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GS Paper 3 – Science & Technology

DRDO's Major Leap: India Advances in Hypersonic Propulsion Technology

Context: The **Defence Research and Development Laboratory (DRDL)**, a key unit of **DRDO**, has successfully completed ground testing of an **Active-Cooled Scramjet Subscale Combustor**.

The test, conducted for over **1000 seconds**, marks a significant achievement towards developing indigenous **hypersonic weapon technology** in India.

Understanding Hypersonic Propulsion Technology:

Hypersonic propulsion is a cutting-edge domain focused on enabling vehicles to travel at speeds exceeding **Mach 5** (five times the speed of sound).

Applications:

- Hypersonic cruise missiles
- Advanced aerospace systems

What is a Mach Number?

A **Mach number** represents the ratio of the object's speed to the speed of sound. For instance, Mach 5 means five times faster than the speed of sound.

Key Features of Hypersonic Propulsion:

Air-Breathing Engines:

Hypersonic vehicles employ **Scramjet Engines** (**Supersonic Combustion Ramjet**) which **breathe atmospheric oxygen** for combustion, eliminating the need to carry onboard oxidizers. This significantly enhances the **efficiency** and **range** of hypersonic vehicles.

Scramjet Engine: The Core of Hypersonic Flight

What is a Scramjet?

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A **Scramjet** is a type of **air-breathing engine** designed to operate efficiently at hypersonic speeds. Unlike conventional engines, it allows **supersonic combustion** of incoming air.

Key Differences: Scramjet vs Ramjet

- **Ramjet**: Slows down incoming air to **subsonic speeds** before combustion.
- Scramjet: Maintains supersonic airflow throughout the combustion process, enabling much higher speeds.

Working Principle:

• Utilizes the vehicle's **forward motion** to compress incoming air without using any **rotating compressors**.

India is now the **fourth country** — after the **USA**, **Russia**, and **China** — to successfully demonstrate **flight testing** of a Scramjet engine.

Importance of the Latest Scramjet Test:

Validation of Long-Duration Supersonic Combustion:

• The successful **1000-second test** confirms the **design reliability** and **efficiency** of India's scramjet technology.

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• It builds upon the earlier **120-second test** held in **January**, showcasing continuous progress.

Boost to India's Hypersonic Missile Program:

- **Scramjet engines** enable **air-breathing propulsion**, reducing dependency on onboard oxidizers and significantly enhancing **missile range** and **payload capacity**.
- This successful test lays the groundwork for **full-scale flight testing** of **hypersonic cruise missiles** in the near future.



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GS Paper 3 – Indian Economy

Overseas Remittances by Indians under LRS Drop by 29%

Context: Overseas remittances by Indian residents under the **Liberalised Remittance Scheme (LRS)** of the **Reserve Bank of India (RBI)** declined by **29%** to **\$1,964.21 million** in **February 2025**, compared to **\$2,768.89 million** in **January 2025**.

What is the Liberalised Remittance Scheme (LRS)?

• LRS is part of the Foreign Exchange Management Act (FEMA), 1999, which governs outward remittances from India.



- **Permitted purposes** include:
 - Education abroad
 - Medical treatment overseas
 - Purchase of property
 - Investment in foreign stocks

Recent Update:

The **Union Budget 2025** raised the threshold for collecting **Tax Collected at Source (TCS)** on LRS transactions from **7 lakh to 10 lakh**.

This move is expected to **boost outbound tourism**, **foreign education**, and **airline sectors** by reducing upfront tax burdens.

Reasons Behind the Decline:

1. Drop in Indian Students Abroad:

• A sharp decline of at least 25% was recorded in the number of Indian students receiving study permits in Canada, the United States, and the United Kingdom during 2024.

2. Volatile Global Economy:

• Economic and market volatility led many individuals to **postpone or cancel** their **travel** and **investment plans**.

Understanding Remittances:

What are Remittances?

- **Remittances** refer to the **electronic transfer of money** to individuals, often **family members**, residing in another country.
- Typically sent by those employed in **blue-collar** or **skilled jobs** overseas.

Why are Remittances Important?

- They provide a **significant source of income** for many countries.
- Help **stabilize economies**, support **local consumption**, and even **finance national trade deficits**.

Modes of Remittance Transfer:















- Money Transfer Operators
- Digital Platforms

Types of Remittances:

Туре	Description
Inward Remittance	Funds transferred into India from abroad.
Outward Remittance	Funds transferred from India to another country.

India's Remittance Landscape:

Overall Growth:

• India's remittances more than doubled, rising from \$55.6 billion in 2010-11 to \$118.7 billion in 2023-24 — a trickle turning into a flood.

Contribution by Countries:

- United States and United Kingdom: Together accounted for 40% of India's inward remittances in FY24, up from 26% in FY17.
- **United States**: Emerged as the **top source**, contributing **nearly 28%** in **FY24**.
- **United Arab Emirates (UAE)**: Still the **second-largest** contributor with **19.2%**, driven mainly by Indian migrants in **construction**, **healthcare**, **hospitality**, and **tourism** sectors.

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• **Singapore**: Saw an **increase** in its share to **6.6%** in **FY24**, the **highest** since **FY17**.

State-wise Distribution:

- Maharashtra, Kerala, and Tamil Nadu received half of all remittances.
- Other states like Haryana, Gujarat, and Punjab had smaller shares (below 5%).

Size of Remittances:

- 28.6% of remittances were above 5 lakh. The Will NGAL HER CALLER STATES AND A STA
- 40.6% of remittances were 16,500 or less.



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GS Paper 3 – Defence Technology

Hydrogen Bomb Innovation: A Game-Changer for Modern Warfare

Context: Chinese researchers have reportedly tested a **new hydrogen bomb** that uses **magnesium hydride** to sustain a **fireball** — achieving a thermonuclear reaction **without using traditional nuclear materials**.

What is a Hydrogen Bomb?

A **Hydrogen Bomb**, or **Thermonuclear Bomb**, traditionally operates through a **two-stage detonation process**:

- Primary Stage (Fission Trigger): Uses fissile material such as uranium-235 or plutonium-239 to generate immense heat and pressure.
- Secondary Stage (Fusion Reaction): Under extreme conditions, hydrogen isotopes (deuterium and tritium) undergo fusion, releasing an energy yield many times greater than a pure fission bomb.

What is a Fissile-Free Hydrogen Bomb?

China's breakthrough represents a **fissile-free thermonuclear device**. Instead of relying on fission, **alternative ignition systems** are used:

- Inertial Confinement Fusion (ICF): High-powered lasers compress and heat a small pellet of hydrogen isotopes to initiate fusion.
- Magnetic Compression (Z-pinch Systems): Magnetic fields rapidly compress plasma to achieve the high pressure needed for fusion reactions.

Key Difference: No **uranium** or **plutonium** is required, making it **technically non-nuclear** under traditional definitions.

Key Concerns Arising from this Innovation:

1. Legal Loopholes:

- Nuclear treaties like the Nuclear Non-Proliferation Treaty (NPT) and Comprehensive Test Ban Treaty (CTBT) focus on fissile material.
- Fissile-free devices could bypass treaty restrictions, undermining global arms control efforts.

2. Ease of Development:

- Fusion fuels like deuterium and tritium are less regulated compared to fissile materials.
- Fusion technologies are embedded in civilian research (e.g., energy programs), making dual-use activities harder to monitor.

3. Proliferation Risk:

• **Rogue states** or **terror groups** could exploit the **new pathway** to build powerful weapons **without conventional nuclear infrastructure**.

4. Asymmetric Warfare Implications:

- Compact, **high-yield**, and **non-radioactive** bombs could be:
 - Used in **covert operations**.
 - Deployed in **gray-zone warfare** tactics.















- Smuggled across borders.
- **Disguised** as industrial accidents.

Way Ahead:

Redefining International Law:

- **Update the CTBT** to explicitly ban **non-fissile thermonuclear tests**.
- **Rethink definitions** of nuclear weapons based on **energy yield**, not merely **material composition**.

Strengthening Verification Mechanisms:

• Establish a Fusion Weapons Verification Body (FWVB) under the International Atomic Energy Agency (IAEA), similar to the Organisation for the Prohibition of Chemical Weapons (OPCW).

India's Strategic Response:

- India, guided by its credible minimum deterrence doctrine, must address the emerging strategic uncertainties.
- **Invest** in technologies that can **detect non-radiological fusion detonations** to safeguard national security.

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GS Paper 1 - Geography

Yellowstone Supervolcano: Latest Discovery and Its Implications

Context: A **"breathing" cap of magma** has been discovered inside the Yellowstone supervolcano, according to a new study.

This discovery could help scientists better predict when Yellowstone might erupt next.

About the Yellowstone Supervolcano:

Location:

- Lies beneath Yellowstone National Park, in the western United States.
- Recognized as one of the **largest active volcanic systems** in the world.

What is it?

- Yellowstone is a caldera a large crater formed after the collapse of land following a major volcanic eruption.
- It is part of an **active supervolcanic system**, continuously monitored for activity.

Size of the Caldera:

• Measures about 55 x 72 kilometers (34 x 45 miles).

Formation of the Caldera:

- Formed when pyroclastic material explosively ejected from the volcano, partly emptying the magma chamber.
- As the magma chamber emptied, the roof collapsed, creating a bowl-shaped depression in the ground.

Eruption History:

Yellowstone has experienced three colossal eruptions at the Yellowstone hotspot:

Event	Approximate Time	
1st Major Eruption	2.1 million years ago	
2nd Major Eruption	1.3 million years ago	
3rd Major Eruption	640,000 years ago	

Two of these eruptions released such massive amounts of material that Yellowstone earned its status as a **supervolcano**.

What is a Supervolcano?

A supervolcano is defined as a volcano that has erupted more than 1,000 cubic kilometers of deposits in a single event.

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Supervolcanic eruptions are extremely rare but catastrophically powerful.

Potential Impact of Another Eruption:

- A future **supervolcanic eruption** at Yellowstone could:
 - Blanket North America in ash.



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• Areas near the hotspot could be buried under **more than one meter** of debris.

Climate Effects:

- **Supervolcanoes** release significant amounts of **sulfur dioxide** into the atmosphere during eruptions.
- **Sulfur dioxide** forms **aerosols** that **block sunlight**, leading to **global cooling** for several years.
- This cooling effect would eventually **fade** as the sulfur dioxide **washes out** of the atmosphere.

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GS Paper 1 – Geography

Zero Shadow Day (ZSD): A Fascinating Celestial Event

Context: The **Cosmology Education and Research Training Center (COSMOS)** in **Mysuru**, under the **Indian Institute of Astrophysics**, recently observed **'Zero Shadow Day'**.

What is Zero Shadow Day?

Zero Shadow Day (ZSD) is a unique **celestial phenomenon** where **no shadow** of any **vertical object** is seen at a particular location.

Why does it happen?

- It occurs when the **Sun is exactly overhead** at noon.
- On this day, the **Sun's declination** becomes **equal to the latitude** of the location.
- As the Sun crosses the local meridian, its rays fall exactly vertically on objects, eliminating their shadows.

Scientific Explanation:

- Due to the **tilt of Earth's axis** and its **revolution around the Sun**, the **angle of sunlight** hitting Earth changes throughout the year.
- This change in the Sun's angle affects shadow lengths and directions.
- When the Sun is exactly overhead, shadows disappear briefly, creating the Zero Shadow Day effect.

When Does Zero Shadow Day Occur?

- **ZSD happens twice a year** for locations between the **Tropic of Cancer** and the **Tropic of Capricorn**.
- It corr<mark>esponds</mark> to:
 - **Uttarayan** (when the Sun moves **northward**).
 - **Dakshinayan** (when the Sun moves **southward**).

Duration: The exact "zero shadow" moment lasts for a fraction of a second, but the visible effect can persist for about one to one-and-a-half minutes.

Where Can It Be Observed in India?

• ZSD can be seen in regions **south of Bhopal**, covering a wide range of Indian states, including:

Region	States/UTs	
Southern and Western India	Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telangana, Goa, Maharashtra	
Eastern India	Odisha, Jharkhand, West Bengal, Tripura, Mizoram	
Union Territories	ion Territories Andaman & Nicobar Islands, Puducherry, Daman & Diu, Dadra & N Haveli	
Central India	entral India Chhattisgarh, Southern parts of Madhya Pradesh	
Western India	Most of Gujarat	

Zero Shadow Day is a **remarkable reminder** of the **dynamic relationship** between **Earth and the Sun**, and how **simple observations** can reveal profound truths about **our planet's movements**.

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US Taper I – Geograph









GS Paper 3 – Environment and climate change

Climate Crisis and Gender-Based Violence: Urgent Call to Action

Context: A **report** released by the **UN Spotlight Initiative** highlights a growing crisis: **climate change is worsening gender-based violence (GBV)**, particularly in **vulnerable communities**.

The **report predicts** that by **2100**, climate change could be responsible for **1 in 10 cases of intimate partner violence (IPV)** if urgent action is not taken.



Understanding the UN Spotlight Initiative:

The **Spotlight Initiative** is a **global partnership** between the **European Union (EU)** and the **United Nations (UN)**, dedicated to **eliminating violence against women and girls (VAWG)** worldwide.

Key Findings from the UN Report on Climate and Gender-Based Violence:

Climate Change Intensifies GBV:

- A **1°C rise in temperature** results in a **4.7% increase** in **intimate partner violence (IPV)**.
- With 2°C of warming, 40 million more women and girls could face IPV annually by 2090. This number more than doubles with 3.5°C of warming.
- Limiting the temperature increase to **1.5°C could reduce** IPV rates from **24%** to **14%** by **2060**.

Disaster-Induced Violence & Underreporting:

- In **2023**, **93.1** million people faced climate disasters, and **423** million women suffered IPV.
- **Heatwaves** caused a **28% rise** in **femicide**. Post-disaster situations often lead to an increase in **child marriage**, **human trafficking**, and **sexual exploitation**.
- Gender-based violence is described as a "shadow pandemic", with one in three women globally experiencing physical, sexual, or psychological abuse, and only 7% of survivors reporting the incidents.

Vulnerable Groups at Highest Risk:

- Women in poverty, informal settlements, agriculture, Indigenous communities, those with disabilities, the elderly, and LGBTQ+ individuals are at higher risk of GBV due to limited support systems.
- Women advocating for environmental rights face harassment, violence, abduction, and even murder.

Huge Gap in Gender-Climate Funding:

• Only **0.04%** of **climate-related development assistance** focuses on **gender equality**, signaling a massive gap in addressing GBV within climate action.

Key Recommendations from the UN Report:

Integrating GBV in Climate Policy:

• It is crucial to **mainstream GBV prevention** into all climate policies and programs at the **local**, **national**, and **global** levels, with an increase in **gender-focused climate funding**.

Prioritize Women's Safety and Leadership:

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- Ensure women are central to climate solutions as both leaders and beneficiaries.
- Acknowledge and address GBV as a barrier to climate resilience, making it a core part of sustainable development efforts.

Supporting Women's Movements:

Strengthen the capacity of civil society organizations and women's movements, such as the Pacific Feminist Community of Practice, to ensure gender justice is central to global climate platforms like COP27.

Adopting International Best Practices:

- Implement **gender-responsive programs** as seen in **Vanuatu**, **Liberia**, and **Mozambique**, linking **gender justice** with **climate resilience**.
- Key measures include:
 - Retraining former FGM practitioners in climate-smart agriculture.
 - Embedding GBV services in disaster response.
 - Deploying **mobile health clinics** in **climate-affected areas**.

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GS Paper 1 – Geography

Continental Shelf: Gateway to Oceanic Wealth

Context: India has **expanded its claim** in the **Central Arabian Sea** by nearly **10,000 sq. km** as part of its **Extended Continental Shelf** initiative. Significantly, India also **modified an earlier claim** to sidestep a **long-standing maritime boundary dispute** with **Pakistan**, reflecting strategic foresight in international maritime law.



Understanding the Continental Shelf:

What is a Continental Shelf?

The **Continental Shelf** is the **submerged extension** of a coastal country's landmass, lying under relatively **shallow ocean waters**. It stretches from the **shoreline** to a point known as the **shelf break**, after which the sea floor slopes steeply down into the **continental slope** and eventually to the **deep ocean basin**.

Importantly, a **continent's true geological boundary** lies not at its coastline, but at the **edge of the continental shelf**.

How are Continental Shelves Formed?

- Inorganic materials, carried by rivers as sediments (rock, soil, gravel), gradually accumulate at the ocean's edge.
- **Organic materials** such as the remains of marine plants and animals also settle, enriching the sediments.
- This process spans millions of years, leading to the creation of broad, fertile shelves.

Key Characteristics:

- Average Width: About 65 km (40 miles), but can vary greatly.
- Average Depth: Around 60 meters (200 feet) underwater.
- **Sunlight Penetration**: Allows for rich ecosystems, including **microscopic shrimp**, **seaweed forests** (like **kelp**), and **vibrant marine life**.
- Nutrient Flow: Ocean currents and river runoff bring nutrients, making shelves ideal for marine biodiversity.
- Surface Coverage: Continental shelves make up less than 10% of the total oceanic area.

In certain regions, **deep underwater canyons** and **submarine channels** slice through the shelves, forming **unexplored and mysterious zones**.

The Concept of the Extended Continental Shelf (ECS):

Legal Framework:

Under the **United Nations Convention on the Law of the Sea (UNCLOS)**, coastal nations enjoy **exclusive rights** over the continental shelf up to **200 nautical miles** from their baseline, known as the **Exclusive Economic Zone (EEZ)**.

However, nations can claim an even **greater maritime area** if they can **scientifically prove** that their continental shelf **geologically continues** beyond 200 nautical miles. This claim must be presented to the **Commission on the Limits of the Continental Shelf (CLCS)**, a special UN body.

Why Extend the Continental Shelf?





- **Resource Access**: Countries gain sovereign rights to **explore and exploit** the **seabed and subsoil** for **minerals**, **polymetallic nodules**, **oil reserves**, and **gas hydrates**.
- Strategic Control: Securing an extended shelf strengthens national security and economic influence.
- **Environmental Stewardship**: Nations are also responsible for **protecting the marine environment** within their ECS.

Conclusion:

The **Continental Shelf** is more than just a geological formation; it is a **strategic and economic asset**. As nations like **India** move to secure their rightful claims, the **race for underwater resources** intensifies. Understanding the science and law behind continental shelves is essential to appreciating their **growing importance** in global affairs.

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GS Paper 3 – Science and Technology

3D Microscope: A New Era in Medical Precision

Context: In a historic first, the Indian Army's Department of **Ophthalmology** at **Army Hospital (Research and Referral)**, New Delhi, has successfully performed Minimally Invasive Glaucoma Surgery (MIGS) using a cutting-edge 3D Microscope. This marks a major leap forward in the use of advanced technology for complex eye surgeries in India.

Microscope: A Window to the Invisible World

What is a Microscope?

A **microscope** is an instrument that **magnifies tiny objects**, making them visible to the human eye by refracting (bending) light rays through curved lenses.

The most familiar type is the **optical microscope**, which uses **visible light** focused through a series of lenses to create an **enlarged image** of the specimen.

3D Microscope: Adding a New Dimension to Vision:

What is a 3D Microscope?

- A **3D** Microscope goes beyond traditional imaging by producing images with **depth information** along the X, Y, and Z axes.
- Unlike the flat images from conventional microscopes, **3D microscopes** use advanced optical, electronic, or computational techniques to capture and reconstruct three-dimensional data, providing a more detailed and realistic view of specimens.
- This revolutionary technology is extremely useful for studying **complex biological samples** like **soil** microbes, aquatic organisms, human tissues, and microplastics.

Outstanding Features of the 3D Microscope:

- **Three-Dimensional Visualization**: Allows surgeons to navigate intricate structures with remarkable precision, especially during complex eye surgeries like squint correction, cataract removal, glaucoma treatment, corneal surgeries, and retinal procedures.
- State-of-the-Art Display: Equipped with a 55-inch 4K Ultra-HD screen, offering surgeons a crystalclear, enlarged view of the surgical field.
- **3D Polarization Glasses:** Surgeons wear **specialized glasses** to perceive the surgery in **true 3D**, improving **depth perception** and **accuracy**.
- **Reduced Surgical Time**: Faster procedures with **lower complication rates** compared to surgeries performed using traditional 2D microscopes.
- Lower Photo-toxicity: The system needs reduced endoilluminator power, minimizing the risk of light-induced damage to delicate eye tissues.
- Enhanced Handling of Complex Cases: Makes it easier to perform surgeries on rare and intricate medical conditions.

Extra Knowledge: Where Else Are 3D Microscopes Used?

- Neurosurgery: For operating on extremely delicate parts of the brain and spinal cord.
- **Oncology**: For removing tumors with high precision, minimizing damage to surrounding tissues.









- Material Science: To study microstructures of metals, semiconductors, and nanomaterials.
- Forensic Science: To analyze microscopic evidence with depth and clarity.

Conclusion:

The introduction of the **3D Microscope** in India's premier military hospital showcases the transformative power of **technological innovation** in **healthcare**. As surgeries become safer, faster, and more precise, **3D imaging** is set to become a cornerstone of **modern medicine**, revolutionizing how doctors see and treat the human body.

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GS Paper 3 – Environment and Ecology

Mahuadanr Wolf Sanctuary: India's Exclusive Wolf Haven

Context: Nestled in the **Latehar district** of **Jharkhand**, the **Mahuadanr Wolf Sanctuary** proudly stands as **India's first and only wolf sanctuary**. It plays a pivotal role in safeguarding the **Indian grey wolf**, an iconic yet vulnerable species of the Indian subcontinent.

Discovering Mahuadanr Wolf Sanctuary

Overview:

The **Mahuadanr Wolf Sanctuary** spans an area of approximately **63 square kilometers** and was officially **declared a sanctuary in 1976**. It was established specifically to ensure the **survival and protection** of the **Indian grey wolf (Canis lupus pallipes)**.

This sanctuary is also an important component of the larger **Palamau Tiger Reserve**, blending wolf conservation with broader efforts to protect India's forest ecosystems.

Wildlife Diversity:

While the sanctuary's primary focus is the **Indian grey** wolf, it is also home to a variety of other wildlife species, including:

- Spotted deer
- Wild boars
- Hyenas
- Sloth bears
- Numerous species of birds and reptiles

The coexistence of different species highlights the **rich biodiversity** and **ecological importance** of this region.

The Indian Grey Wolf: A Silent Hunter:

Species Profile:

The **Indian grey wolf** is a **distinct subspecies** of the grey wolf, adapted to the **warm climates** of **Southwest Asia** and the **Indian subcontinent**.

It prefers **scrublands**, **grasslands**, and **semi-arid regions**, often avoiding dense forests.

Behavior and Adaptations:

- Pack Size: Generally smaller compared to other wolf species.
- Vocalization: Less vocal and more stealthy than its northern cousins.
- Activity: Primarily nocturnal, it hunts during the cooler hours from dusk till dawn.

This behavior helps the Indian wolf adapt to **harsher**, **warmer environments**, where conserving energy and water is crucial.

Conservation Status:

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• **IUCN Red List**: Classified as **Endangered**, with an estimated population of just **2,000–3,000 individuals** in India.

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- **CITES**: Listed under **Appendix I**, indicating **maximum international protection** against trade and exploitation.
- Wildlife Protection Act, 1972: Included in Schedule I, granting it the highest level of legal protection within India.

Interesting Facts: Going Beyond:

- The **Mahuadanr wolves** are known for their **unique denning behavior**, digging deep burrows for raising pups—a rare trait among wolf populations worldwide.
- **Cultural ties**: In many local tribal traditions of Jharkhand, the wolf is revered and featured in folklore, highlighting its deep-rooted significance to the region's heritage.
- **Challenges**: Habitat loss, human-wildlife conflict, and declining prey base are the major threats these wolves face today, making sanctuaries like Mahuadanr even more critical.

Conclusion:

The **Mahuadanr Wolf Sanctuary** is more than a protected land—it is a **symbol of hope** for one of India's most elusive and endangered carnivores. Strengthening conservation efforts here ensures that the **Indian grey wolf** continues to roam the wild landscapes of Jharkhand for generations to come.

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GS Paper 2 – Polity and Governance

Supreme Court Suggests Minimum Vote Requirement for Unopposed Elections

Context: In a significant move, the **Supreme Court of India** has proposed that when only **one candidate** contests an election, they should not be declared elected **automatically**. Instead, the candidate must **secure a minimum prescribed share of votes** to be formally elected.

This suggestion came during the hearing of a petition filed by the **Vidhi Centre for Legal Policy**, challenging the constitutional validity of **Section 53(2) of the Representation of the People Act, 1951** — which currently permits uncontested wins without any voting process.

Background: The Petition and Core Arguments

About the Petition:

- Filed: August 2024
- Petitioner: Vidhi Centre for Legal Policy

The petition claims that in uncontested elections, voters are **denied their fundamental right** to express dissent through the **"None of the Above" (NOTA)** option.

Reference to Landmark Judgment

The petition cites the Supreme Court's **2013 judgment** in **People's Union for Civil Liberties vs Union of India**, which established that the **right to cast a negative vote** is protected under **Article 19(1)(a)** of the Constitution.

Main Argument:

- NOTA must be available irrespective of the number of candidates.
- Voters' ability to **reject candidates** is essential for **true democracy**.

Uncontested Elections: Historical Context in Lok Sabha

According to the petition:

- 26 Lok Sabha constituencies witnessed unopposed elections between 1951 and 2024.
- As a result, over 82 lakh voters were deprived of their right to vote.

Breakdown of Uncontested Elections:

- 1957: 7 seats
- 1951 & 1967: 5 seats each
- 1962: 3 seats
- 1977: 2 seats
- 1971, 1980, 1989, 2024: 1 seat each

Recent Example:

In **2024**, **Mukeshkumar Dalal** (BJP) from **Surat** was elected unopposed after all other candidates withdrew or were disqualified.

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State Assembly Elections:

The petition also highlights that **unopposed victories** are **more common in State Assembly elections**, underlining a deeper systemic issue.

Response from the Election Commission of India (ECI):

Key Points from ECI's Affidavit:

- Rare Occurrence: Only 9 out of 20 Lok Sabha elections saw unopposed wins.
- **Recent Trend:** Since **1989**, only **one uncontested MP** has been elected.
- **Growing Political Participation:** Increasing number of candidates has **reduced uncontested elections** significantly.

ECI's Stand on NOTA:

- **NOTA** is available **only when polling occurs**.
- NOTA is **not a contesting candidate** and thus **irrelevant** in unopposed situations.

Need for Legislative Amendments:

• Recognizing NOTA or enforcing a minimum vote requirement would require **changes to the Representation of the People Act, 1951** and the **Conduct of Elections Rules, 1961**.

Supreme Court's Perspective:

Minimum Vote Threshold Suggestion:

The Court suggested that a sole candidate must secure a minimum percentage of votes, such as 10% or 15%, from the entire electorate to be declared elected.

Democracy and Majority Principle:

- The **Supreme Court** emphasized that in a **true democracy**, even uncontested winners should have **affirmative support** from a **minimum number of voters**.
- It questioned the fairness of letting a candidate **enter Parliament by default**, without voter validation.

Advice to the Government:

The Court urged the **Union Government** to **consider legislative measures** addressing this issue, stating that **Parliament** is best suited to define the specifics.

Extra Insight: Why This Matters for Indian Democracy

- **Strengthening Voter Rights**: Ensuring minimum approval protects the **integrity of the electoral process**.
- **Discouraging Political Manipulation**: Prevents parties from achieving uncontested victories through intimidation, withdrawal, or technical disqualifications.
- **Global Examples**: Countries like **France** and **Australia** require minimum turnout or specific vote percentages in some elections to validate results.

Conclusion:

The **Supreme Court's suggestion** for introducing a **minimum vote threshold** for unopposed elections aims to **safeguard democratic legitimacy** and **empower voters**. Whether through legislative action or broader electoral reforms, this debate could redefine the **future of Indian democracy** by ensuring that **every elected representative truly commands public support**.

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GS Paper 3 – Economy

CSR Spending in India Jumps 16% in FY24: Key Highlights and Insights

Context: India's **Corporate Social Responsibility (CSR)** landscape witnessed robust growth in **FY24**, with **listed companies** increasing their CSR spending by **16%** to a total of **17,967 crore**, compared to the previous year.

What is Corporate Social Responsibility (CSR)?

Corporate Social Responsibility (CSR) refers to a company's commitment to operate in an economically, socially, and environmentally sustainable manner.

Under the **Companies Act, 2013**, effective from **April 2014**, Indian companies meeting specific financial thresholds must allocate **at least 2%** of their average net profits from the last three years towards CSR initiatives.

Who Must Comply?

- Companies with **net worth** ≥ **500 crore**
- Or **turnover ≥ 1,000 crore**
- Or **net profit ≥ 5 crore**

The objective is to ensure businesses contribute **meaningfully to societal development** while aligning corporate growth with **national priorities** such as **education**, **healthcare**, **rural development**, **environmental protection**, **and cultural preservation**.

Important Figures:

- Mandated CSR spend: 18,309 crore
- Actual CSR spend: 17,967 crore
- Unspent CSR (to be utilized later): 2,329 crore

This marks a return to **strong growth** after **three years of muted expansion**, showing companies' renewed commitment to social causes alongside increasing profitability.

Top 10 CSR Contributors in FY24:

The largest corpor<mark>ate house</mark>s continued to **lead the CSR efforts**:

Company	CSR Spend (Crore)
HDFC Bank	945.31
Reliance Industries	900
Tata Consultancy Services (TCS)	827
Oil and Natural Gas Corporation (ONGC)	634.57
Tata Steel	580.02
ICICI Bank	518.87
Indian Oil Corporation (IOC)	457.71
Infosvs Ltd	455.67
ITC Ltd	404.05
Power Grid Corporation of India	330.48

Together, these companies accounted for a **significant share** of India's total CSR expenditure, underlining how **large corporations** continue to drive the nation's **social investment ecosystem**.

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Where Did CSR Funds Go? Sector-Wise Breakdown

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CSR spending was primarily directed towards **priority sectors**:

- Education: 1,104 crore (Top sector)
- Healthcare: 720 crore
- Environmental Sustainability: Notable 54% increase over the previous year!

However, certain sectors saw sharp declines:

- Slum development: -72%
- **Rural development:** -59%
- Armed forces veterans' welfare: -52%

This shift indicates an **evolving focus** towards **sustainability, climate action**, and **urban-centric development**.

Compliance and Governance: A Positive Trend

India's corporate sector showed **strong compliance** with CSR rules:

- **98%** of **1,394 eligible companies** met their CSR obligations.
- **49%** of companies **exceeded** their mandated spending.
- Only 259 companies underperformed, mainly due to multi-year project planning.

Public Sector Undertakings (PSUs):

• **66 PSUs** contributed **3,717 crore**, a **19% increase** compared to the previous year.

Corporate Governance in CSR:

Companies with **CSR budgets exceeding 50 lakh** must form a **CSR Committee**. Of the **1,028 companies** required to establish committees, **990** were fully compliant, ensuring **better oversight** and **transparency**.

Future Outlook: CSR as a Strategic Asset:

Looking ahead, CSR in India is set to transform from a **compliance checklist** to a **core strategic pillar** for corporate success.

Emerging Focus Areas:

ging rocus Areas:

- Climate change mitigation and resilience
- Digital inclusion and access to technology
- Skill development for the future workforce
- Healthcare innovations (telemedicine, biotechnology)
- Integration with ESG (Environmental, Social, Governance) standards

Fact: Many global investors now evaluate a company's CSR and ESG performance before investing, linking **social responsibility directly with financial success**.

Conclusion: India's **CSR landscape** in **FY24** reflects a **mature, evolving corporate consciousness**, blending **profit with purpose**. With **rising corporate profits**, **strong governance structures**, and **new focus areas**, CSR is poised to play a **transformative role** in building a **sustainable**, **inclusive India**.













GS Paper 2 – Polity and Governance

UDAN Scheme: Revolutionizing Regional Air Connectivity

Context: The UDAN (Ude Desh ka Aam Naagrik) Scheme recently celebrated its **8th anniversary**, marking a significant milestone in making air travel more accessible, affordable, and inclusive for the common citizens of India.

What is the UDAN Scheme?



About the Initiative:

Launched under the National Civil Aviation Policy (NCAP), 2016, the UDAN scheme aims to democratize air travel by enhancing regional connectivity, especially for Tier-2 and Tier-3 cities.

It operates on a market-driven model supplemented with financial support to make aviation economically viable for airlines and passengers alike.

The **Airports Authority of India (AAI)** acts as the **nodal agency** for its effective implementation.

Fact: The scheme's tagline, "Ude Desh ka Aam Naagrik", literally means "Let the common citizen of the country fly".

Objectives and Significance of UDAN:

- **Promote balanced regional growth** by connecting underserved and unserved airports.
- Make air travel affordable for the common citizen.
- **Boost economic development** in smaller towns by facilitating business, tourism, and investment. ٠
- **Enhance air infrastructure** across the country, including remote and isolated regions. •

Key Features of the UDAN Scheme:

- 1. Viability Gap Funding (VGF): Airlines receive financial support to cover potential losses, ensuring operations remain viable even on less profitable routes.
- 2. Regional Connectivity Fund (RCF): Funded through a small levy on major flight routes, this supports the VGF payments needed for regional routes.
- **3.** Airfare Cap: Airfares are capped at affordable rates (approximately 2,500 for a one-hour flight) to keep flying within reach of the middle and lower-income groups.
- 4. Tax Concessions: Reduced taxes on Aviation Turbine Fuel (ATF) and other operational incentives help airlines lower their operational costs.
- 5. Collaborative Governance: Strong partnership between the Centre, State governments, AAI, and private airport operators to ensure smooth execution and monitoring.

Evolution and Growth of the UDAN Scheme:

Major Achievements:

- 625 routes operationalized, connecting 90 airports, including 15 heliports and 2 water aerodromes.
- Over 1.49 crore passengers have benefited from affordable regional flights.

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• India's airport network **expanded dramatically** from **74 airports (2014)** to **159 airports (2024)**.

Key Innovations Introduced Under UDAN:

- 1. UDAN Yatri Cafes: Affordable Cafeterias launched at Kolkata and Chennai airports, providing quality meals at reasonable prices for travelers.
- 2. Seaplane Operations: UDAN 5.5 initiated to explore over 50 water bodies for potential seaplane connectivity, enhancing access to remote areas and boosting tourism.
- 3. Krishi UDAN Scheme:
 - A special wing under UDAN to **support farmers** by providing **affordable air logistics** for **agriproduce**, especially from **Northeast India**, **hilly**, and **tribal regions**.
 - **Objective:** Increase value realization for farmers and reduce wastage of perishable goods.
- **4.** Lifeline UDAN: Introduced during the COVID-19 pandemic to transport essential medical supplies and PPE kits to remote regions via air logistics, ensuring critical support.

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GS Paper 1 – Geography

History and Evolution of Monsoon Forecasting in India

Context: The **India Meteorological Department (IMD)** recently forecasted **'above normal' rainfall (105% of the Long-Period Average)** for the **2025 southwest monsoon** (June–September).

This prediction holds vital significance, as the **southwest monsoon accounts for nearly 70% of India's annual rainfall**, playing a **critical role in agriculture, the economy, and water resource management**.



Did You Know? Ancient Indian Weather Wisdom:

- Meteorology in India has deep roots in ancient knowledge systems.
- Classical Indian texts such as the **Upanishads**, **Brihatsamhita**, **Arthashastra**, and **Meghdoot** contain **detailed observations on rainfall patterns**, clouds, and seasons.
- These works demonstrated an **advanced understanding** of nature's cycles long before modern meteorology.

Scientific Beginnings and Colonial Developments:

- The modern study of meteorology in India began in the **17th century** when **Edmund Halley** proposed a scientific explanation for the **monsoon winds**.
- During British rule, early observatories were established in Madras (1796), Calcutta (1829), and Bombay (1841).
- Captain Henry Piddington, a British officer, coined the term "cyclone" while studying tropical storms in the Bay of Bengal.

Timeline of Monsoon Forecasting in India:

1877 – Forecasting Begins:

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• IMD started monsoon forecasting following the **Great Famine of 1876–78**, which highlighted the urgent need for rainfall prediction.

1886 – First Long-Range Forecast:

• **Henry Francis Blanford**, IMD's first Meteorological Reporter, linked **Himalayan snow cover** to monsoon strength and made the **first seasonal forecast**.

1904–1920s – Sir Gilbert Walker's Contributions:

- Sir Gilbert Walker introduced statistical models using 28 global parameters, including the Southern Oscillation (SO)—a precursor to what we now know as ENSO (El Niño-Southern Oscillation).
- He divided India into **three meteorological subregions** for better accuracy.

Post-Independence Developments:

Challenges with Early Models:

- Walker's model continued until **1987**, but its effectiveness declined due to **changing climate patterns**.
- In **1988**, a new **regression model** (called the **Gowariker Model**) was introduced using **16 predictors**, but it struggled with **regional accuracy**.

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Modernization and Technological Shifts:

Key Improvements Over the Years:

2003 - Two New Models Introduced

• IMD added two statistical models using **8 and 10 parameters**, along with a **two-stage forecast strategy**.

2007 - Statistical Ensemble Forecasting System (SEFS):

- Introduced **ensemble forecasting**, which uses **multiple model runs** to provide a range of outcomes.
- The number of parameters was reduced to streamline predictions.

2012 - Monsoon Mission and MMCFS:

- The Monsoon Mission Coupled Forecasting System (MMCFS) was launched.
- It integrates **ocean**, **atmospheric**, and **land interactions**, greatly enhancing forecast accuracy and long-range prediction capability.

2021 – Multi-Model Ensemble (MME):

 IMD adopted a global ensemble model approach, combining outputs from multiple climate models, including MMCFS, to refine and increase the reliability of forecasts.

Impact and Accuracy Gains:

- From **1989 to 2006**, monsoon forecast errors were significantly higher.
- Since 2007, the absolute forecast error has dropped by 21%, a testament to technological upgrades and scientific advancements.

Why It Matters:

- The **southwest monsoon** is the **lifeline of Indian agriculture**, especially for rain-fed farming systems.
- Accurate forecasting:
 - Helps farmers plan sowing and harvesting cycles
 - Aids in **drought and flood preparedness**
 - Informs water reservoir management
 - Supports **policymakers and disaster response agencies**

Extra Insight: What is the Long-Period Average (LPA)?

The **LPA** refers to the **average rainfall received during the monsoon season over a 50-year period** (currently calculated from 1971–2020).

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It acts as a **benchmark** to define monsoon categories:

- **Below Normal**: < 96% of LPA
- Normal: 96–104% of LPA
- Above Normal: 105–110% of LPA
- **Excess**: >110% of LPA

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GS Paper 2 – International Relation

The Bandung Conference: A Turning Point in Global Politics

Context: In **1955**, the Indonesian city of **Bandung** hosted a landmark event that reshaped the geopolitical landscape—the **Bandung Conference**. Held **70 years ago**, this historic gathering brought together **29 newly independent nations** from **Asia and Africa**, united by their shared history of colonialism and a vision for a sovereign future.

The conference marked the **first large-scale Afro-Asian summit**, setting the stage for what would later become a powerful voice in international affairs—the **Global South**. In a Cold War era dominated



by two superpowers, the conference boldly asserted that emerging nations would not be mere pawns in a bipolar world order.

The Purpose: Decolonization and Collective Voice

The **primary objective** of the Bandung Conference was to **strengthen economic and cultural cooperation** among developing nations while **rejecting all forms of colonialism, imperialism, and neocolonialism**. The participating countries recognized the need for a **unified front** to address global inequalities and forge an **independent path of development**.

The Ten Principles of Bandung (Dasasila Bandung):

The spirit of Bandung was enshrined in **Ten Foundational Principles**, which laid the moral and diplomatic groundwork for future cooperation:

- 1. Respect for human rights and adherence to the UN Charter
- 2. Sovereignty and territorial integrity of all nations
- 3. Equality among all races and nations, large or small
- 4. **Non-intervention** in the internal affairs of states
- 5. **Right to self-defense**, in line with the UN Charter
- 6. **No military alliances** serving big power interests
- 7. Avoidance of force or aggression in international relations
- 8. Peaceful dispute resolution through dialogue and negotiation
- 9. Mutual interests and cooperation among nations

10. Commitment to justice and international obligations

These principles remain **timeless ideals** for international diplomacy and are echoed in today's multilateral forums.

The Birth of the Non-Aligned Movement (NAM):

The Bandung spirit gave rise to the **Non-Aligned Movement (NAM)**, formally established in **1961 in Belgrade**, Yugoslavia. The movement was led by **five visionary leaders**:

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- Jawaharlal Nehru (India)
- Gamal Abdel Nasser (Egypt)
- Kwame Nkrumah (Ghana)

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- Sukarno (Indonesia)
- Josip Broz Tito (Yugoslavia)

NAM emerged as a platform for countries to **remain independent** of both Western and Soviet blocs during the Cold War, advocating for **sovereignty, peace, and development** without external interference.

NAM is the **second-largest international organization after the United Nations**, currently comprising **120 member states**, representing over **55% of the world's population**.

Current Relevance: Bandung's Legacy in a Multipolar World

Today, as the world experiences **shifting power dynamics** and rising tensions among global powers, the Bandung message is more relevant than ever. Calls for a **just**, **inclusive**, **and multipolar world order** echo the original aspirations of the 1955 conference. Issues such as **economic inequality**, **digital colonialism**, and **climate justice** are modern challenges that resonate deeply with Bandung's core ideals.

Conclusion: A Symbol of Unity and Resistance

The **Bandung Conference** remains a **powerful symbol of dignity, unity, and independence** for the Global South. It signaled the rise of a new global consciousness—one grounded in **mutual respect**, **peaceful coexistence**, and **collaborative progress**.

As we mark the **70th anniversary** of this transformative event, it is a moment to **reinvigorate the Bandung Spirit** and work collectively toward a **fairer, more equitable global future**.

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GS Paper 3 – Internal Security and Technology

Government Strengthens Cybercrime Fight with I4C-ED Collaboration

Context: In a significant move to **tighten the grip on cyber-enabled** financial crimes, the Government of India has empowered the Indian Cyber Crime Coordination Centre (I4C) to share and receive information with the Enforcement Directorate (ED) under the Prevention of Money Laundering Act (PMLA), 2002. This strategic inclusion under Section 66 of PMLA will significantly enhance investigative capabilities and track illicit money trails, especially in transnational cyber frauds.



What is I4C?

The Indian Cyber Crime Coordination Centre (I4C) is an initiative under the Ministry of Home Affairs, designed to provide a robust framework for law enforcement agencies to coordinate and tackle cybercrimes effectively. It works as a hub for data analytics, investigation support, and capacity **building**, facilitating a pan-India response to digital threats.

About the Enforcement Directorate (ED):

The Enforcement Directorate, established in 1956, is a multi-disciplinary law enforcement agency under the **Department of Revenue**, Ministry of Finance. It enforces key financial laws, including:

- The Foreign Exchange Management Act (FEMA), 1999 a civil law that governs foreign exchange dealings in India.
- The Prevention of Money Laundering Act (PMLA), 2002 a criminal law that empowers the ED to investigate and prosecute money laundering.
- The Fugitive Economic Offenders Act (FEOA), 2018 targets economic offenders trying to evade Indian laws by remaining overseas.

By joining forces with I4C, the ED can now track digital footprints of criminals and intercept illicit fund flows across borders more effectively.

Understanding Cybercrime:

Cybercrime refers to unlawful activities carried out through **computers**, **networks**, **or digital devices**. It targets both individuals and institutions, aiming to **steal**, **disrupt**, **or manipulate data** for profit or malicious intent.

Common Types of Cybercrime:

- Hacking Unauthorized access to systems or data
- Phishing Deceptive attempts to obtain sensitive information .
- Malware Malicious software like viruses and ransomware •
- Identity Theft Misuse of personal or financial data
- **Cyber Espionage** – Unauthorized surveillance or information gathering
- **Cyberbullying** Online harassment and intimidation •

Impact of Cybercrime on Society:

Threat to National Security – Critical infrastructure such as defense, banking, and energy sectors are prime targets.

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- Massive Data Breaches Can lead to exposure of personal information and trade secrets.
- Service Disruptions Attacks on power grids or telecom networks cause public chaos.
- **Reputational Damage** Organizations may lose public trust and investor confidence.

Government Measures to Combat Cyber Threats:

Key Initiatives Include:

- Indian Computer Emergency Response Team (CERT-In): National agency for responding to cybersecurity incidents and issuing threat advisories.
- **National Critical Information Infrastructure Protection Centre (NCIIPC):** Safeguards sectors critical to national survival like energy, finance, and healthcare.
- **Cyber Crime Prevention against Women and Children (CCPWC):** Financial assistance to states for setting up cyber forensic labs and specialized units.
- **National Cyber Crime Reporting Portal:** A platform for citizens to report cybercrime (<u>https://cybercrime.gov.in</u>) and dial **1930** for real-time assistance.
- Cyber Swachhta Kendra: Offers free tools to detect and remove malware and botnets from infected devices.

New Trend Alert: Cybercriminals are increasingly using **AI-driven deepfakes** and **cryptocurrency laundering** to evade detection.

International Cybersecurity Frameworks:

India aligns with global best practices through international conventions:

- **Budapest Convention on Cybercrime:** The first international treaty addressing crimes like data interference and content misuse.
- Malabo Convention (Africa): Focuses on cybersecurity and data protection in African nations.
- **United Nations Internet Governance Forum (IGF):** A global platform for policy discussions on digital governance and cyber laws.

Conclusion: A Smarter, Safer Digital India

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Bringing I4C under the ambit of PMLA is a landmark step toward building a safer digital ecosystem. This integration enables real-time intelligence sharing, boosts the ability to detect and prosecute complex cyber frauds, and strengthens financial and cyber governance.

As India moves forward in its digital transformation, this collaboration between I4C and ED will be crucial in **safeguarding citizens, institutions, and the economy** from rising cyber threats.

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GS Paper 3 – Environment and Conservation

New Vision for Indian Cities: River and Urban Planning in Harmony

Context: In a forward-thinking move, the **National Mission for Clean Ganga (NMCG)** has approved an **Annual Master Plan** under the **River Cities Alliance (RCA)** to mainstream **river-sensitive urban planning** across India. This bold initiative marks a critical step in ensuring that urban growth aligns with the **ecological and cultural vitality of rivers**.

The plan includes a robust framework for **capacity-building programs**, **technical guidance**, **knowledge-sharing platforms**,



and **thematic research**, with a vision of making rivers a **central element of urban development**.

Urban River Management Plans (URMPs): A Sustainable Blueprint

Launched in **2020** by the **National Institute of Urban Affairs (NIUA)** and **NMCG**, the **Urban River Management Plans (URMPs)** provide a first-of-its-kind approach to manage rivers through an integrated environmental, economic, and social lens.

Key Highlights:

- Five cities—Kanpur, Ayodhya, Chhatrapati Sambhaji Nagar, Moradabad, and Bareilly—have already developed URMPs.
- An additional **25 cities** will develop their URMPs in the coming year, as part of a broader goal to prepare **60 such plans** across India.
- Steering Committees have been established in key states like Uttarakhand, Uttar Pradesh, Bihar, and West Bengal to support and guide this process.
- The initiative is **supported by the World Bank**, emphasizing its global alignment and importance.

Fun Fact: Rivers in cities like London (Thames), Seoul (Cheonggyecheon), and Paris (Seine) have undergone successful rejuvenation, serving as global models for integrating waterways into urban life.

River Cities Alliance (RCA): A Platform for Urban-River Synergy

The **River Cities Alliance**, launched in **2021** by **NMCG and NIUA**, functions as a **national-level collaborative platform** for Indian cities to share **best practices and technical support** for river management.

Core Pillars:

- Networking among cities to promote peer learning
- Capacity Building through training and knowledge dissemination
- Technical Assistance for river-centric urban planning

Since its inception with **30 cities**, the RCA has grown to over **145 members**, including cities from **both Ganga and non-Ganga river basins**. In a notable milestone, **Aarhus (Denmark)** joined the alliance, adding an international perspective.





Insight: River-sensitive urban planning promotes not just ecological balance, but also **flood resilience**, **air quality improvement**, and **urban beautification**.

Global River Cities Alliance (GRCA): Taking India's Model Worldwide

India's success with RCA paved the way for the **Global River Cities Alliance (GRCA)**, launched at **COP28 in 2024**. This platform brings together **over 275 river cities** from **11 countries**, including **Japan**, **Australia**, **the Netherlands**, **Egypt**, **Ghana**, **and Bhutan**, creating a global dialogue for **river conservation and urban water resilience**.

Supported by institutions like the World Bank, Asian Development Bank (ADB), and Asian Infrastructure Investment Bank (AIIB), the GRCA aims to promote integrated water resource management and international collaboration.

National Mission for Clean Ganga (NMCG): The Force Behind the Mission

The NMCG, established as a **registered society** under the **Societies Registration Act, 1860**, is the nodal agency for implementing the **Namami Gange Programme**—the government's flagship mission for **Ganga rejuvenation**.

Key Functions of NMCG:

- Pollution abatement and ecological rejuvenation of River Ganga.
- Maintain **minimum ecological flows** while ensuring **sustainable development**.
- Managed through a two-tier structure: Governing Council and Executive Committee, both headed by the Director General.
- The Executive Committee can sanction projects up to 21000 crore

Conclusion: Towards Resilient, River-Friendly Cities

The approval of the **Annual Master Plan** under RCA reflects India's commitment to **sustainable urbanization** by placing rivers at the heart of city planning. With an ambitious roadmap for **URMPs**, **international collaborations**, and a **robust policy framework**, India is setting a benchmark for **river-centric urban development**—a model that other nations are beginning to follow.

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GS Paper 3 – Environment and Economy

Tax Exemption Granted to NMCG: A Boost to Ganga Rejuvenation Efforts

Context: The **Central Board of Direct Taxes (CBDT)** has officially notified the **National Mission for Clean Ganga (NMCG)** as an **authority under the Income Tax Act, 1961**. This major decision grants **income tax exemption** to NMCG, strengthening its financial and operational capacity under the ambitious **Namami Gange Programme**.



Namami Gange Programme: India's Flagship River Rejuvenation Mission

Launched in **2014**, the **Namami Gange Programme** is an **integrated conservation mission** to clean and rejuvenate the **Ganga River**. With a massive budget outlay of **20,000 crore**, it is one of India's most comprehensive river revitalization efforts.

Key Objectives:

- Pollution abatement
- Conservation and rejuvenation of the National River Ganga

Administrative Setup:

- Implemented by NMCG and State counterparts called State Program Management Groups (SPMGs)
- Overseen by the National Ganga Council (NGC), chaired by the Prime Minister
- Three-tier monitoring mechanism:
 - National Level: High-level task force chaired by Cabinet Secretary
 - State Level: Committee chaired by Chief Secretary
 - **District Level:** Chaired by **District Magistrate**

Implementation Phases:

- 1. Entry-Level Activities Quick, visible impact
- 2. **Medium-Term Activities** Within 5 years
- 3. Long-Term Activities Within 10 years

Recent Developments: Tax Relief for NMCG

Legal Foundation of Exemption:

- Section 10, Clause 46A of the Income Tax Act, 1961
- Applicable to authorities formed under a Central/State Act for public benefit
- NMCG qualifies under the Environment (Protection) Act, 1986
- Effective from Assessment Year 2024–25

Significance of the Tax Exemption:

- Enhances financial autonomy
- Improves operational efficiency
- Crucial for the execution of Namami Gange projects
- Reduces fiscal strain from past tax liabilities

Background & Legal Transition of NMCG: *Download <u>Our Application</u> _____*











- 2011: Established as a society under the Societies Registration Act, 1860
- 2016: Upgraded to an authority under the Environment (Protection) Act, 1986
- Despite the upgrade, its **PAN status** remained as an **Association of Persons (AOP)**, causing tax-related confusion and scrutiny

Income Tax Disputes and Resolution:

- Faced tax demands totaling 243.74 crore
- **CBDT intervention:** Permitted **delayed revised returns** for three assessment years
- **Retrospective exemption** allowed
- Action facilitated by the Ministry of Jal Shakti in coordination with the Ministry of Finance

Additional Insights & Facts:

- NMCG is critical not just for cleaning the Ganga but also for building climate-resilient cities and reviving aquatic biodiversity
- **Tax-exempt status** ensures smoother **foreign and multilateral funding**, especially from partners like the **World Bank**, **Japan International Cooperation Agency (JICA)**, and others
- The Ganga River Basin covers **26% of India's landmass** and supports **over 40% of the population**—making its rejuvenation **nationally vital**

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GS Paper 3 – Environment and Ecology

Draft GEI Target Rules 2025: Paving the Way for a Low-Carbon Industrial Future

Context: The **Ministry of Environment, Forest and Climate Change** (MoEFCC) has introduced the **Draft Greenhouse Gases Emissions Intensity** (GEI) Target Rules, 2025.

These rules set **sector-specific emission reduction targets** for **"obligated entities**" and establish a robust **compliance framework** under the **Carbon Credit Trading Scheme (CCTS), 2023**—a significant step toward achieving India's **Paris Agreement climate commitments**.



What are Greenhouse Gases (GHGs)?

GHGs are atmospheric gases that **trap heat**, contributing to **global warming** through the **greenhouse effect**.

Major GHGs:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Ozone (0₃)
- Water vapour
- Synthetic gases like CFCs and HCFCs

Understanding GEI: Greenhouse Gas Emissions Intensity

GHG Emissions Intensity (GEI) measures **emissions per unit of output**, e.g., tonnes of CO_2 equivalent (tCO₂e) per tonne of cement or aluminium produced.

As defined by the Draft Rules:

"Greenhouse gases emission intensity in tCO₂e / equivalent output or product."

This provides a **standardized benchmark** for industries to track, reduce, and report emissions.

Key Highlights of Draft GEI Target Rules, 2025:

Baseline and Targets:

- Baseline Year: 2023–24
- Target Years: 2025–26 and 2026–27
- Tied to CCTS 2023 and India's long-term emission strategy

Industries Covered:

- Aluminium (13 plants)
- Cement (186 plants)
- Pulp & Paper (53 plants)
- Chlor-Alkali (30 plants)

Total Units Covered: 282

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Major Corporations Assigned Targets:

• Vedanta, Hindalco, Ultratech, JK Cement, Grasim, Shree Cement, Dalmia Cement, NALCO, and others.

Compliance & Penalties:

- Defined compliance mechanisms
- **Penalties** for failure to meet reduction targets
- Performance-linked incentives via carbon credits

From PAT to CCTS: A Greener Evolution

Foundation: PAT Scheme (2012)

- **Perform, Achieve, Trade (PAT)** encouraged energy efficiency.
- Earned Energy Saving Certificates (ESCerts) for overachievers.

Evolution to Carbon Credit Trading Scheme (CCTS), 2023:

- Expands focus to **GHG reduction** across sectors.
- Establishes **GEI targets** and promotes **carbon** market participation.

How CCTS Works: India's Carbon Market Explained

Framework:

- Carbon Credit Certificates generated when targets are exceeded.
- Traded on the Indian Carbon Market.
- Overseen by **Bureau of Energy Efficiency (BEE)** and **Ministry of Power**.

Industries Must:

- Submit Action Plans to achieve GEI targets.
- **Buy credits** or **face penalties** (enforced by **CPCB**) if underperforming.

Incentives & Market Dynamics:

- Surplus achievers: Sell credits for profit
- Lagging sectors: Buy credits and invest in clean technologies

Global Comparisons & Context:

- European Union ETS (2005): First large-scale carbon market
- China's ETS (2021): Now world's largest by emissions covered
- India's CCTS aligns with global best practices under Article 17 of the Kyoto Protocol

Alignment with India's Climate Goals:

Key Target under the Paris Agreement:

Reduce **emissions intensity of GDP** by **45% by 2030** compared to 2005 levels.

- GEI targets drive climate-smart industrial growth
- Encourages adoption of advanced, low-carbon technologies
- Ensures India's development pathway remains sustainable

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GS Paper 3 – Environment, Ecology

Guidelines for Setting Up Bio-Resource Centres (BRCs) under NMNF

Context: The **Ministry of Agriculture & Farmers' Welfare** has released detailed **guidelines** for the establishment of **Bio-Input Resource Centres (BRCs)** under the **National Mission on Natural Farming (NMNF)**. This move is aimed at accelerating the adoption of **natural and organic farming** practices across India.



What Are Bio-Input Resource Centres (BRCs)?

BRCs are envisioned as cluster-level hubs that will produce and supply natural

bio-inputs tailored to local needs. These centres will also serve as **knowledge and training hubs**, empowering farmers with region-specific solutions for sustainable agriculture.

Financial Assistance & Support:

- Each BRC will receive a **financial support of 1 lakh**, disbursed in **two installments** of 50,000.
- Assistance is **only for operational costs**—not for sheds, land, or permanent infrastructure.
- The funds aim to ensure **cost-effective production and distribution** of bio-inputs to **small and marginal farmers**.

Eligibility & Implementation:

- BRCs must be managed by entrepreneurial farmer groups already practicing natural farming.
- Where such groups are not available, State Natural Farming Cells will onboard interested farmers
 willing to make the shift.
- Inputs produced must remain affordable and accessible to all farmers in the cluster.

Integration with Other Schemes:

The initiative will be aligned with major agricultural schemes, including:

- Formation & Promotion of 10,000 Farmer Producer Organizations (FPOs)
- National Mission on Edible Oilseeds
- Mission Organic Value Chain Development for North Eastern Region (MOVCDNER)
- Paramparagat Krishi Vikas Yojana (PKVY)

This **convergence model** ensures better resource utilization and wider reach.

Significance of BRCs under NMNF:

- Ensure local availability of natural farming inputs
- Promote community-based models to reduce input costs
- Encourage eco-friendly agricultural practices
- Serve as centres of capacity building, innovation, and grassroots mobilization
- Facilitate the **transition from chemical to natural inputs**, reducing soil and water degradation

About National Mission on Natural Farming (NMNF):

Feature	Details			
Туре	Centrally Sponsored Scheme (CSS)			
Nodal Ministry	Ministry of Agriculture & Farmers' Welfare			
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Launch Date	November 25, 2024
Objective	Promote nature-based , sustainable agriculture and reduce dependency on synthetic inputs
Implementation Target	15,000 Gram Panchayat clusters , reaching 1 crore farmers and covering 7.5 lakh hectares within 2 years

Additional Insights:

- Natural farming techniques promoted include **Jeevamrit**, **Beejamrit**, and **Ghanjeevamrit**, rooted in traditional Indian practices.
- **India aims to become a global leader** in sustainable agriculture, targeting the reduction of chemical fertilizer use by **20-30%** in coming years.
- BRCs can also become **rural employment generators**, especially for youth interested in agribusiness and eco-entrepreneurship.

Conclusion:

The establishment of **Bio-Input Resource Centres** is a strategic and timely intervention to **transform India's agricultural landscape**. By ensuring the **affordable**, **localized production of bio-inputs** and empowering farmers through knowledge, the **NMNF** is paving the way for a **resilient**, **sustainable**, **and inclusive agricultural economy**.

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GS Paper 2 – International Relations

India-France Inter-Governmental Agreement on Rafale-M Jets for Indian Navy

Context: India has officially signed a **64,000 crore Inter-Governmental Agreement (IGA)** with **France** for the procurement of **26 Rafale-Marine (Rafale-M)** fighter jets. This deal is a **Government-to-Government (G2G)** arrangement, ensuring a direct and strategic defence partnership without intermediaries.



Key Highlights of the Rafale-M Agreement:

- Total Aircraft: 26 Rafale-M jets tailored for carrier-based operations.
- **Delivery Timeline**: Starts in **mid-2028**, with completion by **2030**.
- **Training Provisions**: Comprehensive training for **crew members in both France and India**.
- Support for IAF Fleet: The agreement also includes spares and equipment for the existing Indian Air Force Rafale jets.
- Transfer of Technology (ToT):
 - Integration of **Astra BVR (Beyond Visual Range) missile**, an indigenous air-to-air missile.
 - Establishment of a production facility for Rafale fuselages in India.
 - Creation of Maintenance, Repair & Overhaul (MRO) infrastructure for engines, avionics, and weapons systems.

Boost to Indian Industry & Economy:

- Expected to generate thousands of jobs.
- Will benefit **numerous MSMEs** (Micro, Small & Medium Enterprises).
- Strengthens India's push for **self-reliance in defence manufacturing** under **'Make in India'** and **Atmanirbhar Bharat** initiatives.

Modernising the Indian Navy's Air Power:

- Current Carriers:
 - **INS Vikramaditya** (Russian-origin)
 - **INS Vikrant** (Indigenous; commissioned in 2022)
- Current Fighter Fleet: 45 MiG-29K aircraft
 - Facing low availability and end-of-service-life issues
- **New Acquisition Need**: Rafale-M chosen to address urgent carrier-based combat requirements.

Rationalising Fleet Strength:

- Initial plan: 54 jets
- Revised to **26 jets** due to:
 - Development of Twin Engine Deck-Based Fighter (TEDBF) by DRDO
 - Aim to support **indigenous defence innovation**

Other Major Defence Procurement: MQ-9B Sea Guardians

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- India will procure **31 MQ-9B HALE RPAS** (High Altitude Long Endurance Remotely Piloted Aircraft Systems) from the **United States**.
 - \circ 15 for Navy
 - 8 each for the Army and Air Force
- Deliveries scheduled from January 2029 to September 2030.
- Enhances India's maritime domain awareness and long-range surveillance capabilities.

Strategic Significance:

- Strengthens the India-France defence partnership, one of the oldest and most trusted.
- Enhances India's ability to **project power in the Indo-Pacific region**.
- A critical step in preparing for **future naval warfare**, integrating **cutting-edge technology** and **multilateral partnerships**.

Did You Know?

- The **Rafale-M** is the **naval variant** of the combat-proven Rafale fighter, capable of operating from **short runways and aircraft carriers**.
- India becomes the **first country outside France** to operate both **Air Force and Navy variants** of the Rafale.
- The **TEDBF**, India's upcoming indigenous carrier jet, is expected to take its first flight by **2026** and be inducted by **2032**.

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GS Paper 3 – Science & Technology

Exploring the Sun's Secrets: Breakthrough in Near-Surface Shear Layer (NSSL) Dynamics

Context: An **international team of solar physicists**, including experts from the **Indian Institute of Astrophysics (IIA)**, has successfully mapped the **plasma currents** within the **Sun's Near-Surface Shear Layer (NSSL)**. This breakthrough reveals flow patterns **tied closely to the Sun's 11-year sunspot cycle**, offering new insights into solar dynamics and magnetic activity.



What is the Near-Surface Shear Layer (NSSL)?

- The **NSSL** is a **highly dynamic zone** located **just beneath the Sun's visible surface**, extending to a depth of approximately **35,000 kilometers**.
- In this layer, the **Sun's angular velocity** (its rotation speed) **decreases sharply with radius**, creating a **rotational shear** that varies with **depth**, **latitude**, and the **Sun's magnetic cycle**.
- It serves as a **crucial interface** for solar magnetic and rotational processes, influencing **surface flows** and **subsurface convection**.

Key Findings from the Study:

- Surface plasma flows were observed to converge toward sunspot latitudes. However, midway through the NSSL, these flows reverse direction, moving outward to form large-scale circulation cells.
- These dynamic patterns are shaped by the **Sun's rotation** and the **Coriolis force**—the same force that governs hurricanes on Earth.
- Despite this dynamism, these localized flows do not account for the Sun's large-scale zonal flows, called torsional oscillations, suggesting the existence of deeper, unexplored forces within the solar interior.
- 3D velocity maps confirmed the dual nature of these flows—surface inflows and deeper outflows—especially in sunspot-rich regions.

Scientific Methods & Instruments Used:

Researchers relied on **helioseismology**, a technique akin to "**ultrasound for the Sun**," which tracks **sound waves** generated within the Sun to probe its interior layers.

Data Sources:

- NASA's Solar Dynamics Observatory (SDO) particularly the Helioseismic and Magnetic Imager (HMI).
- Global Oscillations Network Group (GONG) part of the National Solar Observatory (NSO), USA.
- These instruments provided **over a decade's worth of continuous data**, ensuring high precision and reliability of results.

Why This Matters:

- Understanding the NSSL is **vital to decoding solar activity cycles**, which affect **space weather**, **satellite communications**, and **power grid stability on Earth**.
- The study improves our models of **solar dynamo processes**, the mechanism responsible for generating the **Sun's magnetic field**.

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• Findings may lead to better **predictions of solar flares and coronal mass ejections (CMEs)**, which have major implications for Earth's technological infrastructure.

Did You Know?

- The **Sun's magnetic activity** varies over an **11-year cycle**, influencing the number of **sunspots**, **solar flares**, and **geomagnetic storms**.
- Helioseismology has also been used to **detect sunquakes**, which are solar equivalents of earthquakes.
- The NSSL plays a **pivotal role in the solar dynamo theory**, which seeks to explain how the Sun **generates and sustains its magnetic field**.

Conclusion:

This landmark study in the **Near-Surface Shear Layer** deepens our understanding of the Sun's **plasma dynamics and internal structure**. With advanced observational tools and collaborative international efforts, scientists are inching closer to unraveling the mysteries of our closest star—enhancing not only **space science** but also safeguarding **Earth's technological future**.

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GS Paper 3 – Science and Technology & Environment

Breakthrough in Green Hydrogen Production by INST Scientists

Context: Scientists from the **Institute of Nano Science and Technology (INST), Mohali**, have introduced a **new approach to green hydrogen production** by enhancing the **efficiency of the Hydrogen Evolution Reaction (HER)**. Their innovative work revolves around **proton adsorption dynamics** on specially engineered catalyst surfaces, potentially revolutionizing the green hydrogen landscape.



Key Scientific Breakthrough:

Novel Catalyst Design:

- The team developed a **heterostructure catalyst** made by combining **Copper Tungsten Oxide** (CuWO₄) and Copper Oxide (CuO).
- This combination forms a **p-n heterojunction**, utilizing the **Built-In Electric Field (BIEF)** effect, which creates an **asymmetric electronic environment** at the interface.

Role of BIEF in Hydrogen Evolution:

- The **BIEF** influences how **protons are adsorbed and released**, directly impacting the **efficiency of HER**, a core step in hydrogen production.
- The gradient in **Gibbs Free Energy** (ΔG) at the **CuO-CuWO₄ interface** helps:
 - Enhance hydrogen adsorption on the CuO side
 - **Promote desorption** on the CuWO₄ side

Unique Mechanism: Negative Cooperativity:

- This system exhibits negative cooperativeity, where increased proton binding at one site reduces binding at adjacent sites, encouraging proton desorption.
- This property is particularly beneficial for **alkaline water electrolysis**, where desorption is a **rate-limiting step**.

Understanding Green Hydrogen:

What is Green Hydrogen?

- **Green hydrogen** is generated via the **electrolysis of water** powered by **renewable energy sources** such as **solar, wind, or hydropower**.
- It emits **no greenhouse gases**, with **water vapour as the only by-product**, making it a **carbonneutral** energy solution.

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Comparison with Other Types of Hydrogen:

Туре	Source	Emissions	
Green Hydrogen	Renewable energy + water	Zero emissions	
Grey Hydrogen	Natural gas (methane)	High CO ₂ emissions	
Blue Hydrogen	Natural gas + CCS*	Lower CO ₂ (partial)	

CCS: Carbon Capture and Storage

Major Green Hydrogen Production Methods:

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1. Alkaline Electrolysis:

- Most mature and cost-effective
- Uses KOH or NaOH as electrolyte
- Requires nickel or platinum electrodes
- Suitable for large-scale deployment
- 2. Proton Exchange Membrane (PEM) Electrolysis:
 - Offers high efficiency and fast response
 - Operates at **low temperatures**
 - Involves **expensive catalysts** (e.g., platinum, iridium)
 - Ideal for fluctuating renewable power inputs

3. Solid Oxide Electrolysis (SOEC):

- Works at high temperatures (700-1000°C)
- Can co-electrolyze H₂O and CO₂
- Offers high conversion efficiency
- Requires advanced materials and robust infrastructure

Why This Matters for India and the World:

- India aims to become a global hub for green hydrogen under the National Green Hydrogen Mission.
- Efficient catalysts like the CuO-CuWO₄ heterostructure can help lower the cost of green hydrogen production.
- This breakthrough supports the goal of **decarbonizing energy**, **industry**, and **transportation**, critical sectors in achieving **net-zero emissions** by **2070**.

Did You Know?

- One kilogram of green hydrogen can power a fuel cell vehicle for over 100 km.
- **Green hydrogen** can also be used to **store surplus renewable energy** and convert it back into electricity when needed—acting as a **clean energy battery**.

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GS Paper 2 – Education

Modernising India's Education System: Government's Push for 21st Century Readiness

Context: In a major policy thrust, Prime Minister Narendra **Modi** has reiterated the government's commitment to modernising India's education system to meet 21st-century challenges. At the YUGM Innovation Conclave held at Bharat Mandapam, New Delhi, he outlined a vision for a future-ready, inclusive, and globally competitive education ecosystem.

Introduction: A New Era in Indian Education

India is undergoing a **paradigm shift in education**, led by the



government's proactive approach to align academic systems with the **knowledge economy** and global standards. Central to this transformation is the New Education Policy (NEP) 2020, which seeks to prepare Indian youth with the **skills**, **mindset**, **and values** needed for global leadership in innovation.

Driving Forces Behind the Reform

The reforms are underpinned by a **trinity of development principles**:

- **Talent**: Unlocking the potential of India's vast youth population
- **Technology**: Integrating digital tools and platforms across the learning ecosystem
- **Temperament:** Fostering curiosity, critical thinking, and entrepreneurial spirit ٠

The **NEP 2020**, constantly evolving to meet changing needs, serves as the cornerstone of this educational revolution.

Key Interventions & Infrastructure Overhaul: edom

National Curriculum Framework:

- Revamping the curriculum for Classes 1–7
- Emphasis on conceptual clarity, experiential learning, and multilingual education
- Teaching materials being developed in over 30 Indian languages

Higher Education Expansion:

- Expansion of **IITs**, **AIIMS**, and other premier institutes
- Launch of **meditech and AI-integrated programs** to bridge industry-academia gaps
- Increased capacity for STEM and innovation-based disciplines

Digital Infrastructure: One Nation, One Platform

- Under **PM e-Vidya** and **DIKSHA**, the government is creating a **national digital education backbone**
- Content available in **30+ Indian and 7 foreign languages**, enabling **inclusive access** •

Boosting Research, Innovation & Discovery:

Research Parks & R&D Cells:

- Rise in **Research Parks** from **3 in 2014** to **9 currently**, with **13 more planned**
- Nearly 6,000 higher education institutions now host R&D Cells
- Encouragement for a research-led academic environment •

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Anusandhan National Research Foundation (ANRF):

- Proposed to become India's apex body for cutting-edge research funding and policy
- Gross Expenditure on R&D (GERD) doubled from 260,000 crore (2013–14) to 21.25 lakh crore

Lab-to-Market Ecosystem:

- Support for startups, IP creation, and academic innovation hubs
- Focus on **commercialising student-led innovations** and **industry collaboration**

Global Academic Engagement & Mobility:

- International expansion of Indian institutions:
 - o IIT Delhi in Abu Dhabi
 - o IIT Madras in Tanzania
 - Plans for **IIM Ahmedabad** in **Dubai**
- Foreign universities (e.g., from the US, UK, Australia) invited to set up campuses in India
- Enhanced student exchange and faculty collaboration with global institutions

Access to World-Class Knowledge:

One Nation, One Subscription:

- Nationwide academic access to leading global research journals and publications
- Designed to eliminate institutional paywalls and **democratise access to scientific literature**

India's AI-Driven Educational Future:

AI for Smart <mark>Learnin</mark>g:

- Integrated with the IndiaAl Mission, educational reforms include:
 - Personalised learning platforms
 - Skill gap identification through data analytics
 - Adaptive learning modules based on student performance

AI is expected to **transform pedagogy**, make learning **more inclusive**, and **enhance administrative efficiency** in educational institutions.

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GS Paper 3 – Environmental Pollution & Degradation

Understanding the Urban Heat Island Effect

Context: A recent study reveals the **dual impact of the Urban Heat Island (UHI) effect**: While it **increases heat-related mortality**, it also **substantially reduces cold-related deaths**. In 2018, the global decline in **cold-related fatalities** was **4.4 times greater** than the rise in **heatrelated deaths**, with cities like **Moscow** witnessing even larger differentials.



What is the Urban Heat Island (UHI) Effect?

An **Urban Heat Island (UHI)** refers to an **urban area** significantly warmer than its surrounding rural areas. This occurs because materials like **concrete** and **asphalt** absorb and retain heat more effectively than natural landscapes, making **cities** hotter. The UHI effect is most pronounced in **large, densely populated cities** like **New Delhi**, **New York**, **Paris**, and **London**.

Key Causes of UHI:

- **Impervious Surfaces**: Materials such as **asphalt**, **concrete**, and **steel** absorb heat during the day and release it slowly at night, trapping heat due to their **low albedo**.
- Lack of Vegetation: Limited green cover and tree canopy reduce evapotranspiration, cutting off natural cooling processes and increasing heat buildup in urban areas.
- Anthropogenic Heat: Human activities such as vehicular emissions, industrial processes, and air conditioning contribute excess heat, further raising urban temperatures.
- Air Pollution & Soot: Black carbon and other particulate matter absorb solar radiation, which exacerbates the UHI effect by raising ambient temperatures.
- **Urban Morphology**: The **design** of cities, with dense buildings, narrow streets, and poor airflow, creates an **urban canyon effect**, trapping heat within confined spaces. **Skyscrapers** and high-rises restrict airflow, intensifying heat accumulation.

Consequences of the Urban Heat Island Effect:

Increased Energy Demand:

• The rise in **local temperatures** due to UHI leads to higher **energy consumption** for **cooling** purposes, straining power grids and escalating **carbon emissions**. This positions **urban heat islands** as localized accelerators of **climate change**.

Deterioration of Air Quality:

• Higher temperatures amplify **ground-level ozone formation**, worsening **smog** and respiratory issues, making it harder to breathe in urban environments.

Heat-Related Health Risks:

UHI intensifies the occurrence of heat strokes, dehydration, and cardiovascular stress, particularly in vulnerable groups such as the elderly, children, and those with pre-existing health conditions.
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Strain on Water Resources:

• With higher temperatures, **evaporation rates** increase, reducing available **water resources** for consumption and **cooling** purposes.

Biodiversity Loss:

UHI negatively affects **native vegetation**, disrupts **ecosystems**, and poses a threat to **urban wildlife** due to excessive heat and the reduction of green spaces.

Solutions and Mitigation Strategies:

- **Increasing Green Cover**: Expanding **urban forests**, **green roofs**, and **vegetative walls** can help cool cities by enhancing **evapotranspiration** and providing shade.
- **Cool Roofs and Pavements**: Using reflective materials with **high albedo** for roofing and pavements can reduce heat absorption, helping lower temperatures.
- **Smart Urban Planning**: Designing cities with wider streets, more open spaces, and better **airflow** can help mitigate the **urban canyon effect** and enhance cooling.
- **Energy-Efficient Buildings:** Promoting **energy-efficient building designs** with natural cooling can significantly reduce the urban heat footprint.

The **Urban Heat Island (UHI) effect** highlights the urgent need for sustainable urban planning to combat the growing temperature disparity between cities and their rural surroundings. By taking proactive measures to reduce UHI effects, cities can improve quality of life, health, and environmental sustainability for their residents.

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GS Paper 2 – Governance and Social Justice

Cabinet Approves Caste Enumeration in the Upcoming Census

Context: The Cabinet Committee on Political Affairs (CCPA), chaired by Prime Minister Narendra Modi, has approved the inclusion of caste enumeration in the forthcoming **decennial Census**, marking a **major policy transformation** in the way India collects demographic data.

Caste-Based Enumeration: A Historical Overview

- Last Full Caste Census: Conducted in 1931 during British rule, documenting 4,147 distinct castes.
- 1941 Census: Caste data collected but not published due to World War II.
- Post-Independence: Only Scheduled Castes (SCs) and Scheduled Tribes (STs) have been officially counted.
- 1961 Directive: States were permitted to conduct surveys to identify Other Backward Classes (OBCs).
- **2011 Socio-Economic and Caste Census (SECC)**: Captured socio-economic data but did **not classify** or publish caste data comprehensively.

Legal & Constitutional Basis:

- Union Subject: As per Article 246 and the Seventh Schedule of the Constitution, Census operations are the exclusive domain of the Union Government.
- Census Act, 1948: Governs all Census activities, including data collection, procedures, **responsibilities**, and **penalties** for non-compliance.
- The current move ensures national uniformity, legal backing, and transparency in caste data collection.

Significance of the New Caste Enumeration:

Digital Census for a Digital India:

- The **upcoming Census** will be conducted **digitally**.
- Respondents can use a **mobile application** to fill out their data.
- A new caste column with a drop-down code directory will make selection streamlined and standardized.Data-Driven Governance
- Reliable caste data enables evidence-based policymaking in:
 - Education 0
 - Employment 0
 - Welfare and Reservation Programs
- Will assist in the implementation of the 33% women's reservation in Parliament and State Assemblies.
- Helps tailor **development initiatives** to address **socio-economic inequalities**.

Judicial Support:

The Supreme Court's Indra Sawhney judgment mandates that any declaration of a group's "backwardness" must be based on **objective**, data-driven analysis.

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• A robust caste enumeration aligns with this directive.

Concerns and Challenges:

Political Exploitation:

- There is a risk that caste data could be **manipulated** for **electoral gains**.
- Critics cite **past instances** where caste surveys lacked **transparency** and were driven by **political motivations**.

Social Fragmentation:

- Emphasis on caste identities could **exacerbate social divisions**, rather than promote **inclusivity**.
- May intensify **debates around caste-based reservations**, leading to **public unrest or tension**.

Implementation Difficulties:

- Ensuring accurate and scientific classification of castes is complex.
- There is a need for **methodological clarity**, **training of enumerators**, and **technological safeguards** to prevent **data misrepresentation**.

Conclusion: Towards Inclusive Development

The decision to include **caste enumeration** in the **next Census** is a **landmark policy move** that could reshape India's **socio-economic architecture**. While it brings promise for **inclusive growth**, **targeted policymaking**, and **social equity**, it must be handled with **caution**, **scientific rigor**, and **political neutrality**.

The success of this exercise will depend not only on **technical execution** but also on the **integrity of its purpose**—to **uplift**, **empower**, and **unify**, not to divide.

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GS Paper 3 – Science and Technolog

S8 Tension and the Clumpiness of the Universe: A Cosmic Puzzle

Context: Recent astrophysical studies suggest that the **key** to understanding the universe's fundamental nature may lie in measuring how "clumpy" the matter in the universe is. This has led to the growing scientific focus on an emerging anomaly known as the **S8 tension**.



What is Clumpiness in the Universe?

The Birth of Structure After the Big Bang:

- Approximately **13.8 billion years ago**, the universe emerged from the **Big Bang**, starting as an extremely hot and dense point. As it expanded, matter began to gather, forming galaxies, clusters, stars, and planets.
- However, when scientists observed the Cosmic Microwave Background (CMB)—the leftover radiation from the early universe—they noticed an exceptionally smooth glow, indicating that the early cosmos was strikingly uniform, with only minor density fluctuations.

From Smooth to Structured:

Over billions of years, gravity pulled matter together into clumps, forming the large-scale structure ٠ we see today—webs of galaxies surrounded by vast cosmic voids. This non-uniform distribution of matter is what cosmologists refer to as "clumpiness."

Understanding S8: The Cosmic Clumpiness Factor dom

What is S8?

The **S8** parameter is a cosmological quantity that measures the degree of matter clustering in the universe. It combines information about:

- σ_8 (sigma-8): How strongly matter clumps together on 8 megaparsec scales. ٠
- Ω (Omega matter): The proportion of the universe made up of matter.

Formally, $S8 = \sigma_8 \times (\Omega \square / 0.3)^{0.5}$.

Higher vs Lower S8 Values:

- A higher S8 value means more clustering of matter—galaxies are tightly packed. ٠
- A lower S8 value indicates a smoother, more uniform matter distribution. •

What is the "S8 Tension"?

A Disagreement in the Data:

When scientists measured S8 using two different techniques, they found **inconsistent results**:

- 1. CMB observations (like those from the Planck satellite) suggest a higher S8 value.
- 2. Local measurements based on gravitational lensing and galaxy surveys indicate a lower S8 value.

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This persistent discrepancy is known as the **S8 tension**—a growing challenge in modern cosmology.

Why Does the S8 Tension Matter?

If this mismatch isn't due to **measurement errors**, it could indicate that:

- The **ΛCDM model** (Lambda Cold Dark Matter)—our standard model of the universe—may be **incomplete or flawed**.
- **Dark matter or dark energy** might have **unusual interactions** or **evolving properties** not yet understood.
- It could signal the need for **new physics**, such as:
 - Modified gravity theories
 - Time-varying fundamental constants
 - Decaying or interacting dark energy
 - Non-standard neutrino properties

Did You Know?

The **Hubble tension**, another major cosmic inconsistency, parallels the S8 tension. Both could be interconnected and hint at a **deeper underlying issue** in our cosmological models.

Conclusion: The Frontier of Cosmic Discovery

The **S8 tension** isn't just a technical issue—it's a potential **gateway to revolutionary insights** about the universe. Whether it leads to a **new theory of gravity**, a **revised dark matter model**, or an **entirely new paradigm**, one thing is clear:

The universe may be hiding secrets that defy our current understanding—and solving the S8 mystery could be the key to uncovering them.

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GS Paper 3 – Environment and Ecology

India Opposes Inclusion of Chlorpyrifos in Stockholm Convention

Context: At the ongoing Conferences of the Parties to the Basel, Rotterdam, and Stockholm (BRS) Conventions in Switzerland, India has opposed the proposed listing of Chlorpyrifos under the Stockholm Convention on Persistent Organic Pollutants (POPs).

The opposition stems from concerns about food security and the lack of readily available alternatives for pest control.

Over 40 countries have already banned Chlorpyrifos due to health and environmental risks.

What is Chlorpyrifos?

- **Chlorpyrifos** is a **broad-spectrum organophosphate insecticide** used extensively in agriculture and public health.
- It has been linked to:
 - Neurodevelopmental disorders
 - **Reduced birth weight** 0
 - Lung and prostate cancers 0
- The World Health Organization (WHO) classifies it as a moderately hazardous pesticide.
- It works by **inhibiting acetylcholinesterase**, an enzyme critical for nervous system function, leading to toxic effects in humans and animals.

About the Stockholm Convention on POPs:

- Adopted in May 2001 and entered into force in May 2004.
- Aims to **protect human health and the environment** from long-lasting, toxic chemicals known as persistent organic pollutants.
- The Convention classifies chemicals under three annexes:
 - **Annex A: For elimination** 0
 - Annex B: For restricted use 0
 - Annex C: To minimise unintentional production \circ
- The Convention allows for **exemptions** in specific cases based on national priorities.

Steps Toward Global Phase-Out:

- In **2021**, the **European Union** nominated Chlorpyrifos for elimination under the Convention.
- In 2024, the Persistent Organic Pollutants Review Committee (POPRC) recommended its inclusion in Annex A (elimination), with limited exemptions:
 - **Plant protection** 0
 - **Cattle tick control** 0
 - Wood preservation 0
- Global debates continue over exemption clauses, with India and some other nations advocating for **flexibility** due to agricultural and health needs.
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India's Position:

- **Registered since 1977**, Chlorpyrifos was **India's most-used insecticide** in 2016–17.
- India highlights its **continued necessity**:
 - Effective for **urban pest control** (cockroaches, termites)
 - Crucial for vector-borne disease management (like dengue and malaria)
- A **2024 study** found **Chlorpyrifos residues in 33%** of Indian food samples.
- The Anupam Verma Committee (2013–2015) acknowledged its toxicity to aquatic life and pollinators, but did not recommend an outright ban at the time.

India's Future Path:

- The government is promoting a **National Mission on Natural Farming**, a centrally sponsored initiative by the **Ministry of Agriculture & Farmers' Welfare** to reduce chemical use in farming.
- India is also engaging in **ongoing deliberations** about other harmful chemicals at the BRS Convention, including:
 - Medium-chain chlorinated paraffins
 - Long-chain perfluorocarboxylic acids (LC-PFCAs)

Conclusion: India's stance underscores the complex balance between public health, agriculture, and environmental safety. While global consensus grows around eliminating hazardous chemicals, developing nations like India are seeking a phased, practical transition that considers food security, pest control needs, and economic realities.

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GS Paper 3 – Environment and Ecology

The Red-Crowned Roofed Turtle: A Triumph for Conservation

Context: In an extraordinary milestone for **biodiversity conservation**, the critically endangered Red-Crowned Roofed Turtle (Batagur kachuga) has returned to the Ganga River after an absence of three decades. This marks a significant victory for conservation efforts aimed at preserving this unique species.

About the Red-Crowned Roofed Turtle:

- Scientific Name: Batagur kachuga ٠
- Known also as the Bengal Roofed Turtle, this species is a freshwater turtle native to the Indian subcontinent, including India, Bangladesh, and Nepal.

Historical and Current Distribution:

- Historical Range: Once widely distributed in the Ganga River and parts of Bangladesh, this species thrived in these regions.
- **Present Distribution:** The National Chambal River Gharial Sanctuary in India is now home to the largest population of the Red-Crowned Roofed Turtle.
- It is also found in the **Brahmaputra basin**, but populations are now sparse and fragmented.

Physical Features of the Red-Crowned Roofed Turtle:

- Size: A medium-sized turtle, it can grow up to **56 cm** in length and weigh up to **25 kg**.
- **Sexual Dimorphism**: Males are smaller, reaching only **half the length** of the females.
- **Coloration**:
 - The head is reddish-orange with a black crown. 0
 - The upper shell (carapace) is greenish-brown with yellowish patterns. 0
 - The **lower shell** (**plastron**) is **yellow**, marked with **black**. 0
- **Physical Features**:
 - The turtle has a **broad head**, **strong jaws**, and **webbed feet**, ideal for both swimming and 0 feeding.

Diet and Behavior:

The Red-Crowned Roofed Turtle is **omnivorous**, feeding on a mix of **plants** and **small animals**, which includes insects, fish, and aquatic vegetation.

Conservation Status:

- IUCN Red List: Critically Endangered
- Wildlife (Protection) Act of 1972: Schedule I (highest protection under Indian law)
- CITES: Appendix II, which lists species that are not necessarily threatened with extinction but may become so if trade is not regulated.

A Remarkable Conservation Effort:

The return of the Red-Crowned Roofed Turtle to the Ganga River highlights the success of ongoing conservation initiatives. These efforts, led by organizations and government bodies, are crucial for

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preserving this unique species, which has faced numerous challenges, including **habitat loss**, **pollution**, and **illegal poaching**.

Additional Facts and Conservation Efforts:

- The **Ganga River** has long been a symbol of India's cultural and natural heritage, and the return of such species emphasizes the river's ecological significance.
- Conservation measures include **protected habitats**, **sustainable fishing practices**, and community engagement in **river conservation**.
- Additionally, the **Indian Government** has focused on creating a balance between **human activity** and **wildlife conservation** along the river.

The **Red-Crowned Roofed Turtle's** return is a testament to the resilience of nature when given the right protection and care. With continued effort, this species can hope to thrive in its natural habitat for generations to come.

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GS Paper 1 – Geography

Vembanad Lake: A Jewel of Kerala's Natural Heritage

Context: The **Vembanad Lake**, Kerala's largest and longest freshwater lake, is undergoing a significant restoration effort, inspired by the **Namami Gange Programme**. With a **2188.25 crore** investment, the project aims to rejuvenate this vital water body over the next **five years**, with ongoing studies influencing potential revisions.



Key Highlights of the Rejuvenation Plan:

- Collaborative Effort: The Alappuzha District Administration is leading the initiative, supported by eight specialized subcommittees covering sectors such as agriculture, fisheries, water resources, biodiversity, sanitation, and disaster management.
- **Restoration Goals**: The plan targets reversing the alarming **27% shrinkage** in the lake's surface area between **1917 and 1990**, caused by **land reclamation**, sedimentation, and encroachment.
- **Recent Actions:** Efforts have included successful **cleaning drives**, removing **28.72 tonnes of plastic waste** and large amounts of **water hyacinth**, a weed that chokes the water body.

About Vembanad Lake: An Ecological and Cultural Treasure

- Size and Location: Vembanad is not only the longest lake in India but also the largest in Kerala, stretching across 96.5 km. It spans three districts: Alappuzha, Kottayam, and Ernakulam, covering an impressive area of 2,033 square kilometers.
- Local Names: The lake is known by several names, including Vembanad Kayal, Vembanad Kol, Punnamada Lake (in Kuttanad), and Kochi Lake (in Kochi).

Ecological Importance:

- **River Sources**: Vembanad is fed by **six major rivers**, notably the **Meenachil**, **Achankovil**, **Pamba**, and **Manimala**, which contribute to its vast catchment.
- **Arabian Sea Outlet**: The lake has an outlet to the **Arabian Sea** on its western side, linking it to the broader marine ecosystem.
- **Islands**: The lake is home to several important islands, including **Pathiramanal**, **Perumbalam**, and **Pallippuram**, which are crucial for both ecological balance and tourism.
- Kumarakom Bird Sanctuary: On the lake's eastern shore, the Kumarakom Bird Sanctuary attracts nature lovers and birdwatchers from across the world.

Cultural Significance:

• Nehr Trophy Snake Boat Race: The famous Nehru Trophy Snake Boat Race (known as Vallam Kali) is held annually in August in the Punnamada segment of the lake, drawing spectators globally.

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International Recognition:

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Vembanad is part of the **Vembanad-Kol Wetland**, a **Ramsar site** designated in **2002** for its international ecological importance. This wetland is a critical habitat for numerous species of migratory birds and aquatic life, contributing significantly to Kerala's biodiversity.

Additional Insights:

- **Tourism**: Vembanad is a central part of Kerala's famous **backwater tourism**, attracting both domestic and international tourists for boat rides, birdwatching, and eco-tourism experiences.
- **Water Quality**: Beyond the lake's aesthetic and cultural value, its water quality directly impacts the livelihood of thousands who depend on it for fishing and agriculture.
- **Sustainability**: The ongoing rejuvenation project aims not only to restore ecological balance but also to **sustain the traditional livelihoods** of the local communities, ensuring that Vembanad remains a vibrant resource for future generations.

The rejuvenation of **Vembanad Lake** is an essential step towards preserving Kerala's natural heritage, balancing ecological restoration with sustainable development. Through these concerted efforts, Vembanad is poised to reclaim its position as one of India's most treasured ecosystems.

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GS Paper 2 – Governance, Constitution, Polity, Social Justice

Bridging the Digital Divide: Key Highlights of the Landmark Verdict

Context: In a historic move, the **Supreme Court of India** has ruled that **digital access** is an intrinsic part of the **fundamental right to life and liberty** under **Article 21** of the Constitution. This judgment significantly impacts India's approach to digital infrastructure, marking digital inclusion as a constitutional obligation for the state.

RIGHT TO DIGITAL ACCESS

Key Highlights of the Verdict:

- Constitutional Provisions Invoked:
 - Article 21: Right to life and dignity.
 - **Article 14**: Right to equality.
 - **Article 15**: Prohibition of discrimination.
 - Article 38 (DPSP): The state's duty to promote welfare and reduce inequalities.
- Digital Access as a Constitutional Right:
 - The Court recognized **digital access** as an **"instinctive component"** of the **right to life** under Article 21.
 - The right to digital access is now viewed as a **constitutional imperative**, essential for participating in governance, accessing education, healthcare, essential services, and economic opportunities in today's digital age.
- Substantive Equality Principle:
 - The Court stressed the importance of ensuring that digital transformation is **inclusive** and **equitable**, addressing the varying needs of society.

Bridging the Digital Divide: A Constitutional Responsibility

- Despite rapid digital growth in India (through initiatives like **Aadhaar**, **online platforms**, and **net banking**), significant sections of the population—particularly rural areas, senior citizens, economically weaker sections, linguistic minorities, and persons with disabilities—continue to face **systemic exclusion** due to lack of digital access.
- **Inclusive Digital Infrastructure**: The judgment emphasizes that it is not merely a policy choice, but a **constitutional responsibility** to ensure that everyone has access to digital services, protecting their **dignity**, **autonomy**, and the ability to participate fully in public life.

Political Background and Relief Granted:

• The verdict came in response to petitions by **two acid attack survivors** who faced barriers in completing the **digital KYC** process due to their inability to take a live photograph by blinking, an essential requirement for online identity verification.

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• Directions by the Court:

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- The **Reserve Bank of India (RBI)** and other governmental bodies have been instructed to revise **KYC norms** to accommodate **visually- and hearing-impaired** individuals.
- Develop accessible alternatives such as **Braille**, **voice-enabled**, and other user-friendly digital interfaces.
- Provide alternative modes to verify "liveness" for KYC purposes, and allow **paper-based KYC** as an accessible option.

Implications for Governance and Policy:

- **Inclusive Digital Governance**: The Court's verdict calls for a proactive approach from the state in designing digital ecosystems that include **diverse needs** and ensure **no one is left behind**.
- **Future of Technology**: The Court's directive reaffirms the principle that **technology** should never be a barrier to essential services, and inclusive design is vital to ensuring **true participation** in the digital world.

This ruling paves the way for a more **inclusive digital ecosystem** in India, ensuring that **technology** serves everyone, leaving no one behind. The Supreme Court has not only protected an individual's **right to digital access** but also emphasized the importance of **equality and inclusivity** in an increasingly digital world.

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GS Paper 2 – Economy

World Audio Visual and Entertainment Summit (WAVES) 2025

Context: At the **inaugural WAVES Summit 2025** held in **Mumbai**, the **Prime Minister of India** emphasized the **creative economy** as a vital force driving **GDP growth**, **innovation**, and **inclusive development** in the digital era.

Major Announcements:

Launch of the Indian Institute of Creative Technology (IICT)

- A National Centre of Excellence to be set up by the Ministry of Information & Broadcasting.
- Developed in partnership with **FICCI** and **CII**.
- Aims to **upskill youth**, promote **media innovation**, and nurture talent in:
 - Animation
 - Gaming
 - Content creation
 - Film and media technologies

Targeting a \$5<mark>0 Billion Market by 2</mark>029:

• WAVES 2025 envisions unlocking a **\$50 billion global market** in **media, entertainment, and content sectors**, positioning India as a **world leader in the creative economy**.

Understanding the Creative Economy (Orange Economy):

"Creativity is the new currency of the digital age."

The **Creative Economy** refers to industries that generate **economic value through creativity, intellectual property (IP), and cultural expression**.

Key Sectors:

- Cultural Industries: Music, cinema, theatre, literature, dance, crafts
- Creative Industries: Fashion, architecture, advertising, design
- Digital Sectors: Animation, VFX, gaming, OTT platforms, XR, YouTube, influencer content

Term Popularised by: John Howkins

"Orange Economy" coined by: Former Colombian President Iván Duque and Felipe Buitrago

Current Status of India's Creative Economy (2025):

- \$30 Billion contribution to GDP
- Employs around 8% of the workforce
- Creative exports exceed \$11 Billion annually, led by film, music, and digital content
- India is among the top global players in fintech, mobile tech, and startups

India's Untapped Potential in the Creative Sector:

Demographic Advantage:

• Over **65% of India's population** is below 35

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• Youth are key drivers of gaming, design, content creation, and short videos

Digital Backbone:

- Second-largest internet user base globally
- Supported by initiatives like:
 - Digital India
 - BharatNet
 - 5G rollout

Cultural Soft Power:

- Rich traditions in language, music, art, and mythology
- Exports like Bollywood, yoga, and Indian cuisine strengthen India's global identity

Key Challenges Hindering Growth

Challenge	Description		
Lack of IP awareness	Weak enforcement of copyrights and royalties		
Fragmented industry	Mostly informal, lacking formal structures		
Skill Gaps	Outdated training methods in fast-evolving digital tools		
Limited Funding	Inadequate access to grants and credit		
Urban-centric Growth	Rural artists and talent remain underrepresented		

Way Forwar<mark>d:</mark>

- Expand IICT's reach to Tier 2 & Tier 3 cities
- Strengthen IP laws and royalty systems
- Formalize creative sectors with MSME-style incentives
- Support rural artisans through digital platforms and e-commerce
- Update skilling programs to include XR, AI in art, and blockchain for IP

Conclusion:

The **WAVES 2025 Summit** marks a turning point in recognizing **creativity as capital**. With policy support, digital tools, and youth participation, **India's creative economy** can not only entertain the world—but also **enrich its economy and empower its people**.

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GS Paper 3 – Science and Technology

World's Largest Fusion Project Hits Major Milestone - With India's Crucial Contribution

Context: The **International Thermonuclear Experimental Reactor (ITER)** has achieved a major construction milestone by **completing its main magnet system**, with **India** playing a vital role in this landmark scientific achievement.

What is ITER?

ITER (International Thermonuclear Experimental Reactor) is the **world's largest nuclear fusion project**, under construction on a **180-hectare site in southern France**. It is a **collaborative megaproject** involving **35 countries**, including:

India, China, the United States, Russia, Japan, South Korea, and the European Union

Purpose:

To demonstrate the **feasibility of nuclear fusion** as a **safe, large-scale, carbon-free** energy source for the future.

Understanding Nuclear Fusion:

"Fusion is the process that powers the Sun and stars."

- Fusion involves combining two light atomic nuclei (like **deuterium** and **tritium**) into a **heavier nucleus**, releasing immense energy.
- Unlike fission, fusion:
 - **Does NOT produce long-lived radioactive waste**
 - Is **inherently safer** (no meltdown risk)
 - Is clean and sustainable

Objectives of ITER:

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- To generate **500 MW** of energy output from just **50 MW** of input, achieving a tenfold energy gain.
- To demonstrate a **self-sustaining "burning plasma"**—a critical condition for viable fusion energy.
- To provide scientific data for **future commercial fusion reactors** (ITER will not generate electricity itself).

Funding and Cost Sharing:

Region/Country	Contribution
European Union	45%
India, China, Japan, Korea, Russia, US	~9% each

Note: All members receive **equal access** to research outputs and **intellectual property rights**.

Contributions by Member Countries:

	Country	Key Contributions
	USA	Built the Central Solenoid , ITER's most powerful magnet
	Russia	Supplied the Poloidal Field magnet
	Europe	Designed and produced four major Poloidal Field magnets
Download Our Application	China	Supplied Correction Coil magnets and Poloidal Field magnets



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Japan	Produced 43 km of Nb ₃ Sn superconducting strand		
South Korea	Developed tooling systems for large component assembly		
India	See details below↓		

India's Pivotal Role in ITER:

India is a **core member** and has made **critical technological contributions**, including:

Cryostat and Cooling Systems:

- Designed and built the **Cryostat** a **30-meter-tall vacuum chamber** that houses the Tokamak.
- Installed **cryolines** and **helium systems** to cool magnets to **-269°C (superconducting state)**.

Heating and Shielding:

• Delivered components for **neutral beam heating**, **cooling water systems**, and **biological shielding structures**.

What Milestone Was Just Reached?

ITER has successfully **completed the assembly of its pulsed superconducting electromagnet system**, a major part of the **Tokamak's magnetic confinement**.

Key Function:

- This system will generate plasma by ionizing deuterium and tritium fuel.
- The plasma will be heated to over 150 million °C—10x hotter than the Sun's core—to trigger fusion reactions.

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Timeline an<mark>d Future</mark> Outlook:

Phase			Target Year	da	m	1/F	15	(
Scientific Operations Begin		2034	90			\sim		
Deuterium-Tritium Fusion Tests		2039	ER W					

If Successful...

- Fusion energy could offer:
 - Near-limitless clean power
 - Zero carbon emissions
 - No radioactive waste
- Could **revolutionize the global energy landscape** and help meet climate targets.

Did You Know?

- ITER's central magnet is so powerful that it can **lift an aircraft carrier**.
- The cryostat built by India is the largest high-vacuum pressure chamber ever built.
- Fusion produces **4 million times more energy** than burning coal, per unit mass of fuel.

Conclusion: The ITER milestone, achieved with significant **Indian scientific and engineering input**, represents a **historic step toward achieving clean, sustainable fusion energy**. As we move closer to 2034, the world watches as **ITER becomes humanity's biggest bet on the energy of the stars**.











GS Paper 3 – Infrastructure & Economic Development

Vizhinjam International Seaport: India's Gateway to Global Maritime Power

Context: Prime Minister Narendra Modi is set to inaugurate the **Vizhinjam International Seaport**, placing **Kerala** firmly on the **global maritime map**. This event marks a significant leap in India's port infrastructure and trade capabilities.

Location & Overview:

Located in **Vizhinjam**, a serene coastal town near **Thiruvananthapuram**, Kerala, this port is set to be a **game-changer** in India's maritime sector.

- India's First: Dedicated transshipment port
- Semi-Automated Operations: The first of its kind in the country
- Project Cost: 28,900 crore
- **PPP Model**: Operated by **Adani Group**, with the **Kerala Government** holding a **majority stake**

Cutting-Edge Infrastructure & Technology:

- **Deepest Breakwater in India**: Nearly **3 km long**, offering unmatched protection
- Natural Draft of 20 Metres: Ideal for ultra-large container vessels (ULCVs)
- Minimal Littoral Drift: Reduces dredging and maintenance costs
- AI-Powered Vessel Traffic Management System (VTMS): India's first indigenously developed system, in collaboration with IIT Madras
- Automation at Its Best:
 - **Remotely operated ship-to-shore cranes**
 - Fully automated yard cranes
 - Ensures faster, safer, and cost-efficient cargo handling

Strategic Importance:

- Location Advantage: Just 10 nautical miles from the busiest international East-West shipping route
- **Transshipment Revolution**: Currently, **75% of India's transshipment** is handled by foreign ports like **Colombo, Singapore, and Dubai**, leading to **foreign exchange outflows**
 - Vizhinjam aims to reclaim this traffic, retaining economic value within the country
- **Global Connectivity**: Now part of direct shipping routes to **Shanghai**, **Singapore**, **Busan**, and other major ports

Future Expansion & Multi-Modal Connectivity:

Vizhinjam is envisioned as more than a port—it's set to become a **multi-modal logistics hub**:

- Direct highway access via NH-66
- Kerala's first cloverleaf interchange
- Upcoming rail link to integrate with the national railway network
- Plans for **free trade warehousing zones**, **cold chains**, and **inland container depots** to boost regional trade

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Extra Insights & Global Comparison:

- **Transshipment Defined**: It refers to transferring cargo from one ship to another—crucial for countries with global trade ambitions.
- Why This Matters: Ports like Singapore and Dubai grew into financial powerhouses by dominating transshipment. Vizhinjam aims to replicate this model in India.
- **Environmental Edge**: The port's naturally deep waters reduce ecological disruption and save on costly dredging operations.

Key Takeaways:

- First-of-its-kind project in India with world-class features
- Will enhance India's competitiveness in global maritime trade
- A transformational asset for Kerala's economy and employment
- Supports Make in India and Atmanirbhar Bharat by boosting local infrastructure

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GS Paper 1,3 – Geography, Environment and Ecology

Ukraine's Critical Minerals: Powering the Future of Green Tech and Global Security

Context: In a major strategic shift, the **United States and Ukraine** have signed a critical minerals partnership. The agreement gives the U.S. preferential access to Ukraine's rich mineral deposits and establishes a joint investment fund to support **Ukraine's post-war reconstruction** and energy independence.



What Are Critical Minerals and Rare Earth Elements?

Critical Minerals are naturally occurring materials essential to modern technology, clean energy, and national defense. Their supply chains are highly vulnerable due to geopolitical risks and limited global sources.

Rare Earth Elements (REEs) — a subgroup of 17 metals — are indispensable for:

- **Electric vehicle (EV) motors**
- **Smartphones**
- Missile guidance systems .
- Wind turbines
- Military and aerospace technology •

According to the U.S. Geological Survey (USGS), 50 minerals, including lithium, cobalt, nickel, and rare earths, are considered critical due to their:

- Non-substitutability
- High economic importance Supply vulnerability

Ukraine's Hidden Treasure Trove:

Ukraine holds immense untapped potential in critical mineral reserves, making it a vital resource partner for the West.

Mineral Riches at a Glance:

- **22 of the 34** EU-classified critical minerals are found in Ukraine.
- Rare Earth Elements: Includes neodymium, cerium, lanthanum, erbium, scandium, and yttrium.
- Lithium: Estimated reserves of **500,000 metric tonnes**, among the largest in Europe. ٠
- Nickel, cobalt, manganese: Key for EV batteries and energy storage. •
- Graphite: Ukraine holds about 20% of global reserves, vital for nuclear reactors and battery • anodes.

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Titanium: Used in aircraft, satellites, defense, and high-performance materials.

Key Locations:

- Lithium: Central, eastern, and southeastern Ukraine
- Titanium: Northwestern and central Ukraine
- Graphite and REEs: Scattered across central and eastern regions

Strategic Importance: Countering China's Dominance:

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China currently controls **over 80%** of global rare earth production, raising major concerns about **monopolydriven pricing** and **supply chain risks**.

Ukraine's vast resources offer:

- A secure alternative for the EU and U.S.
- A chance to diversify the global critical minerals supply
- Strategic leverage for Ukraine's economic revival and geopolitical relevance

The Road Ahead: Opportunity & Challenge

- **Investment Potential**: With Western backing, Ukraine could become a **European mining hub** post-conflict.
- **Reconstruction Synergy**: Mineral extraction can **fund rebuilding**, create **jobs**, and boost **exports**.
- Environmental Concerns: Sustainable mining practices will be key to long-term viability and global support.

Summary:

Mineral	Use	Ukraine's Strength		
Lithium	EVs, energy storage	One of Europe's largest reserves		
Graphite	Batteries, nuclear reactors	$\sim 20\%$ of global resources		
Rare Earths	Electronics, defense, green tech	Multiple types available across the country		
Titanium	Aerospace, defense, industrial alloys	High-grade, strategically located		

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GS Paper 1 – Geography

Egypt in the Spotlight: Strengthening Strategic Ties with India

Context: India and Egypt have taken a significant step in enhancing their bilateral relationship, particularly in the field of **counter-terrorism**. The two nations convened the **4th Joint Working Group Meeting**, reaffirming their commitment to cooperate on security, intelligence sharing, and regional stability.

Egypt: A Strategic Crossroads of Continents

Geopolitical Location:

Egypt is uniquely positioned at the **northeastern edge of Africa**, acting as a crucial link between **Africa**, **Asia**, and **Europe** through the **Suez Canal**—a globally vital maritime trade route.

- **Capital**: **Cairo**, one of the largest cities in Africa and the Arab world
- Neighbouring Countries:
 - Libya to the west
 - Sudan to the south
 - Israel to the northeast
- Bordering Water Bodies:
 - **Mediterranean Sea** to the **north**
 - Red Sea and Gulf of Aqaba to the east

Fact: The **Suez Canal**, located in northeastern Egypt, handles over **10% of global maritime trade**, making Egypt a critical player in global logistics.

Key Geographical Features of Egypt:

Terrain and Natural Landmarks:

- Major Mountain Ranges:
 - Red Sea Hills (Eastern Desert)
 - o Sinai Mountains (Sinai Peninsula)
- Highest Peak:
 - **Mount Catherine** (2,642 m), located in the **Sinai Peninsula**, is Egypt's tallest mountain and a revered pilgrimage site.
- Major River:
 - The **Nile River**, the **longest river in the world**, flows **northward through Egypt**, playing a vital role in agriculture, economy, and ancient civilization.

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• Deserts:

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- **Western Desert** (*Al-Ṣaḥrā*' *al-Gharbiyyah*): Covers about **two-thirds** of the country.
- **Eastern Desert** (*Al-Ṣaḥrā' al-Sharqiyyah*): Lies between the **Nile River** and the **Red Sea**, rich in mineral resources.

Why Egypt Matters Today:

- **Strategic Location**: Controls the **Suez Canal**, crucial for European–Asian trade.
- **Cultural Influence**: A historic hub of **Arab culture**, **Islamic scholarship**, and **ancient history**.
- Diplomatic Role: A key mediator in Middle Eastern peace processes and African Union initiatives.
- Economic Hub: Investing in mega projects like the New Administrative Capital and clean energy, including one of the world's largest solar farms in Benban.

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GS Paner 1 – Health

Antibiotic Access Crisis Against CRGN Infections

Context: A recent study published in *The Lancet Infectious Diseases* has raised alarm bells over the **severe lack of access to effective antibiotics** for **carbapenem-resistant Gram-negative (CRGN)** infections in India. The study reveals that **only 7.8% of affected patients** in India received appropriate treatment, underscoring a critical gap in managing **multi-drug resistant infections**.



Key Findings: Antibiotic Access and CRGN Infections

Limited Access to Effective Antibiotics:

- The study examined **1.5 million CRGN cases** across **eight low- and middle-income countries (LMICs)** in 2019.
- In **India alone**, out of **nearly 10 lakh CRGN infections**, fewer than **1 lakh patients** received correct antibiotic treatment.
- **Only 7.8%** of Indian patients were treated appropriately—slightly above the **6.9% average** for the studied LMICs (India, Bangladesh, Brazil, Egypt, Kenya, Mexico, Pakistan, and South Africa).
- This **treatment gap** is estimated to have resulted in **approximately 3.5 lakh deaths** in India.

Barriers to Proper Treatment:

The study id<mark>entified multiple obstacles:</mark>

- Insufficient diagnostic infrastructure
- Lack of standardized treatment protocols
- Poor antibiotic availability and affordability

Recommendations by the Study:

- A dual approach is essential:
 - **Preserve** existing antibiotics through **responsible usage** (antibiotic stewardship).
 - Ensure access to effective treatments for all patients in need.
 - **Regulatory reforms**, improved diagnostics, and **supply chain interventions** are vital.
- Urges countries to **bridge the access gap** and **strengthen healthcare capacity** to combat resistance.

Understanding CRGN: A Public Health Threat

What is CRGN?

Carbapenem-Resistant Gram-Negative (CRGN) bacteria are pathogens that have developed **resistance to carbapenem antibiotics**, which are often the **last resort** for treating severe, multi-drug resistant infections.

Mechanism of Resistance

- CRGN bacteria produce **carbapenemase enzymes**, which **neutralize antibiotics**, rendering treatment ineffective.
- Resistance spreads via **horizontal gene transfer**, rapidly affecting hospital and community settings.

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Examples of CRGN Pathogens:

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- Klebsiella pneumoniae
- Pseudomonas aeruginosa

These bacteria can cause:

- Pneumonia
- Bloodstream infections (sepsis) •
- Urinary tract infections (UTIs)

Why CRGN is Dangerous:

- Infections are **difficult to treat**, with **limited alternative options**.
- Linked to:
 - High mortality
 - **Prolonged hospitalizations** 0
 - Escalating healthcare costs
- **Global health agencies**, including WHO, list CRGN as a **top priority pathogen**.

Gram Staining: Classifying Bacteria

Basics of Bacteria:

- Bacteria are unicellular prokaryotes, lacking a true nucleus. •
- Key components: cell wall, DNA, cytoplasm, flagella, ribosomes, etc.
- Classified into:
 - Gram-positive bacteria
 - Gram-negative bacteria 0

The Gram Staining Technique:

A widely used method to **differentiate bacteria** based on **cell wall structure**:

- Gram-positive bacteria: Have a thick peptidoglycan wall; stain violet.
- Gram-negative bacteria: Have a thin wall with an outer membrane; stain red or pink due to the loss of crystal violet during decolorization.

Conclusion: An Urgent Call to Action

The fight against **antimicrobial resistance (AMR)** hinges on:

- Strengthening global healthcare systems
- Ensuring equitable access to effective antibiotics
- Investing in research, diagnostics, and drug development



