India logged the largest rise in greenhouse gas emissions in 2024

Why in News?

In 2024, India recorded the biggest absolute year-on-year increase in greenhouse gas emissions worldwide, adding about **165 $MtCO_2$ e**, the largest increment among nations. With this rise, India moved to become the **third-largest emitter globally** after China and the United States, although its **per capita emissions remain below half the global average** (approximately **3 tCO_2 e** compared with **6.4 tCO_2 e** worldwide). Overall global greenhouse gas emissions reached a record **57,700 $MtCO_2$ e** in 2024, driven primarily by continued fossil-fuel combustion, methane emissions, and land-use changes. The development underlines India's **development-versus-climate dilemma** — fast economic expansion set against claims for an equitable approach to emissions responsibility.

Relevance:

GS 3 – Environment & Climate Change
• Global emissions trajectory and India's sectoral emissions profile
• Issues of climate finance, carbon intensity and sustainable development trade-offs
• Policy instruments: NDCs, NAPCC, and the Mission LiFE initiative
• Contribution of renewables, green hydrogen and electric mobility to mitigation
• Carbon trading markets and India's path to net-zero

GS 2 – International Relations
• India's diplomatic posture in UNFCCC fora and at COP30
• The CBDR-RC principle and negotiations led by the Global South
• Equity and justice debates within international climate governance

Key Data Snapshot (2024)

Indicator	**Global**	**India**
Total GHG emissions	57,700 $MtCO_2$ e (record)	~3,900 $MtCO_2$ e
Increase over 2023	+1,500 $MtCO_2$ e	+165 $MtCO_2$ e (largest absolute rise)
Share in global emissions	—	~6.7%
Per capita GHG emissions	6.4 tCO_2 e	3 tCO_2 e (<50% of global avg)
Growth rate of per capita emissions (2023–24)	0.04%	3.7%

Sources of Greenhouse Gas Emissions

A. CO_2 (≈69% of total GHGs)
Originates from burning coal, oil and gas. Key sectors: electricity generation (around 40% of CO_2), industry (steel, cement, fertilizer manufacture), transport (rising emissions from road and aviation), and residential energy use (LPG, biomass, coal).

B. Methane CH_4 (≈16% of total)
Major contributors: agriculture (flooded rice paddies, enteric fermentation in livestock), waste streams (landfills, sewage) and fugitive emissions from mining and hydrocarbon production.

C. Nitrous oxide & fluorinated gases
Associated with fertiliser application and industrial refrigerants (HFCs, SF_6), forming the remaining slice of the GHG pie.

India's Emission Drivers & Dynamics

• Rapid, energy-intensive growth under industrialisation and infrastructure pushes (Make in India).
• Heavy reliance on coal for electricity — roughly 70% of power from coal-fired plants.
• Urban expansion increasing transport and construction emissions.
• Agricultural methane from rice and livestock.
• Land-use change and forest loss weakening carbon sinks.
• Energy access inequalities — biomass/diesel dependence in rural areas.

Climate Justice Angle

Under **CBDR**, India points out its low historic contribution (roughly 4% of cumulative emissions from 1850–2019) and stresses equity: lower per-capita footprints and developmental needs warrant a differentiated transition schedule. Unfulfilled climate finance commitments (the $100 billion/year pledge) constrain developing countries' mitigation and adaptation choices.

India's Commitments & Policy Measures

A. NDCs (updated 2022):
• Cut emission intensity of GDP by 45% by 2030 (from 2005 baseline).
• Achieve 50% cumulative electric power capacity from non-fossil sources by 2030.
• Add 2.5–3 billion tonnes CO_2 e of carbon sink through afforestation.

B. Domestic Programmes:
• NAPCC's eight missions (solar, energy efficiency, Green India, etc.).
• PAT scheme for industrial energy efficiency.
• FAME for EV uptake.
• National Hydrogen Mission (green hydrogen targets).
• Carbon credit trading platform (2023).
• LiFE initiative to promote low-carbon lifestyles.

Consequences of Rising Emissions

Environmental: More frequent heatwaves, floods and irregular monsoons; glacier retreat and sea-level rise threatening mountain and coastal ecosystems.
Economic: Escalating adaptation and loss-and-damage costs (estimates ~2–2.5% of GDP by mid-century) and risk of carbon-border levies that could hit exports.
Social: Greater agricultural stress, food insecurity and health burdens from pollution (India hosts many of the world's most polluted cities).
Strategic: Increased pressure in international negotiations (COP30) to chart faster decarbonisation.

Pathways Forward

A. Energy Transition: Phased down coal with just-transition plans for coal regions; scale renewables to 500 GW by 2030; bolster storage and green hydrogen; expand nuclear and offshore wind.
B. Carbon Management: Build CCUS infrastructure; promote bio-CNG and ethanol blending.
C. Agriculture & Methane: Adopt AWD in paddy, biogas and livestock feed additives to curb methane.
D. Forests & Land Use: Expand mangrove restoration, community forestry, and Green Credit initiatives.
E. International & Finance: Mobilise climate finance via GCF, LiFE bonds and push for operational Loss & Damage mechanisms at COP30.

Why do astronauts wear pressurised suits?

Purpose: They protect the human body from the vacuum of space, preventing ebullism (the boiling of bodily fluids), oxygen deprivation and tissue expansion.
How they work: Maintain internal pressure, supply oxygen and remove CO_2 , regulate temperature, shield from micrometeoroids and avert rapid decompression injuries.

Relevance:

GS 3 – Science & Technology (Space Technology)
- Crew safety systems: pressure regulation, gas supply and thermal control.
- India's Gaganyaan mission and indigenous crew systems development.
- Use of legacy technologies (Sokol KV-2) from Russian collaboration.
- Physical principles: decompression physiology, Boyle's law and vacuum effects.

Why IVA suits are compulsory during ascent and descent

Ascent and re-entry are the most hazardous mission phases owing to risks of cabin depressurisation, extreme accelerations, vibrations and thermal stress. The **Soyuz 11** tragedy (1971) — where a premature valve opening caused depressurisation and the death of three cosmonauts — led to mandatory intra-vehicular activity (IVA) suits during these phases. IVA suits serve as an individual life-support fallback.

Suit Types

Type	Use	Features	Weight
EVA (Extra-Vehicular)	Spacewalks, external repairs	Multi-layered (12–14 layers), full vacuum, radiation & micrometeoroid protection; functions as a miniature spacecraft	100–130 kg
IVA (Intra-Vehicular)	Inside spacecraft, launch/re-entry	Pressure retention, emergency oxygen, thermal regulation	8–10 kg

Gaganyaan's IVA suit

Model: Sokol KV-2 (Russian, Zvezda).
Design: Two-layer construction — an inner rubberised pressure bladder (polycaprolactam) and an outer nylon restraint layer for structural strength. It has heritage from over a hundred

Soyuz missions and guards crew survival in cabin-pressurisation emergencies. The suit reflects India's push into human spaceflight while using reliable international technology.

Key Concept — Atmospheric Pressure

Sea-level pressure (~1 atm ≈ 101.3 kPa) exerts a large overall force on the body; sudden loss causes catastrophic physiological failure. Pressure garments act as the vital interface preserving human viability in near-vacuum environments.

Status of the Rare Earth Hypothesis

Why in News?

JWST observations of TRAPPIST-1 and other exoplanet studies (2023–24) found that even Earth-sized worlds may lack stable atmospheres, renewing debate about the **Rare Earth Hypothesis (REH)** — the notion that complex life like Earth's is exceptionally uncommon. While rocky planets in habitable zones are relatively frequent, conditions that sustain stable, life-supporting atmospheres and long-term habitability appear uncommon.

Relevance:

GS 3 – Science & Technology
• Exoplanet missions (Kepler, JWST) and astrobiology.
• REH debates (Ward & Brownlee).
• Interplay of astrophysics, geology and biology.

GS 1 – Geography / Earth Systems
• Distinctiveness of Earth's life-supporting conditions; planetary evolution and habitability concepts.

Origins of the Hypothesis

Ward and Brownlee's 2000 thesis argues microbial life might be widespread, but complex, multicellular life requires a rare suite of planetary and astrophysical circumstances.

Why Earth Might Be Unusual

A cluster of interrelated factors likely make Earth hospitable: being in a habitable zone for liquid water; a stable atmosphere; a protective magnetic field; active plate tectonics managing long-term climate; presence of a large Moon stabilising axial tilt; and favorable system architecture (giant planet presence influencing impact rates). Each is critical for long-term, complex-life-friendly stability.

Recent Evidence & Developments

(a) **Kepler results:** A significant fraction of Sun-like stars host Earth-sized planets in habitable zones — undermining the idea that rocky habitable-zone planets are rare.
(b) **JWST data (TRAPPIST-1):** Some Earth-size exoplanets lack substantial atmospheres, indicating that size alone doesn't ensure Earth-like conditions.
(c) **Atmospheric retention & magnetic fields:** M-dwarf stars' high activity often strips atmospheres; magnetic protection and volcanic replenishment may be necessary but uncommon.
(d) **Plate tectonics:** Its centrality to long-term climate stabilisation is debated; models show alternative stabilising processes might exist but are likely less effective.

(e) **Giant planet effects:** Jupiter-like bodies can both shield and perturb impactors; outcomes depend on system specifics.
(f) **Technosignature searches:** Projects like Breakthrough Listen have found no definitive signals, keeping open the question of technological civilisation scarcity.

Scientific Debates

Optimists emphasise the abundance of rocky planets, while REH proponents highlight that stable atmospheres, tectonics and long-term stellar quietude are rarer — favouring the view that complex life is not commonplace.

Implications

Microbial life could be widespread, but multi-layered ecosystems and sustained evolutionary breadth seem less likely, making Earth potentially unusual in the cosmos.

Future Directions

Observational advances (JWST, ELTs, future missions like LUVOIR/HabEx) and theoretical work on planetary geology, magnetic fields and carbon-cycle stability will refine habitability assessments.

India cautions against reworking Paris architecture at COP30

Why in News?

At **COP30 (Belém, Nov 2025)**, India reaffirmed that the Paris Agreement's structure must remain intact and be guided by **equity and CBDR-RC**. Speaking for LMDC and BASIC groupings, India warned against attempts to alter the Agreement's fundamental architecture during anniversary deliberations and stressed adaptation, predictable finance and accelerated net-zero action by developed countries.

Relevance:

GS 2 – International Relations
• India's position on preserving Paris rules and CBDR.
• Role within BASIC and LMDC blocs.
• Negotiating stances on finance, adaptation and fair burden-sharing.

GS 3 – Environment
• Implementation of NDCs, adaptation frameworks and finance needs.
• Domestic policy alignment with global obligations.

Background — Climate Governance

UNFCCC institutionalised CBDR-RC in 1992. Kyoto set binding targets for developed states, while Paris (2015) introduced nationally determined contributions for all, retaining CBDR's spirit. COP30 was expected to press for tangible implementation following the Global Stocktake.

India's COP30 Priorities

(a) **Defend Paris architecture:** Resist reinterpretations that would shift disproportionate mitigation burdens to developing countries.
(b) **Adaptation emphasis:** Insist on adaptation parity with mitigation, and call for National

Adaptation Plans aligned with national needs.
(c) **Climate finance:** Highlight the shortfall in developed-country pledges (only $300bn by 2035 vs demands for ~$1.35tn); press for additional, concessional funding and MDB reform.
(d) **Net-zero & negative emissions:** Urge developed countries to lead earlier decarbonisation and invest in negative-emission technologies; India's target remains net-zero by **2070**.
(e) **Global South unity:** BASIC and LMDC defended equitable treatment and resisted attempts to downplay finance/adaptation.

Context (2024–25)

Recent years saw faltering trust: incomplete delivery on pledges, contested NCQG discussions (COP29), and mounting climate losses. COP30 was therefore pivotal for rebuilding North–South trust.

India's Domestic Position

India reiterates its NDC goals (emission intensity reduction, non-fossil capacity goals) and domestic missions (LiFE, Hydrogen Mission, state adaptation plans). The challenge remains balancing development with decarbonisation and securing affordable technology and finance.

Global Consequences

India's stance reinforces Global South claims for fairness and underlines the fissures in global climate politics; the COP process must translate commitments into finance and technology that empower adaptation and development.

Supreme Court judge: imported doctrines may not protect endangered species adequately

Why in News?

Justice P.S. Narasimha of the Supreme Court observed that Western-derived environmental concepts (e.g., inter-generational equity) are anthropocentric and may not suffice to conserve endangered fauna. The comment came during hearings concerning the conservation crises of the **Great Indian Bustard** and the **Lesser Florican**.

Relevance:

GS 3 – Environment & Biodiversity
• Debate between ecocentric and anthropocentric conservation philosophies.
• Constitutional duties (Art. 48A; Art. 51A(g)) and wildlife statutes (1972 WPA).
• Legal approaches to protecting species like the GIB and Florican.

GS 2 – Polity & Judiciary
• Judicial interpretative role in environmental protection and integration of Indian ecological thought.

Case Context

Conservationist M.K. Ranjitsinh challenged insufficient protection measures as populations of GIB (~150 wild, ~70 captive) and Lesser Florican (~70 individuals) teeter on the brink, with captive-breeding showing limited success.

Justice Narasimha's Point

He criticised reliance on Western-influenced doctrines like inter-generational equity for being centered on human utility; instead, he urged a more **ecocentric** legal approach that recognises intrinsic worth of species beyond their usefulness to humans.

Conceptual Distinctions

Anthropocentrism: Values nature instrumentally for human benefit.
Ecocentrism: Recognises ecosystems and species as having intrinsic value and legal worth independent of human needs — an orientation consistent with certain Indian philosophical traditions and increasingly reflected in Indian jurisprudence.

Judicial Evolution

India's courts have moved from human-centred environmental law towards doctrines affirming intrinsic species value (Red Sanders, T.N. Godavarman, Animal Welfare Board rulings). The burst of litigation around the Great Indian Bustard reflects this jurisprudential shift.

Legal Underpinnings

Articles 48A and 51A(g), the Biological Diversity Act and WPA provide the constitutional landscape for privileging ecocentric protections and government duty.

Not all plastics can be recycled — here's why

Why in News?

The write-up explains why only particular plastic types are recyclable despite push for circularity and India's Plastic Waste Management Rules (2016; amended 2022). The debate is topical amid global plastics-treaty talks (INC-5) and India's implementation of Extended Producer Responsibility (EPR).

Relevance:

GS 3 – Environment & Pollution Control
• Polymer science and the recyclability divide between thermoplastics and thermosets
• Plastic Waste Management Rules and EPR mechanisms
• Recycling technologies (mechanical vs chemical) and systemic constraints
• SDG linkages: responsible consumption, life below water, climate action

GS 3 – Material Science
• Chemistry of polymers and innovation in biodegradable plastics

What are plastics?

Plastics = synthetic polymers made of repeating monomers derived from fossil feedstocks. They comprise a base polymer (e.g., PE, PP) and multiple additives (plasticisers, dyes, stabilisers), which together determine performance and recyclability.

Classification & Recyclability

Type	Bonding	Heating Behaviour	Examples	Recyclability
Thermoplastics	Weak intermolecular forces	Soften on heating and can be remoulded	PET, HDPE, LDPE, PVC	Readily recyclable
Thermosets	Covalent cross-links	Do not melt; char or fracture on heating	Epoxy resins, Bakelite, melamine	Not recyclable by conventional methods

Why only some plastics are recyclable?

(a) **Molecular structure:** Thermoplastics can be melted and reshaped repeatedly; thermosets' permanent cross-links prevent remelting.
(b) **Additives & contamination:** Food residues, dyes and plasticisers degrade mechanical properties of recycled resin.
(c) **Multi-material packaging:** Laminates (chips, sachets, tetra packs) combine polymers and foils that are hard to separate.
(d) **Economics:** Recycling is viable when feedstock is clean, homogeneous and available at scale; mixed streams lack market for recycled output.

Mechanical vs Chemical Recycling

Mechanical: Shredding and remelting — energy-efficient but limited to clean mono-polymers.
Chemical: Depolymerisation or pyrolysis to convert plastics back into monomers or oils — can treat mixed wastes but is energy- and capital-intensive and not yet scalable economically.

India's Plastic Waste Landscape

• Annual generation ~3.5 million tonnes (CPCB 2023).
• Recycling estimates ~60%, largely informal and mechanical.
• Regulations: PWM Rules (2016/2022), EPR mandates, bans on select single-use plastics.
• Policy push: NITI Aayog roadmap for circular plastics.

Environmental & Health Impacts

Non-recyclable plastics clog landfills and produce microplastics and toxic leachates; incineration of mixed plastics emits dioxins and GHGs; marine plastics threaten biodiversity and human food chains.

Way Forward

• Promote mono-material packaging and invest in chemical recycling R&D.
• Strengthen EPR enforcement and municipal segregation infrastructure.
• Government procurement to create demand for recycled products.
• Integrate informal waste collectors into formal systems.
• Encourage bio-based polymers and design for recyclability.

India must protect its baryte resources

Why in News?

Although India has been the world's leading **baryte exporter** since 2018, it controls only about **4% of global reserves**. The rapid exhaustion of the **Mangampet** deposit in Andhra Pradesh — which supplies over 95% of domestic baryte output — jeopardises energy and defence needs. Given export curbs by major powers (China, US, Russia), safeguarding domestic baryte is a strategic priority.

Relevance:

GS 3 – Economy & Energy Security
• Strategic mineral role in oil-drilling and defence supplies
• Depletion concerns at Mangampet and export-driven extraction
• Critical Minerals Strategy and resource-security implications

GS 2 – Governance & Policy
• Centre–State roles in mineral governance (APMDC)
• Export regulation and national strategic stockpiling lessons from other countries

What is baryte?

Barium sulphate ($BaSO_4$) — dense, chemically inert, non-magnetic and non-radioactive. It has high specific gravity and X-ray opacity, and India's premier deposit is at Mangampet (Kadapa district).

Uses & Strategic Value

Sector	**Application**	**Strategic relevance**
Energy	Weighting of drilling muds for oil and gas wells	Crucial for safe hydrocarbon exploration
Defence	High-density uses in missile components, radar shielding	No ready substitutes
Medical	Barium meals for X-ray imaging	Civilian health use
Industry	Fillers in paints, plastics, electronics	Broad industrial use

India's Baryte Situation

• Reserves fell from ~49 Mt (2015) to <23 Mt (2024) at projected depletion rates of 2–3 Mt/year.
• Production ~2.5–3 Mt/year, mostly Andhra Pradesh.
• Exports ~2.3 Mt in 2023 — India supplies about 40% of world exports despite only ~4% of deposits.
• Heavy export orientation risks running domestic needs short.

Global Context

Countries like China, US and Russia have placed export restrictions to conserve strategic stocks. India currently lacks export caps, leaving it exposed to future supply shocks if other producers curb exports.

Policy Problem

An export-first strategy is depleting reserves faster than domestic strategic demand grows, risking a shift from exporter to importer for baryte, similar to patterns in oil and critical minerals.

Risks & Implications

Energy security: Shortfalls could disrupt drilling operations and exploration activities.
Defence: Dependence on foreign supply for defence-critical applications would be risky.
Sustainability: Unchecked mining could exhaust reserves in a few years and degrade local environments.

Comparative Lessons

• China: export controls and domestic prioritisation.
• US & Russia: strategic management and restricted extraction.
Lesson: resource nationalism and stockpiling preserve long-term national security.

Way Forward

• Impose calibrated export limits and prioritise domestic allocation for oil, gas and defence sectors.
• Build a Strategic Baryte Reserve analogous to petroleum SPRs.
• Incorporate baryte into the National Critical Minerals Policy.
• Invest in R&D for substitutes or synthetic materials via CSIR/DRDO collaborations.
• Enforce sustainable mining norms and rehabilitate mining landscapes.
• Promote domestic beneficiation and value addition to reduce raw-ore exports and create industrial capacity.

13th November 2025: Daily MCQs

Q1. With reference to India's greenhouse-gas (GHG) emissions in 2024, consider the following statements:

1. India recorded the largest absolute rise in GHG emissions in 2024, adding about 165 MtCO_2 e.
2. India became the third-largest emitter worldwide (after China and the USA) in 2024.
3. India's per-capita GHG emissions in 2024 were roughly half the global average (≈3 tCO_2 e vs ≈6.4 tCO_2 e).
   Which of the statements given above are correct?
   (A) 1 and 2 only
   (B) 2 and 3 only
   (C) 1 and 3 only
   (D) 1, 2 and 3
   Answer: (D) 1, 2 and 3
   Explanation: All three statements reflect the data points in the brief — India added ~165 MtCO_2 e, became the 3rd largest emitter, yet its per-capita emissions remain below half the global average.

Q2. With reference to sources of methane (CH_4) emissions in India, consider these statements:

1. Paddy cultivation is a significant source of agricultural methane.

2. Enteric fermentation in livestock contributes substantially to methane emissions.
3. Fugitive emissions from coal mining and gas extraction are negligible sources of methane.
Which of the statements given above is/are correct?
(A) 1 only
(B) 1 and 2 only
(C) 3 only
(D) 1, 2 and 3
Answer: (B) 1 and 2 only
Explanation: Paddy fields and enteric fermentation are major methane sources. Fugitive emissions from mining and gas extraction are **not** negligible — they are an important methane source, so statement 3 is false.

Q3. Regarding India's Indoor Air Quality (IAQ) model developed (as described), which of the following statements are correct?

1. The IAQ score ranges from 22 (worst) to 100 (best).
2. Pollutant concentration carries the highest weight (~59.5%) in the index.
3. Consumer air purifiers typically measure multiple pollutant classes including benzene and VOCs to the same extent as the IAQ model.
Select the correct answer using the code given below:
(A) 1 and 2 only
(B) 2 and 3 only
(C) 1 and 3 only
(D) 1, 2 and 3
Answer: (A) 1 and 2 only
Explanation: The IAQ index uses a 22–100 scale and weights pollutant concentration highest (~59.5%). Typical air purifiers mainly detect particulate matter (PM) and humidity — they do **not** normally measure benzene, VOCs, exposure time and ventilation the way the IAQ model does.

Q4. With reference to spacecraft pressure suits and India's Gaganyaan mission, which of the following statements are correct?

1. IVA (Intra-Vehicular Activity) suits are mandatory during ascent and descent to protect against cabin depressurisation.
2. The Soyuz 11 accident led to mandatory use of IVA suits in critical mission phases globally.
3. Gaganyaan's IVA suit is the Sokol KV-2, a Russian design with an inner pressure bladder and outer restraint layer.
Choose the correct answer using the code below:
(A) 1 and 2 only
(B) 2 and 3 only
(C) 1 and 3 only
(D) 1, 2 and 3

Answer: (D) 1, 2 and 3
Explanation: All three are true: IVA suits are required during ascent/reentry as a backup; the Soyuz 11 depressurisation tragedy prompted mandatory IVA requirements; and Gaganyaan adopts the Sokol KV-2 design with the described two-layer construction.

Q5. With respect to India's baryte resources, consider the following statements:

1. Baryte is chemically barium sulphate ($BaSO_4$) and is used in drilling muds for oil and gas exploration.
2. India supplies a very large share of global baryte exports despite holding only a small fraction of global reserves.
3. Mangampet deposit in Andhra Pradesh contributes over 95% of India's baryte output.
Which of the statements given above are correct?
(A) 1 and 2 only
(B) 2 and 3 only
(C) 1 and 3 only
(D) 1, 2 and 3
Answer: (D) 1, 2 and 3
Explanation: Baryte = $BaSO_4$ and is critical for drilling muds. India, though holding ~4% of global reserves, has been a major exporter and Mangampet supplies the overwhelming bulk (>95%) of domestic output.

Mains: India recorded the largest absolute rise in greenhouse-gas emissions in 2024 but continues to have low per-capita emissions. Critically examine the development–climate trade-off this statistic represents. Analyse India's domestic mitigation and adaptation strategies and suggest policy measures to reconcile growth with equitable decarbonisation. (250 words)