Today's Prelims Topics

Polar Geoengineering

Context

A new study led by Martin Siegert (University of Exeter) published in Frontiers in Science (September 9, 2025) critically evaluated five prominent geoengineering proposals aimed at cooling Earth's polar regions.

What is meant by Polar Engineering?

- It refers to **large-scale technological interventions** in the Earth's polar regions (Arctic and Antarctica) designed to **counter global warming, slow ice melt, and reduce sea-level rise**.
- **Techniques:**
    - **Stratospheric aerosol injection (SAI):** Releasing reflective particles (like sulphur dioxide) into the stratosphere to cool Earth by reflecting sunlight.
    - **Sea curtains/walls:** Sub-sea barriers built to block warm ocean currents from reaching and melting polar ice sheets.
        - **E.g.**, Proposal of **placing curtains in the Amundsen Sea (West Antarctica)** to protect the Thwaites Glacier ("Doomsday Glacier")
    - **Sea-ice management (glass microbeads, seawater pumping):** Ideas like scattering reflective glass microbeads on Arctic ice or pumping seawater onto the surface
        - **E.g., the Arctic Ice Project** aimed to deploy silica microspheres onto Arctic ice.
    - **Basal water removal:** Draining meltwater beneath glaciers to slow sliding
        - **E.g.,** Proposals for **Antarctica's Pine Island Glacier,** where subglacial water flow accelerates ice loss.
    - **Ocean fertilisation (iron filings):** Sprinkling iron filings to boost phytoplankton growth and carbon capture
        - **E.g.,** The **LOHAFEX experiment (2009, Southern Ocean)** led by India and Germany tested iron fertilisation but showed limited CO_2 absorption.

What are the Issues Associated with these?

- **Limited Effectiveness**: Many methods (e.g., SAI in polar winters) simply don't work due to natural constraints.
- **Ecological Damage**: Microbeads, ocean fertilisation, or sea curtains could disrupt marine ecosystems, nutrient cycles, and food chains.
- **High Costs & Logistics**: Estimates run into billions annually; operations in remote, hostile polar regions are extremely difficult.
- **Global Side-Effects**: Interventions in one region can disrupt **global weather patterns**, agriculture, and security.
- **Moral Hazard**: May create a false sense of security and delay decarbonisation efforts ("technological cop-out").
- **Termination Shock Risk**: Sudden stop in projects like SAI could trigger rapid warming spikes.
- **Governance Gaps**: No international legal frameworks exist to regulate responsibility, liability, or funding.

- **Energy & Carbon Costs**: Some methods (like pumping seawater) consume massive energy, undermining climate goals.

Source: The Hindu

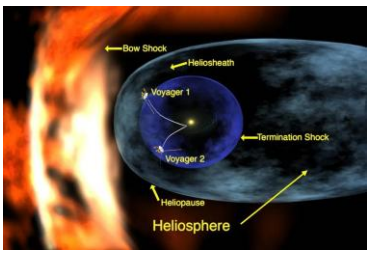
Interstellar Mapping and Acceleration Probe (IMAP)

Context

Recently, NASA launched the Interstellar Mapping and Acceleration Probe (IMAP).

About IMAP

- It is aimed to map the heliosphere's boundary, trace energetic particles, and improve space weather forecasting that directly affects satellites, astronauts, and communication systems on Earth.
- **Key Features:**
  - **Equipped with 10 scientific instruments** including neutral-atom detectors (IMAP-Lo, IMAP-Hi, IMAP-Ultra), charged particle detectors, magnetic field sensors, and dust detectors.
  - Will operate from the **Sun-Earth Lagrange Point 1 (L1)**, about **1.6 million km from Earth**, ensuring stable and continuous observation.



  - Sends **near real-time data** for monitoring space weather.
  - Provides the **most detailed maps** of the heliosphere's boundary, showing how the solar wind collides with the interstellar medium.
  - IMAP-Lo has a specialised role: detecting **interstellar neutral hydrogen and deuterium** to study conditions at the heliopause (outermost heliosphere boundary).

What is a Heliosphere?

It is a massive "bubble" of solar wind and magnetic fields that extends far beyond the planets of our solar system, acting as a protective shield against cosmic rays and other interstellar particles.

Source: The Hindu

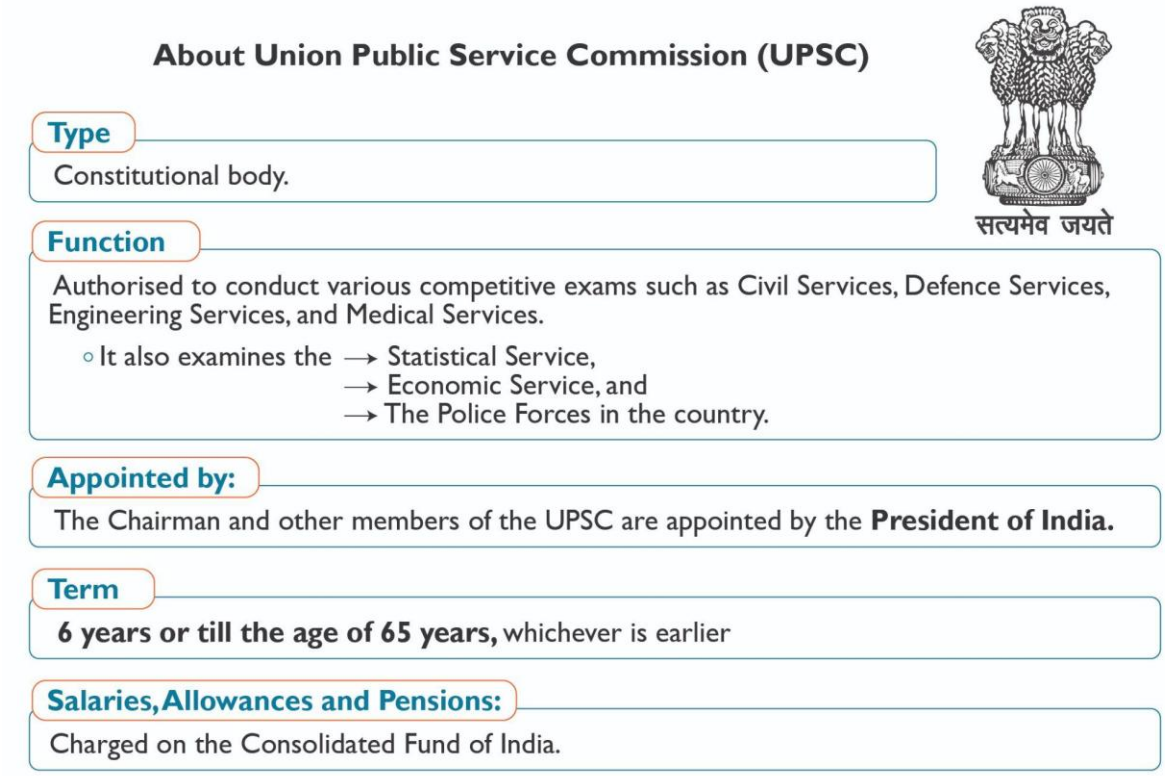
Union Public Service Commission (UPSC)

Context

On October 1, 2025, the Union Public Service Commission (UPSC) marked 100 years of its establishment.

About UPSC

- **1919 GOI Act**: First provided for a Public Service Commission.
- **1926**: Public Service Commission set up under British rule, following **Lee Commission (1924)** recommendations.
- **1935 GOI Act**: Became the **Federal Public Service Commission**.
- **1950**: With the Constitution, assumed its present status as the **UPSC**.



Recent Reforms:

- **Digitalisation** of applications and processes.
- **Face-recognition technology** to curb impersonation.
- **PRATIBHA Setu Initiative:** helping candidates who reached interviews but did not make the final list to find other employment opportunities.

Source: The Hindu

Model Youth Gram Sabha

Context

The Centre will launch the Model Youth Gram Sabha (MYGS) initiative from October 2025.

About Model Youth Gram Sabha

- An educational simulation of Gram Sabha (local assembly in villages).
- Similar to Model United Nations (MUN), but focused on village governance and development.
- **How it Works:**
    - Students from **classes 9–12** will enact roles like **Sarpanch, ward members, village secretary, Anganwadi worker, ANM (Auxiliary Nurse Midwife), and junior engineers**.
    - They will conduct **mock Gram Sabha meetings**, discuss local issues, prepare **village budgets** and **development plans**.
- **Implementation:**
    - Phase 1 (Oct 2025): To be launched in **600 Jawahar Navodaya Vidyalayas (JNVs)** and **200 Eklavya Model Residential Schools (EMRSs)**.
    - Also in selected **Zilla Parishad schools in Maharashtra and Karnataka**.
    - Later, expansion to other schools run by state governments.
    - About **1,100 schools** will be covered in the first phase.

Source: Indian Express

International Civil Aviation Organization (ICAO)

Context

India was re-elected to Part II of the Council of the International Civil Aviation Organization (ICAO) during its 42nd Assembly Session in Montreal.

About ICAO

- **Established:** 1944 under the **Chicago Convention** (Convention on International Civil Aviation).
- **Type:** A **specialized agency of the United Nations**.
- **Headquarters:** Montreal, Canada.
- **Membership:** 193 countries (all signatories to the Chicago Convention).
- **Structure:**
    - **Assembly:** Meets every **3 years**, sovereign body of ICAO.
        - Comprises representatives of all 193 member states.
    - **Council: 36-member governing body**, elected by the Assembly for a **3-year term**.
        - Divided into 3 parts:
            - **Part I:** States of chief importance in air transport.
            - **Part II:** States making the **largest contribution to facilities for international civil air navigation** (India is in this group).
            - **Part III:** States ensuring representation of all major geographical regions.
- **Functions:**
    - **Sets international aviation standards and regulations** on safety, security, efficiency, and environmental protection.
    - Develops **policies and regulatory frameworks** for global civil aviation.
    - Works on **air navigation, accident investigation, and aviation security measures**.
    - Promotes **equitable growth of international air transport** and ensures **"No Country Left Behind"** in aviation development.
    - Acts as a global forum for **cooperation among member states and industry stakeholders**.

Source: PIB

Amazon Rainforest

Context

A new study published in Nature Plants has found that **trees in the Amazon rainforest are getting bigger in size**, growing by about **3.3% in diameter every decade.**

About the Amazon Rainforest

- Covers around **5.5 million sq km** across **nine countries**: Brazil, Peru, Colombia, Bolivia, Ecuador, French Guiana, Guyana, Suriname, and Venezuela.
    - **Brazil contains ~60%** of the rainforest.
- Known as the **"lungs of the Earth"**, as it produces ~20% of the world's oxygen.
- Houses **10% of the world's biodiversity**.
- Stores **150–200 billion tonnes of carbon**, acting as a major **carbon sink**.
- Home to **1 in 10 known species** on Earth, including many endangered and endemic species.

Source: Indian Express

Personality in News

Muthulakshmi Reddy (1886–1968)

About Her

- **Contribution:**
  - **First woman in India** to be admitted into a **men's college (Madras Medical College)**.
  - As a member of the Madras Legislative Council (1927), introduced:
    - **Abolition of the Devadasi system**.
    - Law against **child marriage**.
    - Efforts to raise the **age of marriage for girls**.
  - Advocated for **reservation of seats for women** in education and politics.
  - Founded the **Adyar Cancer Institute (1954, Chennai)**
  - **Established Avvai Home in Chennai** for destitute and orphan girls.
  - Co-founder of the **Women's Indian Association (WIA)** in 1917, along with Annie Besant and Margaret Cousins.
- **Honours: Padma Bhushan (1956)**.

Source: The Hindu

Prasanta Chandra Mahalanobis (1893 – 1972)

About Him

- **Contribution:**
  - Introduced the famous **"Mahalanobis Distance (1936)"**, a statistical measure of comparison between two data sets.
  - Founded Indian Statistical Institute (ISI) in 1931 (Calcutta/Kolkata).
  - Established the **National Sample Survey (1949)** to provide comprehensive statistical data for planning, later evolved into the **National Sample Survey Office (NSSO)**.
  - Architect of the **Second Five-Year Plan (1956–61)**, which emphasised **industrialisation through heavy industries** ⟶ Known as the **"Mahalanobis Model"**

	of economic planning. ● **Honours:** ○ **"Father of Indian Statistics"** ○ Awarded the **Padma Vibhushan (1968)**. ○ Fellow of the **Royal Society (FRS)**, UK. ○ His birthday, **29 June**, is celebrated as **National Statistics Day** in India. **Source:** The Hindu

Places in News

Phillipines

News? A 6.9 magnitude earthquake struck off the coast of central Philippines.

About Phillipines

- **Location:** Southeast Asia, an archipelago of over **7,600 islands** between the **Philippine Sea (Pacific Ocean)** and the **South China Sea**.
- **Capital:** Manila (with Quezon City as the most populous city).
- **Geography:** Mountainous, volcanic islands with a tropical maritime climate.
- **Other key facts:** Part of the **Coral Triangle**, rich in biodiversity; member of ASEAN.

Why is It Prone to Earthquakes?

- Located in the **Pacific Ring of Fire** , where ~90% of earthquakes occur.
- Lies at the convergence of the **Philippine Sea Plate** and **Eurasian Plate**, creating intense seismic activity.
- Crisscrossed by major faults like the **Philippine Fault System** and **Valley Fault System**.
- **Presence of deep trenches** (Philippine Trench, Manila Trench) and ~24 active volcanoes linked to frequent quakes.

Source: The Hindu

Mains Topics

Need of Environmental Surveillance

Context

Environmental surveillance, especially through wastewater monitoring, is emerging as a critical tool for India to detect, prevent, and manage disease outbreaks more effectively.

What is Environmental Surveillance?

- **Definition:** A method of monitoring pathogens (bacteria, viruses, parasites) and other health-related markers in the environment (sewage, hospital effluents, soil, even air samples).
- **Scope**: Goes beyond individual testing and captures the **collective health profile of a community**.
- **Examples:** Polio virus detection in sewage, COVID-19 viral load in wastewater, monitoring antibiotic resistance in hospital effluents.

How Does It Work?

- **Sample Collection:** Sewage treatment plants, hospital waste outlets, railway stations, airplane toilets, or contaminated soil.
- **Pathogen Detection**: Pathogens shed in human stool, urine, or respiratory secretions are identified through molecular techniques (e.g., PCR, genome sequencing).
- **Data Analysis**:
  - Comparing pathogen load over time ⟶ indicates rising or declining trends.
  - Whole-genome sequencing helps identify **new variants** or resistant strains.
- **Early Warning:** Wastewater levels often precede clinical cases by 7–10 days, giving time for preventive action.

Why is Environmental Surveillance Important? (Significance)

- **Early Warning System**
  - Detects outbreaks before symptoms appear widely.
  - Helps in timely deployment of medicines, vaccines, and hospital preparedness.
- **Captures Asymptomatic & Untested Cases:** Traditional clinical surveillance misses those who don't show symptoms or avoid testing.
- **Public Health Planning:** Helps policymakers understand true infection burden in a community. Crucial for resource allocation (beds, oxygen, vaccines).
- **Supports Disease Eradication:** Used globally for polio, measles, cholera eradication campaigns.
- **Cost-effective and Scalable:** Monitoring sewage is cheaper than testing millions of individuals.
- **Links to One Health:** Tracks zoonotic pathogens (like avian flu) and antimicrobial resistance, protecting both human and animal health.

India's Current Efforts

- **Polio Surveillance (since 2001):** First piloted in Mumbai through sewage testing.
- **COVID-19 Pandemic**: 5 Indian cities started wastewater monitoring; continues today.
- **ICMR Initiative (2025)**:
    - Plan to conduct **wastewater surveillance for 10 viruses across 50 cities**.
    - Includes avian influenza and other high-risk pathogens.
- **Research & Pilot Projects:** Some universities and state labs experimenting with genomic surveillance in wastewater.

Challenges in India

- **Fragmented Approach:** Project-driven efforts; no integrated **national programme** yet.
- **Standardisation Issues:** Lack of uniform sampling protocols and data-sharing across states.
- **Infrastructure Gaps:** Many Indian cities lack functional sewage treatment plants (STPs), especially in tier-2/3 towns.
- **Data Management:** Weak centralised systems for analysing and sharing results with public health authorities.
- **Funding & Skilled Manpower:** Limited trained microbiologists, epidemiologists, and lab technicians.
- **Privacy & Ethics:** Concerns about misusing surveillance data for targeting communities.
- **Neglect of Rural Areas:** Surveillance efforts largely urban; rural India faces equal, if not greater, risks.

Way Forward

- **National Wastewater Surveillance System:** A centralised framework under ICMR/NDMA integrated with routine disease surveillance.
- **Standard Protocols:** Develop common templates for sampling, sequencing, and data reporting across states.
- **Expand Infrastructure:** Invest in modern sewage treatment plants and lab facilities across all major urban centres.
- **Integration with Health Policy:** Link surveillance with National Health Mission, Ayushman Bharat, and NDHM.
- **Capacity Building:** Train public health professionals, epidemiologists, and municipal staff in sample handling and genomic analysis.
- **Community Transparency & Ethics:** Publish results openly to build public trust and avoid stigma.
- **Leverage Technology:** Use **AI/ML tools** for predicting outbreaks; integrate with early-warning dashboards for health planners.
    - Explore novel surveillance methods (e.g., audio monitoring, air sampling in crowded spaces).
- **Global Best Practices:** Learn from countries like the Netherlands and Australia, where wastewater surveillance is part of national health systems.
    - Align with WHO's Global Polio Laboratory Network and emerging global initiatives for pandemic preparedness.

Source: The Hindu