funding in India

- A **comprehensive political finance law** should aim to ensure equity, transparency, and accountability across parties.
- Electoral trusts should be mandated to **publicly disclose donor–party linkages**, enabling informed citizen oversight.
- Political parties should be brought under the **Right to Information Act** to enhance financial and organisational transparency.

Source: IE

INDIA'S GAIN FROM RCEP WITHOUT RISKING CHINA

Context

- India has managed to strategically position itself to reap benefits of **Regional Comprehensive Economic Partnership (RCEP)** without formally joining the bloc or exposing itself to the vulnerabilities associated with Chinese market dominance.

RCEP and India's 2019 Exit

- The **RCEP** includes the **10 ASEAN nations** *(Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam)* plus **Australia, China, Japan, South Korea, and New Zealand**.
  - It covers **nearly 30% of global GDP** and population.
- India, in **November 2019**, announced that it would **not join RCEP 'in its present form',** citing the agreement's **failure to address India's core concerns, like:**
  - **Unrestricted Chinese access** to its markets;
  - Lack of safeguards for domestic industries like agriculture and manufacturing;
  - Inadequate protection for services and data localization;

India's Alternative Strategy To RCEP Members

- India pursued a **bilateral and minilateral trade strategy** to secure access to key markets while avoiding overexposure to Chinese imports, rather than joining RCEP.
- **Bilateral FTAs with RCEP Members:** India has signed or is negotiating Free Trade Agreements (FTAs) with **nearly all RCEP members except China.**
  - India now has **trade agreements with 14 of the 15 RCEP countries,** effectively integrating itself into the RCEP trade network, minus China.
  - India ensures market access while maintaining **tariff sovereignty**, by securing FTAs with **14 of the 15 RCEP members.**

India's FTA Network with RCEP Members

- **ASEAN–India Trade in Goods Agreement (AITIGA):** *In effect since January 2010.*
  - India is currently **re-negotiating the ASEAN Deal (AITIGA)** to correct the **trade deficit** that has grown since its inception.
- **India–South Korea Comprehensive Economic Partnership Agreement (CEPA):** *January 2010*
- **India–Japan CEPA**: *August 2011*
- **India–Australia Economic Cooperation and Trade Agreement (ECTA):** *December 2022*
- **India–New Zealand FTA**: *Negotiations concluded December 2025.*
  - The **newer agreements with Australia and New Zealand** complete the **RCEP-minus-China framework**.

Strategic Decoupling from China: India avoids automatic tariff reductions on Chinese goods, which could have flooded Indian markets and hurt domestic industries by staying out of RCEP.

- It aligns with **India's broader China+1 strategy**, aimed at **reducing economic dependence on China** amid geopolitical tensions.

- **Focus on Trusted Supply Chains:** India has joined initiatives like the **Supply Chain Resilience Initiative (SCRI) with Japan and Australia** to diversify trade and reduce reliance on China.
  - These efforts complement **India's Production-Linked Incentive (PLI) schemes,** which aim to boost domestic manufacturing and exports.

- **Limited Engagement with China via APTA:** India and China remain part of the **Asia-Pacific Trade Agreement (APTA)**, a **preferential trade pact** offering limited tariff concessions on select goods.
  - APTA is far less extensive than a full FTA and helps India maintain **policy flexibility** while managing its trade exposure to China.

India's Approach: A Calculated Trade-Off

- India's approach reflects a calibrated trade policy that balances openness with strategic caution.
  - It forgoes the formal benefits of RCEP membership like dispute resolution mechanisms and deeper integration.
- It gains market access through bilateral deals, policy autonomy to protect sensitive sectors, geopolitical leverage by avoiding entanglement with China-dominated trade rules.
- India's current trade architecture delivers **strategic balance**, broad regional access **without overexposure to China.**
- By staying out of RCEP, India has **retained its economic autonomy**, and through carefully negotiated bilateral agreements, it has effectively **replicated RCEP's benefits** on its own terms.

Source: TH

GREEN HYDROGEN TO RESHAPE RE SECTOR IN INDIA

Context

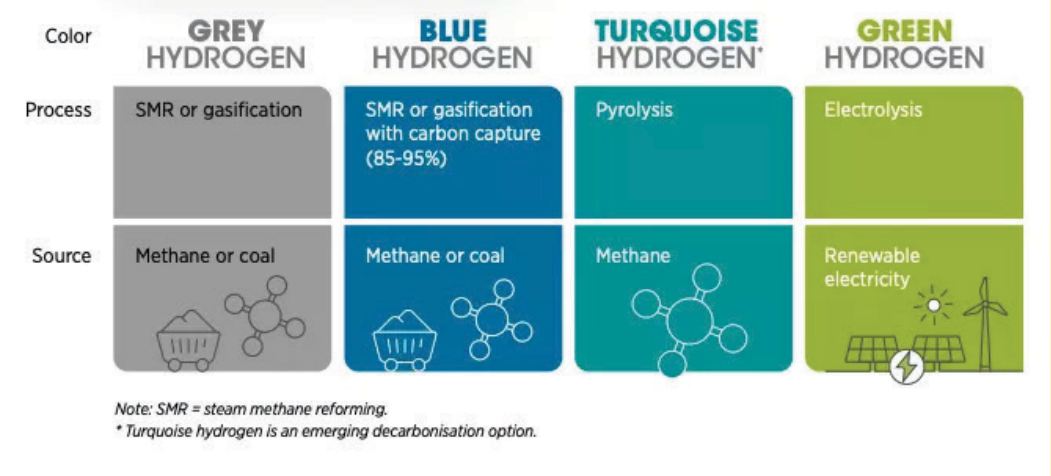
- In the next five years, **technologies like energy storage and green hydrogen** would fundamentally reshape India's renewable energy ecosystem.

India's Green Hydrogen Mission

- **Green hydrogen** has emerged as a **clean, scalable fuel alternative** that can **decarbonize** hard-to-abate sectors, reduce import dependence on fossil fuels, and support India's goals for energy security.
- The Indian government launched the **National Green Hydrogen Mission (NGHM)** in **2023,** as an umbrella programme that aims to establish a **Green Hydrogen ecosystem**.
- **India targets 5 MMT** of Green Hydrogen production annually by **2030.**
- **Hydrogen mobility pilots** launched across 10 routes, involving 37 fuel cell and hydrogen internal combustion engine vehicles.
- **The Mission focuses on four key pillars,** including policy and regulatory framework, demand creation, research and development & innovation, and enabling infrastructure and ecosystem development.

What is Green Hydrogen?

- Green Hydrogen is Hydrogen produced **using renewable energy, such as solar or wind power, instead of fossil fuels.**
- In this process **water is split into hydrogen and oxygen** through electrolysis, using **electricity from solar panels or wind turbines.**
- Hydrogen made this way is considered "green" if the total emissions from the process are very low, not **more than 2 kg of CO_2 equivalent for every 1 kg of Hydrogen produced.**
- **Green Hydrogen** can also be produced by **converting biomass** (like agricultural waste) into hydrogen, as long as emissions remain below the same limit.



India's Targets

- India has a vision to achieve **Net Zero Emissions by 2070,** in addition to attaining the short-term targets which include:
  - Increasing renewables capacity to **500 GW by 2030,**
  - Meeting **50% of energy requirements** from renewables,
  - Reducing cumulative emissions by **one billion tonnes by 2030,** and
  - Reducing emissions intensity of India's gross domestic product (GDP) by **45% by 2030 from 2005 levels.**

India's Current Electricity Generation through Non Fossil Fuel Sources

- The country's total installed electricity capacity has crossed **500 GW, reaching 500.89 GW.**
- **Non-fossil fuel sources** (renewable energy, hydro, and nuclear): 256.09 GW – over 51 % of the total.
- **Fossil-fuel-based sources:** 244.80 GW about 49 % of the total.
- **Within renewables:**
  - Solar power generates 127.33 GW.
  - Wind power generated 53.12 GW
- **India** has already achieved one of its major COP26 Panchamrit goals i.e. to have **50% of installed electric power capacity** from non-fossil fuel sources by 2030, five years early.

Challenges in Green Hydrogen Production

- **High Production Costs:** Green hydrogen is currently much more expensive than conventional (grey) hydrogen in India.
- **Infrastructure Deficit:** No dedicated nationwide hydrogen transport network (pipelines) exists yet requiring costly trucking or rail transport.
- **Supply Chain and Technology Gaps:** Limited domestic electrolyser manufacturing capacity means high dependency on imports of key components, raising costs and vulnerability to supply disruptions.
- **Renewable Power & Grid Integration Issues:** Green hydrogen requires continuous, affordable renewable electricity but round-the-clock clean supply is limited and energy storage remains costly.
  - Grid instability in some regions complicates green hydrogen production, as electrolyser utilization drops without reliable power.
- **Water Scarcity:** Electrolysis demands high-purity water, which poses stress in already water-scarce regions.
- **Financing and Investment Barriers:** Green hydrogen projects are capital intensive with long gestation periods, posing challenges for Indian banks and traditional financing models.
- **Export and Global Competition:** India aims to be a global green hydrogen exporter, but global demand uncertainties and competing hubs in Europe, Australia, and the Middle East complicate market entry.

Government Initiatives

- **Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme:** A financial incentive mechanism up to 2029-30 provides incentives for the manufacturing of electrolysers that are used for production of green hydrogen.
- **Development of Green Hydrogen Hubs:** In 2025, the Ministry of New and Renewable Energy (MNRE) has announced the recognition of three major ports Deendayal Port Authority (Gujarat), V.O. Chidambaranar Port Authority (Tamil Nadu), and Paradip Port Authority (Odisha) as Green Hydrogen Hubs under the NGHM.
  - These coastal gateways will serve as integrated centres for production, consumption, and future export.
- **Standards, Certification and Safety:** Launched in 2025, the Green Hydrogen Certification Scheme of India (GHCI) provides a national framework to certify hydrogen as "green" by assessing its greenhouse gas emissions across the entire production cycle.
  - It provides transparency, traceability, and credibility for producers, buyers, and export markets.
  - The Bureau of Energy Efficiency (BEE) is the Nodal Authority responsible for accrediting agencies that monitor and certify projects.
- **Strategic Hydrogen Innovation Partnership (SHIP):** The Mission fosters public-private partnerships for R&D through the Strategic Hydrogen Innovation Partnership (SHIP).
  - It is designed to support the development of advanced, globally competitive hydrogen technologies through collaborative research involving Government institutions, industry, and academic organisations.

Source: TH

MARGINAL FARMERS LARGELY OUTSIDE COOPERATIVES

Context

- A report by **Forum of Enterprises for Equitable Development (FEED)** highlights that less than **25%** of India's marginal farmers are members of agricultural cooperatives, despite making up nearly **60-70 percent** of the country's agricultural households.

What are Cooperatives?

- A cooperative is an **organization or business** that is **owned and operated by a group of individuals** who share a common interest, goal, or need.
- These **individuals**, **known as members**, participate in the cooperative's activities and **decision-making process**, typically on a one-member, one-vote basis, regardless of the amount of capital or resources each member contributes.
- The main purpose of a cooperative is **to meet the economic, social, or cultural needs of its members,** rather than to maximize profits for external shareholders.

Role of Primary Agricultural Credit Societies (PACS)

- Primary Agricultural Credit Societies (PACS) are credit societies that are registered under the **Cooperative Societies Act of the State concerned.**
- They are **grassroots-level institutions** in villages with individual farmers, artisans, and other weaker sections as member shareholders.
- They form the **lowest tier of the federated short-term cooperative credit structure** with District Cooperative Banks (DCCBs) and/or State Cooperative Banks (StCBs) in their upper tiers.
- They serve as the closest institutional interface for farmers to access;
  - Agricultural credit
  - Inputs such as seeds and fertilisers
  - Procurement and marketing channels
  - Public services including PDS and digital services.

Key Findings of the Report

- **Marginal farmers,** defined as cultivators owning less than one hectare of land, form the structural backbone of India's agrarian economy.
- **Barriers to Inclusion in Cooperatives:**
  - **Complex membership procedures** and documentation requirements.
  - **Long physical distance** to PACS, raising transaction costs.
  - **Limited capital availability** within cooperatives, reducing their effectiveness.
  - **Persistent social exclusion** based on caste, class, and gender.
- **Digital Divide Limits Benefits:** Digital adoption by cooperatives remains low, particularly in states like **Tripura and Bihar.** Digital skills gaps among farmers, especially older and women farmers, further constrain uptake.
- **Gender and Leadership Gaps:** Cooperatives continue to be male-dominated, especially in leadership roles. While **21.25 lakh women** are registered as cooperative members, **only 3,355 women** serve as directors on cooperative boards nationwide.
- **Positive outcomes of the Cooperative Access:**
  - **45 percent** of cooperative-linked marginal farmers reported an increase in household income.
  - **67 percent** of cooperative members accessed credit and financial services through PACS.
  - **42 percent** of marginal farmers linked to cooperatives reported improved crop yields.

Government Initiatives

- **Formation and Promotion of Farmer Producer Organisations (FPOs):** The Central Sector Scheme for Formation and Promotion of 10,000 FPOs focuses on small and marginal farmers.
  - It provides handholding support, equity grants, and credit guarantee cover.
- **Digital Agriculture Mission:** Aims to build a digital public infrastructure for agriculture, including farmer registries and land records.
- **National Cooperative Development Corporation (NCDC) Support:** NCDC provides financial assistance and capacity-building support to cooperatives.
  - It focuses on strengthening cooperatives in credit, marketing, processing, and storage.

Way Ahead

- In India's agrarian structure those who dominate agriculture numerically remain institutionally marginalised.
- Strengthening PACS, simplifying cooperative membership, bridging the digital divide, and promoting genuine gender inclusion are essential to make cooperatives effective instruments of inclusive rural development.
- For India's agricultural transformation to be equitable and resilient, marginal farmers must be placed at the centre of cooperative reform.

Source: DTE

YEAR-ENDER 2025: INDIA'S SPACE PROGRAMME IN 2025

Context

- The Department of Space's **year-end review shows** a year focused not just on launches, but on mastering complex capabilities needed for human spaceflight, future space stations and a competitive commercial ecosystem.

Major Achievements

- **Docking, biology and in-orbit experiments:** The **SPADEX** (Space Docking Experiment) mission, launched aboard PSLV-C60. Two spacecraft successfully docked and undocked in orbit, essential for future space stations and crewed missions.
  - **CROPS-1**, India's initial space biology experiment on the POEM-4 platform. Cowpea seeds germinated and grew to the two-leaf stage in microgravity, providing early insights into plant growth systems critical for long-duration human missions.
  - **POEM-4** itself completed 1,000 orbits, hosting 24 payloads from ISRO and private entities.
- **Solar science and Earth observation:** ISRO released the first scientific datasets from Aditya-L1, India's solar observatory positioned at the Sun-Earth L1 point.
  - The data, shared globally, offers insights into the Sun's photosphere, chromosphere and corona, strengthening India's profile in solar and space weather research.
  - The launch of the ISRO-NASA joint satellite NISAR later in the year further elevated India's role in global Earth monitoring.
- **Launch infrastructure and propulsion advances:** The Union Cabinet approved the Third Launch Pad at Sriharikota, aimed at supporting next-generation launch vehicles and human spaceflight missions.
  - ISRO marked its 100th launch from Sriharikota with GSLV-F15, while also achieving milestones in propulsion.
- **Human spaceflight gathers momentum:** ISRO conducted the first integrated air drop test of the Gaganyaan crew module parachute system, a critical safety milestone.
  - Indian astronaut Shubhanshu Shukla flew to the International Space Station aboard the Axiom-04 mission, spending 18 days in orbit conducting microgravity experiments.
  - Complementing this were space medicine initiatives, analog missions in Ladakh's Tso Kar Valley, and a new framework agreement with Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST) to deepen research in astronaut health and biomedical systems.
- **Indigenous technology and industry participation:** India advanced its push for self-reliance with the delivery of its first fully indigenous 32-bit space-grade microprocessors—VIKRAM3201 and KALPANA3201—developed with SCL Chandigarh.
  - ISRO also signed a technology transfer agreement to commercialise the Small Satellite Launch Vehicle (SSLV), opening the door for industry-led launches.
  - Private sector participation expanded further with the successful static test of the KALAM-1200 solid rocket motor developed by a startup.
- **Global engagement and future vision:** India assumed a leadership role in the International Charter on Space and Major Disasters, hosted the Global Space Exploration Conference (GLEX) 2025.
  - Internally, the Department of Space held Chintan Shivir 2025 to refine strategies for implementing Space Vision 2047, which envisions an expanded human presence in space, stronger commercial participation and advanced scientific missions.
  - From docking experiments and space biology to human spaceflight and global collaboration, 2025 underscored India's transition from a launch-capable nation to a comprehensive space power—laying the groundwork for ambitious goals in the decades ahead.

Conclusion

- India's space programme marked a defining phase in 2025, combining major technological demonstrations, deeper global partnerships and a clear push towards long-term goals under Space Vision 2047.

Source: DD

NEWS IN SHORT

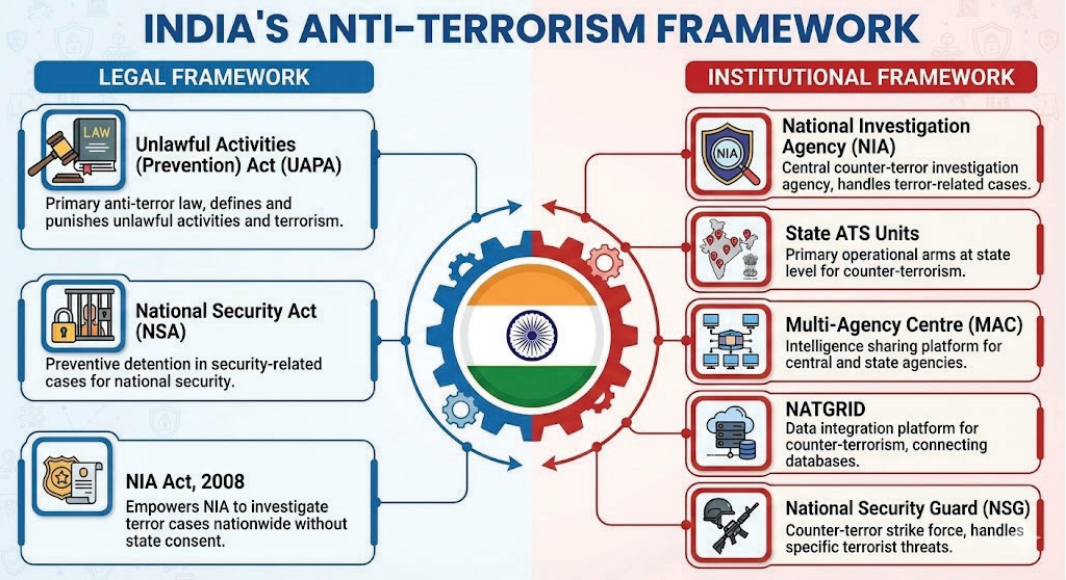
HOME MINISTER CALLS FOR ESTABLISHING COMMON ANTI-TERRORISM SQUAD STRUCTURE

In News

- Home Minister Amit Shah has called for establishing a common Anti-Terrorism Squad (ATS) structure across the country.

Significance of a Uniform ATS Framework

- **Changing Nature of Terrorism:** Terror groups increasingly use technology: encrypted communication, drones, cyber tools, online radicalisation.
- **Standardised Preparedness:** Same training modules, drills, and response timelines across India.
  - This will reduce institutional weaknesses exploitable by terror groups.
- **Federal Coordination Challenges:** Terrorism often spans multiple States. Different ATS structures slow down real-time intelligence sharing and joint operations.
- **Stronger Anti-Terrorism Grid:** Contributes to an "impenetrable and future-ready" security architecture. Ensures readiness not only for present threats but emerging threats.



Source: AIR

GOVERNMENT NOTIFIES COLLIERY CONTROL (AMENDMENT) RULES, 2025

Context

- The Government has amended the provisions governing **approval for opening coal and lignite mines under the Colliery Control Rules, 2004.**

About

- **As per earlier provisions of Rule (9) of the Colliery Control Rules, 2004,** a coal/ lignite mine owner was required to obtain prior permission from the Coal Controller's Organisation (CCO) for opening a coal mine as well as for opening individual seams.
  - Permission of CCO was also required for starting a coal/ lignite mine if a mine was not operational for a period of **180 days or more.**
- **Under the amended provisions,** the authority to approve mine/ seam opening permission has now been entrusted/ vested with the **board of the concerned coal company.**
- **Safeguards Provided:** It has been provided that:
  - the Board of the concerned coal company can approve mine/ seam opening after the requisite **approvals from Central/ State Government and statutory bodies has been obtained,**
  - the company has to submit information about mine opening to CCO, and
  - for entities other than companies, such approval will continue to be through CCO.
- **Significance:** The amendment removes procedural redundancies and enables faster operationalisation of mines, while ensuring continued regulatory oversight.

Source: PIB

NITRATE CONTAMINATION

Context

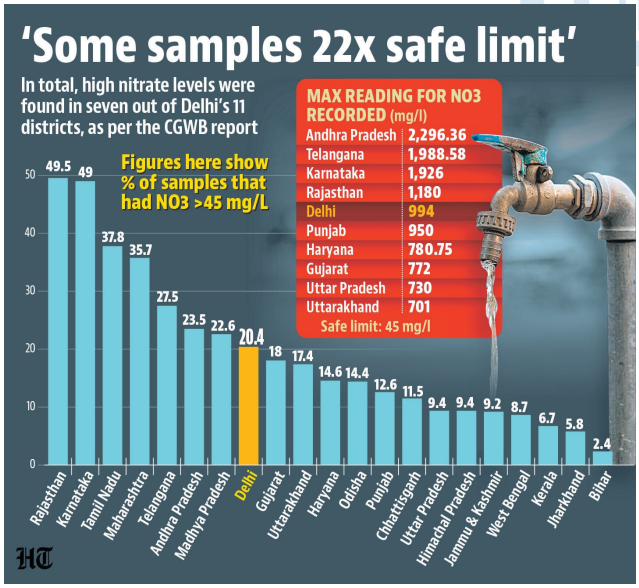
- According to data submitted by the Central Groundwater Board (CGWB) to the National Green Tribunal (NGT), over **20%** of groundwater samples in Delhi exceed the permissible nitrate limit of **45 mg/l.**

About

- **Causes of Nitrate Contamination:**
  - Excessive use of **nitrogen-based fertilizers** in agriculture.
  - **Animal waste and agricultural runoff** entering aquifers.
  - **Leaching from poorly managed septic tanks** and sewage systems, especially in urban and peri-urban areas.
- **Environmental Impacts:** Excess nitrates cause **explosive growth of algae in lakes** and ponds, leading to oxygen depletion (dead zones) that kill aquatic life.
- **Public Health Concerns:** High nitrate levels can cause methemoglobinemia (blue baby syndrome) in infants. Long-term exposure is linked to;
  - Increased risk of certain cancers.
  - Thyroid dysfunction.
  - Reduced oxygen-carrying capacity of blood in adults.

Key Findings from CGWB Data

- **Andhra Pradesh** has recorded the highest level in the country. Nitrate concentrations there have reached **2,296.36 mg/l.**
- Rajasthan is the worst on the scale of pervasiveness, with **49.52%** of its 630 samples exceeding safe limits.



Source: HT

NARASAPURAM LACE CRAFT

In News

- The Prime Minister recently highlighted **Narasapuram (Narsapur) lace craft** as a powerful example of women's empowerment, self-reliance, and grassroots economic progress.

About Narasapuram Lace craft

- **Location:** Narasapur / Narsapur, West Godavari district, Andhra Pradesh
- **Origin:** Introduced in the 19th century by Christian missionaries
- **Alternate Name:** Crochet lace craft
- **Technique & Material:** Handcrafted using fine cotton threads
  - Made with crochet needles
- **Products:** Bedspreads, table covers, cushion covers
  - Curtains, mobile covers, decorative items
- **Design Features:** Intricate floral, geometric, and paisley patterns.
  - Motifs inspired by nature and traditional art
- **Social Significance:** Around 60% artisans are women
  - Promotes women's empowerment through home-based livelihoods
- **Economic Importance:** Source of supplementary income for rural households
  - Supports traditional artisanal economy
- **Recognition:** Granted Geographical Indication (GI) tag
  - Selected under One District One Product (ODOP) scheme.

Source: TH

INS VAGSHEER

In News

- President Droupadi Murmu created history by undertaking a dive and operational sortie aboard the indigenous Kalvari-class submarine INS Vaghsheer.

About INS Vaghsheer

- It is the sixth and final submarine of the Indian Navy's Kalvari-class (Scorpène-class) under Project 75, built by Mazagon Dock Shipbuilders Limited with French technology transfer.
- Other submarines of this class are Kalvari, Khanderi, Karanj, Vagir and Vela.
- It is named after the sandfish, it enhances India's underwater combat capabilities with advanced stealth features.

Source: TH

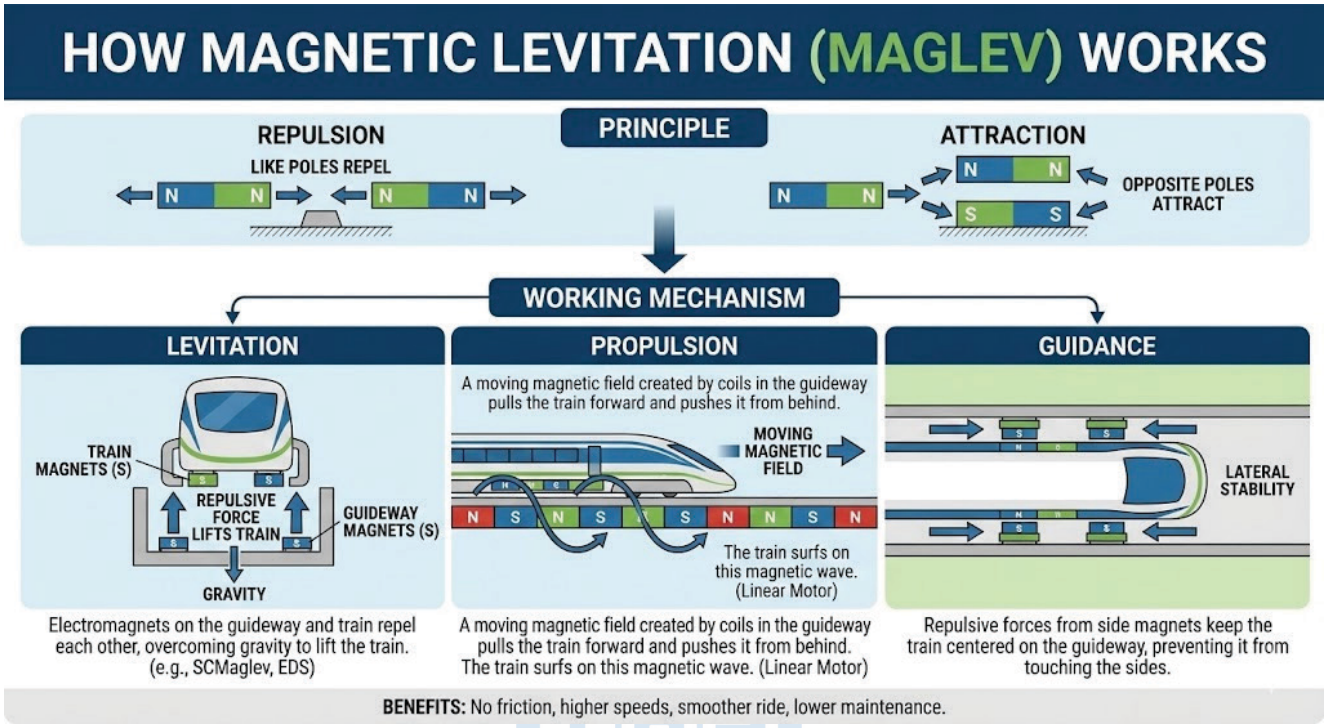
MAGNETIC LEVITATION TECHNOLOGY

In News

- China has set a new world record in magnetic levitation by accelerating a one-ton superconducting maglev test vehicle from 0 to 700 km/h in about 2 seconds on a 400-metre track.

About Magnetic Levitation Technology

- Magnetic levitation (maglev) technology uses magnetic fields to suspend, guide, and propel objects like trains without physical contact, reducing friction for ultra-high speeds.
- Maglev operates on magnetic repulsion (like poles repel) or attraction, often combined with electromagnetic forces.



Source: TOI

K-4 MISSILE

Context

- India recently tested the K-4 submarine-launched ballistic missile (SLBM) from the nuclear-powered submarine INS Arighaat in the Bay of Bengal.
  - INS Arighaat, the country's second nuclear-powered submarine with nuclear-tipped ballistic missiles (called SSBN in naval parlance), was commissioned in 2024.

About the K-4 Missile

- With a strike range of around **3,500 km**, the **DRDO-developed K-4 missile** substantially enhances India's **sea-based nuclear deterrence**.
  - Earlier, the first nuclear-powered submarine, **INS Arihant**, commissioned in 2016, was equipped with K-15 missiles limited to a 750-km range.
- Derived from the **Agni-III** missile, the K-4 is India's longest-range sea-launched strategic weapon and can carry a **2.5-ton nuclear warhead**.
- The K-4 programme, along with future K-5 and K-6 missiles in the 5,000–6,000 km range class, is critical for narrowing India's strategic gap with major nuclear powers, as the US, Russia, and China already deploy SLBMs with ranges exceeding 5,000 km.

Do you know?

- The 'K' in the K-series of missiles is a tribute to APJ Abdul Kalam (Scientist and former President of India), who played a key role in India's Integrated Guided Missile Development Program (IGMDP).

Source: HT

FREQUENCY COMBS

Context

- Frequency combs are emerging as a key precision tool in modern physics, with important applications in atomic clocks, spectroscopy, and high-precision measurements of light.

About Frequency Combs

- A frequency comb is a special type of laser that produces a spectrum of many evenly spaced and highly stable frequencies, resembling the teeth of a comb. Unlike conventional lasers that emit light at a single frequency, frequency combs generate multiple frequencies with extremely regular spacing.
- They are typically produced using mode-locked lasers, which emit ultra-short pulses of light at fixed intervals, creating a precise frequency pattern.
- Frequency combs allow scientists to measure an unknown light frequency by comparing it with the nearest comb frequency and determining the exact offset, enabling extremely accurate measurements.

Source: TH