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Daily News Analysis

The Hindu Important News Articles & Editorial For UPSC CSE

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On April 22, 2025, **26 civilians, including foreign tourists**, were killed in **Pahalgam, Anantnag district** (J&K), when terrorists opened fire on tourists trekking in Baisaran meadows.

- This is the **deadliest attack on civilians in Kashmir since the abrogation of Article 370 in 2019**, marking a serious breach in the Valley's internal security framework.
- The **Resistance Front (TRF)**, reportedly affiliated with **Lashkar-e-Taiba**, claimed responsibility, citing demographic grievances.

26 killed in terrorist attack in J&K's Pahalgam

Militants open indiscriminate fire at a group of about 40 tourists visiting Baisaran in Pahalgam

Two foreigners among those killed; official sources say total number of deaths is likely to rise

Lashkar-e-Taiba offshoot The Resistance Front claims responsibility for the attack

Peerzada Ashiq
SRINAGAR

At least 26 people, including two foreign tourists, were killed by a group of terrorists who emerged from the dense forests around the trekking paradise of the Baisaran meadows in the upper reaches of Pahalgam in Jammu and Kashmir on Tuesday afternoon.

Many others were wounded, some with critical injuries, and the toll is likely to rise, official sources told *The Hindu*. However, there was no official casualty data from the government.

The attack in Anantnag district came on a day when United States Vice-President J.D. Vance is in the country on a four-day visit. Mr. Vance shared condolences with the victims of the attack. "Our thoughts and prayers are with them as they mourn this horrific attack," he posted on X.

Prime Minister Narendra Modi "strongly condemned the terror attack in Pahalgam". He added: "Those behind this heinous act will be brought to justice... They will not be spared! Their evil agenda will never succeed. Our resolve to fight terrorism is unshakable and it will get even stronger."

The Resistance Front, an offshoot of the Lashkar-e-Taiba, claimed responsibility for the attack. However, the security agencies did not confirm the veracity of the claim. The outfit alleged that 85,000 domicile certificates have been issued to non-locals, "creating a pathway for demographic change" in J&K.

"Violence will be directed toward those attempting to settle illegally," it said in a statement.

16 killed on the spot

At least 16 people were killed on the spot, while others died on the way to the hospital.

Syed Hussain Shah, a resident of Anantnag, was among those killed. Among those who were injured was an 83-year-old tourist from Tamil Nadu and a 65-year-old woman from Odisha.

This is the first major terror attack on civilians in Kashmir since the Centre ended J&K's special status in 2019.

Nearly 40 tourists were present at the meadow when the terrorists opened indiscriminate fire, using both automatic rifles and small arms.

They reportedly checked the identity of victims before shooting them at close range. "Gunshots rattled the meadow and there were many in the open meadow who immediately fell to the ground," an eyewitness said.

The aftermath of the terror attack was captured by local guides on mobile cameras. Several tourists were seen pleading for help, and one woman tourist managed to call the J&K police after the attack.

The terrorists, whose numbers could not be ascertained immediately, took advantage of the non-motorable destination – popular among honeymooners, trekkers and adventure junkies – to target tourists and ensure that any help from authorities would take time to reach them, officials said.

Pahalgam remains a high-security zone as it houses the Amarnath shrine and has multi-layer security cover round the year.

Injured tourists

Several injured tourists were seen in the videos, lying unattended and writhing in pain on the ground. Local guides also helped to shift the injured to a nearby hospital.

Later, helicopters were pressed into service to shift seriously injured civilians to an Army hospital in Srinagar. Joint teams of the Army and the J&K police also reached the spot.

With India hosting the U.S. Vice President, Union Home Minister Amit Shah had to leave Delhi for Srinagar.

He was scheduled to visit Pahalgam to chair a meeting of security officials. "Those involved in this dastardly act of terror will not be spared, and we will come down heavily on the perpetrators with the harshest consequences," Mr. Shah said in a post on X.

General Officer Commanding-in-Chief, Northern Command, Lt. Gen. M.V. Suchendra Kumar rushed to Srinagar and was "briefed by local formation commanders on the present security situation in Kashmir Valley".

Shocked: Omar

J&K Chief Minister Omar Abdullah also used strong words to condemn the attack.

"This attack is much larger than anything we've seen directed at civilians in recent years. I'm shocked beyond belief. This attack on our visitors is an abomination. The perpetrators of this attack are animals, inhuman and worthy of contempt. No words of condemnation are enough," the Chief Minister of the Union Territory said.

Valley stunned: Security personnel rush to the spot after terrorists attacked a group of tourists at Pahalgam in Anantnag district on Tuesday. IMRAN NISSAR

PM cuts short visit hours after landing in Saudi

NEW DELHI

Prime Minister Narendra Modi cut short his visit to Saudi Arabia after the terror attack in Pahalgam. Official sources informed that bilateral discussions between the Saudi and Indian sides took place though Mr. Modi decided to leave hours after landing in the Gulf kingdom. » PAGE 6

Attack a blot on humanity, says Cong. president

SRINAGAR/NEW DELHI

Political leaders across the nation condemned the attack, with Congress president Mallikarjun Kharge terming it a 'blot on humanity'. Leader of the Opposition in the Lok Sabha Rahul Gandhi urged the Centre to take "accountability and not make hollow claims of normalcy". » PAGE 5

Key Dimensions of Analysis

1. Security Lapse and Tactical Aspects

- Attackers exploited a **non-motorable, forested terrain**, delaying security response.

- Despite **Pahalgam being a high-security zone** due to proximity to the Amarnath Yatra route, the attack raises questions on **security preparedness, surveillance, and intelligence**.
- **Indiscriminate firing** on tourists, identity checks before shooting – indicates a **pre-planned, ideological act** with targeted motives.

2. Internal Security Challenges in J&K

- Revival of **proxy terror outfits** like TRF shows continued influence of **cross-border terrorism** from Pakistan-based groups.
- **Post-370 Abrogation**: While many areas saw reduced militancy initially, this attack signals possible **re-emergence of hybrid militants** and local sleeper cells.
- Issue of **demographic change narrative** is being weaponized to incite local radicalization and justify violence.

3. Federal & Strategic Response

- **PM and Home Minister's immediate response** shows central government's proactive stance.
- Deployment of **Army, helicopters, and J&K Police** indicates well-coordinated emergency protocols but delayed action remains a concern.
- **Visit of US Vice President J.D. Vance** adds a geopolitical layer – possible aim to internationalize the Kashmir issue or embarrass India diplomatically.

4. Tourism & Socioeconomic Impact

- **Tourism is a key economic driver in Kashmir** – such incidents dent not only **regional economy** but also **confidence of the local populace and investors**.
- **Ethical implications**: Targeting innocent civilians and tourists – challenges state's obligation to protect life under **Article 21** and **ethical governance**.

5. Counter-Terrorism & Policy Implications

- Need for:
  - **Better surveillance technology** in inaccessible tourist routes.
  - **Intelligence-based policing** over conventional security deployment.
  - **Community involvement in counter-radicalization** efforts.
- Reinforcement of **district-level coordination** between civil administration, police, and Army.
- Strengthening **domestic anti-terror laws and judicial speed** in punishing perpetrators.

Ethical & Humanitarian Angle

- The **targeting of civilians and elderly tourists** shows a **complete breakdown of human morality** among perpetrators.
- The incident re-emphasizes the **ethical role of state actors** in ensuring peace and justice, balancing counter-insurgency with civil rights

Way Forward

- **Short-term**:
  - Identify and neutralize attackers.
  - Compensation and trauma care for victims' families.
  - Reassure tourists and public via communication strategy.
- **Long-term**:
  - Re-evaluate the **post-370 integration approach** in J&K with inclusive governance.
  - Develop a **comprehensive counter-terrorism doctrine**, integrating tech, intelligence, and socio-economic strategy.
  - Promote **deradicalization and rehabilitation** programs with local participation.

Conclusion

This tragic attack underscores the **evolving nature of terrorism in India**, especially in sensitive areas like J&K. While the Centre has taken strong steps toward integration and security, the **Pahalgam attack is a grim reminder that peace in the region remains fragile**. A mix of **firm security posture**, **inclusive development**, and **strategic diplomacy** is the only sustainable solution.

UPSC Mains Practice Question

Ques :"Despite significant changes in the constitutional and administrative structure of Jammu and Kashmir post-2019, the region remains vulnerable to terror threats."Discuss the underlying reasons for continued militancy and suggest comprehensive counter-terrorism strategies.**(250 Words)**

Page 05: GS 2 : Indian Polity

Vice-President and Rajya Sabha Chairman **Jagdeep Dhankhar** reiterated that **Parliament is supreme**, asserting that **no authority is visualized above it** in the Constitution.

- His comments follow the **Supreme Court's April 8, 2025 judgment**, which directed the **President to act within 3 months** on Bills passed by State Assemblies and emphasized that a **Governor cannot indefinitely delay assent**.
- Mr. Dhankhar criticized the **judiciary's perceived overreach**, saying it is acting like a **"super Parliament"** and that the **executive must not be subordinated** by judicial pronouncements.

Parliament is supreme, Constitution does not visualise any authority above it: Dhankhar

The Hindu Bureau
NEW DELHI

Digging in his heels in the face of criticism, Vice-President Jagdeep Dhankhar on Tuesday reasserted that the Constitution did not visualise any authority above Parliament.

The Chairman of the Upper House also sought to counter those criticising him for his remarks on a recent Supreme Court order by saying that every word spoken by a constitutional authority was guided by supreme national interest.

Mr. Dhankhar was addressing a Delhi University event.

SC judgment

Mr. Dhankhar had alleged judicial incursion into the Executive in response to the Supreme Court's April 8 directions to the President to act within three months on Bills passed by the Assemblies and referred by the Governor. The court had also ruled that a Governor cannot withhold assent indefinitely.


Jagdeep Dhankhar

Referring to the judgment, Mr. Dhankhar had last week said that India "cannot have a situation where the Judiciary directs the President". He had also criticised the courts for acting as a "super Parliament".

"I find it conceivably intriguing that some have recently reflected that constitutional offices can be ceremonial, ornamental. Nothing can be far distanced from a wrong understanding of the role of everyone in this country – constitutional functionary or a citizen," said the Vice-President.

"There is no visualisation above Parliament. Parliament is supreme and that being the situation, let me tell you, it is as supreme as every individual in the country. Part of 'we the people' is an atom in democracy and that atom has atomic power. That atomic power is reflected during elections and that is why we are a democratic nation," he said.

Opposition slams Vice-President's view

The Hindu Bureau
NEW DELHI

Opposition members on Tuesday reacted sharply to Vice-President Jagdeep Dhankhar's remark.

In an post on X, Rajya Sabha member Kapil Sibal said, "The law: Neither Parliament nor the Executive is supreme, the Constitution is supreme. The provisions of the Constitution are interpreted by the Supreme Court. That's how this country has understood the law so far!"

RJD leader and Rajya Sabha member Manoj K. Jha said, "I would urge Vice-President to revisit the Constituent Assembly debates where the importance of balance between the Judiciary and the Legislature was discussed."

Congress spokesperson Supriya Shrinate said there was a strict division of powers in the Constitution between the Legislature, the Executive, and the Judiciary.

"The judiciary in this country is meant to do judicial review. Yes, Parliament makes the law but the Supreme Court of India is the supreme authority to review those laws. Should the Judiciary be shut down? Is judicial review wrong? So what is the Vice-President talking about?" she said.

Key Issues Raised

1. Parliamentary Supremacy vs Constitutional Supremacy

- Mr. Dhankhar's remarks revive the debate between:
  - **Parliamentary Supremacy** (British model): Parliament is sovereign.
  - **Constitutional Supremacy** (Indian model): All organs derive power from the Constitution and are bound by it.
- **Indian Constitution** follows **constitutional supremacy**, with a written and justiciable Constitution as the highest law (Article 13).

2. Separation of Powers

- The Constitution mandates **separation of powers** among the **Legislature, Executive, and Judiciary** (implied from Articles 50, 121, 122, etc.).
- However, the **checks and balances mechanism** allows the judiciary to:
  - **Review laws** passed by Parliament (Judicial Review under Articles 32 and 226),
  - **Safeguard constitutional morality**, and
  - **Enforce fundamental rights**.

3. Judicial Review of Executive and Legislative Actions

- The **SC judgment on gubernatorial delay** was seen as enforcing **constitutional obligations** under Article 200 and Article 201.
- Critics argue this was necessary to prevent **constitutional paralysis** by **non-action** of Governors.
- Mr. Dhankhar's concern suggests a **fear of judicial encroachment** into **executive functions** and **parliamentary autonomy**.

Constitutional Position

Aspect	**Parliamentary Supremacy**	**Judicial Review & Constitutional Supremacy**
Source of Power	Parliament	Constitution
Highest Law	Parliamentary Act	Constitution
Role of Judiciary	Limited	Interpreter & Guardian of Constitution
Power to Amend Constitution	Parliament (Art. 368)	Subject to Basic Structure Doctrine

Key Judgments to Note

- **Kesavananda Bharati v. State of Kerala (1973)**: Parliament can amend the Constitution, but not its **basic structure**.
- **SR Bommai v. Union of India (1994)**: Judiciary can review **President's Rule**.
- **State of Tamil Nadu v. Governor of Tamil Nadu (2025)**: Judiciary can compel **constitutional functionaries to act** within reasonable time limits.

Broader Implications

- Debate reflects **tensions in a democracy** where roles are interdependent.
- **Judicial interventions** arise when **executive inaction or legislative overreach** hampers constitutional governance.
- However, **frequent commentary by constitutional authorities** can risk **undermining public trust** in institutional balance.

Way Forward

- **Clarity in role demarcation** through constitutional conventions and judicial restraint.
- **Respect for institutional boundaries**, with each organ performing within its limits.
- Promote **inter-institutional dialogue** rather than public confrontation.
- Educate public and leaders on **constitutional ethos and responsibility**.

Conclusion

Vice-President Dhankhar's remarks underscore a **larger debate on the evolving dynamics of power** among the three pillars of Indian democracy. While Parliament represents the **will of the people**, the **Constitution remains the highest legal authority**. The Indian model emphasizes **constitutional supremacy** with **judicial oversight** acting as a necessary check on both legislative and executive arbitrariness.

UPSC Mains Practice Question

Ques :"Judicial review is not judicial supremacy, but a constitutional necessity in a parliamentary democracy."Analyze the role of the judiciary in maintaining constitutional order with recent examples.**(250 words)**

India faces **increasingly frequent and intense extreme weather events** such as **heat waves, cloudbursts, cyclones, and torrential rainfall**.

Traditional weather forecasting uses numerical weather prediction models whereas AI models start with the data and algorithms 'learn' the relationships between some inputs and an output. AFP

AI can supercharge forecasting if it can weather some challenges

Two important challenges with using AI/ML to predict increasingly erratic weather are availability of sufficient data and right human resources; still scientists believe AI/ML models can be useful to forecast extreme weather events in India such as heat waves, droughts, torrential rainfall and floods

T.V. Padma

Every year, India must face intense heat waves and also intense bursts of rainfall. In response, the country has turned to artificial intelligence (AI) for help with modelling and early warnings.

Traditional weather forecasting uses numerical weather prediction models. These models begin with physics equations that simulate atmospheric behaviour using the principles of fluid dynamics and thermodynamics. They process observational data from weather stations and satellites, including temperature and wind speed, and perform their complex, time-consuming calculations on supercomputers.

AI models start with the data instead. AI algorithms 'learn' the relationships between some inputs and an output – e.g. a given set of wind, temperature, and humidity conditions on one hand and the formation of a cyclone on the other – or extract spatial and temporal patterns from large datasets. They do this without prior knowledge of the underlying earth system processes, making them useful for applications that lack a complete theory.

For example, an AI model can explore hidden links between various earth-system variables such as air temperature, pressure and humidity or ocean temperature, salinity, and currents, to uncover cause-effect relationships existing physics-based models do not capture.

The Indian government announced 'Mission Mausam' in September 2024 with an allocation of ₹2,000 crore over two years. Its goals are to exponentially enhance the country's weather and climate observations and to better understand modelling and forecasting for more accurate and timely services.

The Mission aims to do this by, *inter alia*, developing better models and data-driven methods using AI. The Ministry of Earth Sciences has set up a dedicated AI and machine-learning (ML) centre to develop and test different techniques to improve short-range rain forecasts, develop high-resolution urban meteorological datasets, and explore these technologies for nowcasting rainfall and snow using data from Doppler radars.

Researchers are also using AI to predict weather. For example, an international team of researchers including from the DST Centre of Excellence in Climate Modeling (CECM) at IIT-Delhi and the Indraprastha Institute of Information Technology, New Delhi, has developed an ML model to predict monsoon rainfall. The model uses southwest monsoon data from 1901 to 2001 and accounts for the influences of the El Niño (a climate pattern that emerges due to unusual warming of surface waters in the eastern Pacific Ocean) and the Indian Ocean Dipole (IOD).

According to the team, this model had a forecast success rate of 61.9% for 2002-2022, better than current physical models. The team said it can also predict rains months in advance subject to the availability of El Niño and IOD data; can better capture nonlinear relationships among the monsoon's drivers; and is less computationally intensive.

Challenges are only beginning

That said, these are early years and the path ahead is challenging.

Weather systems are nonlinear and chaotic, so sophisticated models are required to capture their dynamic nature, IIT-Delhi associate professor Tanmoy Chakraborty said. AI models in particular require large, high-quality datasets to train on first. These datasets often have problems like sensor error and inconsistent data formats.

Satish Regonda, associate professor in the departments of civil engineering and climate studies at IIT-Hyderabad, said AI/ML models typically require large amounts of high-quality data because weather processes are dominated by randomness. The more data there is, the better it is to find signs of order in the chaos.

Next, scientists are often hard pressed to explain how AI models were able to make certain predictions. This is why in a February 2025 paper in *Nature Communications*, researchers from institutes across Europe wrote that operational challenges in using AI/ML to make predictions include "the complexity of AI outputs, which hinder interpretation by non-experts."

The skepticism stems from "the near impossibility of explaining the reasons for good or bad performance," Regonda added. Traditional weather models provide an intuitive understanding of the underlying processes through their equations, and the framework allows the analysis of model errors and corrections. Efforts are now underway to develop hybrid approaches by combining AI/ML with physics-based modelling for weather forecasting, according to Regonda.

Two bigger problems

In India, many weather forecasters don't use models that require high computing power and high-quality data. Instead they use the information generated from other agencies, including the India Meteorological Department (IMD), or a combination of data produced by multiple models.

Then they overlay their local knowledge, including movement of clouds and past scenarios. Regonda said, "Given the growing interest in AI/ML and as finer resolution data becomes increasingly [better] available, and because of high-intensity and short-duration rainfall events, I think AI/ML models will be used extensively in the near future in India."

Still, two important challenges with using AI/ML to predict (increasingly erratic) weather are (i) the availability of sufficient data and (ii) the right human resources. And experts differ on which of the two is a bigger hurdle.

Saroj Kanta Mishra, a professor at CECM in IIT Delhi and the leader of the team that built the monsoon model, said it was human resources, especially at the interface between AI and predicting the weather. "Climate science is not fundamentally an independent discipline and draws scientists from physics, mathematics, certain engineering branches such as mechanical and civil engineering, and computer science," according to Mishra. "It is, however, not common for many scientists from these disciplines to come into climate science as it falls somewhere between core natural sciences or core engineering disciplines."

"For scientists working on climate science, when one does not have the AI/ML expertise required for climate science, it is like a black box, and very superficial in nature," he said. "Similarly, for hardcore data, core AI/ML scientists don't have an adequate background in climate science. So the scope of doing deep research and making groundbreaking progress is highly unlikely in the present situation."

Critical mass

Climate is a complex phenomenon and its prediction in India has been a challenge for decades, Mishra added.

According to Chakraborty, "India's diverse topography and climate zones demand regionally tailored models, increasing development complexity." This is compounded by inadequate sensor networks and gaps in meteorological infrastructure, particularly in remote regions. The end result is sparse and inconsistent data, leading to subpar model accuracy.

But Mishra did not agree that the paucity of data for use in AI/ML models is a major problem "as there has been a 10-fold increase in observational data in India over the years." The need for more data and more computing power "is a never-satiable demand" that can not be achieved overnight, he added.

Instead, he said India needs a sophisticated model tailored to solve the country's problems. "If we get the right talent together, it can be [developed] in very less time," Mishra said. "For this, active collaborations between the climate scientists and AI/ML scientists are essential, and that will happen if we can keep them under one roof, for example setting up an institute exclusively for applications of AI/ML with a mission to solve the pressing issues the country is facing today."

Chakraborty echoed him: "A critical shortage of professionals with expertise in both meteorology and machine learning hinders the development and deployment of advanced models." This includes data scientists with a good understanding of the physics of the atmosphere. While more data is being collected and better, there are still challenges in data accessibility, standardisation, and integration from diverse sources, he said, especially of historical data and real-time data.

A changing future

Madhavan Nair Rajeevan, former Secretary of the Ministry of Earth Sciences, expressed belief in the reverse: that human resources for and expertise on ML-based weather modelling are not challenges *per se* but that the availability of long-term data of high quality is.

"We should ensure we compile good, reliable data sets for ML-based applications. But we will need a lot of computing resources with graphics processing unit (GPU)-based computers," he said. "In India, we have enough expertise to work with ML for weather-modelling."

> India's diverse topography and climate zones demand regionally tailored models, increasing development complexity
>
> TANMOY CHAKRABORTY
> Associate Professor, IIT-Delhi

In his tenure at the Ministry, Mr. Nair had initiated a centre for excellence in AI/ML at the Indian Institute for Tropical Meteorology, Pune, and supported research projects for weather and climate modelling. "Hopefully in the next one to two years, some good results will come out," he added.

Worldwide as well, scientists are trying to overcome challenges in using ML for climate science. At the 2024 Heidelberg Laureate Forum in Germany, scientists said that while they have been able to apply ML in weather forecasting with good success, they have not been able to do so so readily to problems in climate science.

"An ML model trained to predict good weather today is not very useful in a much warmer future world with a different state of the atmosphere," the forum heard. The atmosphere is also chaotic and the resulting random fluctuations interfere with the average climate change signal.

A notable emerging enterprise in this regard is hybrid modelling, in which scientists combine the physics-based climate models with the tools of ML.

AI/ML and extreme weather

Some scientists believe AI/ML models can be particularly useful to predict extreme weather events such as heat waves and torrential rainfall.

The February 2025 paper in *Nature Communications* stated that "AI has emerged as a transformative tool" to detect, forecast, analyse extreme events, generate worst-case scenarios, and "promises advances in attribution studies, explanation, and communication of risk".

That said, "accurately predicting and modelling extreme weather events, e.g. cyclones, heat waves, and cloud bursts, is crucial but challenging due to their localised and rapid development," Chakraborty said.

The paper also expressed caution about "trustworthiness concerns" that arise from the complexity and interpretability of ML models, the difficulty of generalising across different contexts, and the quantification of uncertainty. Nair agreed: "Though ML is a powerful tool, it should be used carefully, with stringent verification processes."

(T.V. Padma is a science journalist in New Delhi. tvpadma_10@yahoo.co.in)

- To improve **accuracy, efficiency, and timeliness**, the Indian government and scientific institutions are increasingly exploring **Artificial Intelligence (AI)** and **Machine Learning (ML)** in weather forecasting.
- In September 2024, the Government launched **'Mission Mausam'** with ₹2,000 crore allocation for enhancing weather forecasting through AI/ML.
- Despite its promise, several **data, technical, institutional, and human resource-related challenges** hamper full-scale adoption of AI in meteorology.

Traditional vs AI-Based Weather Models

Aspect	Traditional Numerical Models	AI/ML-Based Models
Based on	Physics (thermodynamics, fluid dynamics)	Data-driven, statistical correlations
Requires	Supercomputing, observational data	Large labeled datasets, computing resources
Strength	Process-based explanation, transparency	Pattern recognition, speed, handles nonlinear systems
Limitation	Slow, computationally heavy, limited resolution	Black-box nature, lacks interpretability

Key Benefits of AI/ML in Weather Prediction

- **Early detection of extreme events** (e.g., heat waves, floods, cloudbursts).
- **Faster processing** of massive and complex datasets (satellite, radar, oceanographic).
- **Captures nonlinear relationships** in climatic variables like El Niño, IOD, etc.
- **Enhances nowcasting** (very short-term forecasts).
- **Lowers computational costs** for specific forecasts.

Major Challenges Identified

1. Data-related Issues

- **High-quality, long-term historical datasets** are essential.
- Issues with **sensor errors, inconsistent formats, and sparse data** from remote areas.
- Difficulty in **standardising and integrating datasets** from diverse sources (satellite, ground, radar, ocean).

2. Human Resource Gap

- **Lack of interdisciplinary experts** combining AI expertise with climate science.
- AI researchers lack meteorological knowledge, and climate scientists lack AI skills.
- This gap reduces the ability to develop **robust and explainable AI systems**.

3. Model Complexity & Interpretability

- ML outputs often act as a **black box**: hard to interpret or validate.
- Trust deficit among decision-makers due to **lack of explainability**.
- Difficult to apply present models to **changing future climates** (e.g., warming scenarios).

4. Institutional Capacity

- Weather offices in India often rely on **external models** (like IMD outputs) and **local observation**.
- Limited use of **high-resolution, AI-based forecasting tools** across all regions.
- Need for **dedicated institutions and research centres** on AI in weather/climate.

Government Initiatives & Way Forward

Mission Mausam (2024)

- Enhancing modelling and data-driven forecasting with AI.
- Setting up AI/ML centres (e.g., Indian Institute of Tropical Meteorology, Pune).

Research Collaborations

- IIT Delhi, IIIT Delhi, IIT Hyderabad, IMD, and international partnerships.
- Hybrid approaches (combining **physics-based models + AI**) gaining attention.

Expert Views and Diverging Opinions

- **Saroj Kanta Mishra** (IIT-D): HR is the main bottleneck; AI alone cannot substitute physical understanding.
- **Madhavan Nair Rajeevan** (Ex-Sec. MoES): Reliable datasets and infrastructure are the real need.
- **Tanmay Chakraborty** (IIT-H): Shortage of dual-skilled professionals is the critical limitation.

Suggested Steps Forward

1. **Develop hybrid models** combining AI with physics-based systems.
2. Create a **national framework for weather data integration and access**.
3. Establish **specialised institutions** for AI in environmental and meteorological sciences.
4. Strengthen **academic-industry-government collaborations**.
5. Invest in **GPU-based computing infrastructure** for AI-based forecasting.
6. Develop **interpretability tools** for AI forecasts to ensure decision-maker trust.

Conclusion

AI and ML offer promising solutions to improve the **accuracy, efficiency, and timeliness of weather forecasting in India**, especially in an era of **climate uncertainty and increasing disaster risk**. However, to unlock their full potential, India must invest in **high-quality data, interdisciplinary talent, and institutional infrastructure**. Hybrid approaches and human-AI collaboration will shape the future of climate resilience and disaster preparedness in the country.

UPSC MainsPractice Question

Ques : *"The use of AI/ML in meteorology is promising but suffers from the 'black box' problem."What is the 'black box' issue in AI models? Why is it a concern in public weather forecasting systems? Suggest ways to address it.(250 words)*

As per the **RBI's April 2025 Bulletin**, while global economic conditions remain **volatile**, India's growth momentum is expected to be sustained due to **robust domestic factors**.

'India relatively less susceptible to external headwinds'

The Hindu Bureau
MUMBAI

Although dampening global economic outlook can impact India's economic growth through weaker external demand, domestic growth engines such as consumption and investment were relatively less susceptible to external headwinds, Reserve Bank of India (RBI) officials said in the bank's April bulletin.

Stating an escalation of trade and tariff tensions and the resultant financial market volatility had raised concerns regarding the weakening of global growth in the near term, they said going forward, India was poised to benefit from supply-chain realign-

Global financial conditions are likely to remain volatile.

ments, diversified FDI sources and engagement with global investors seeking resilience and scale, given its already established trade linkages.

"Moreover, India's consistent strength in services exports and remittance inflows continues to provide a vital buffer for the current account," they wrote in the State of the Economy article.

Farm sector boost

"Prospects for the farm sector have been boosted by the forecast of an above normal southwest monsoon for 2025, which could augment farm incomes and keep food prices under check. Headline inflation moderated to a 67-month low of 3.3% in March, mainly due to a moderation in food prices," they wrote.

"Going forward, global financial conditions are likely to stay volatile and EMEs are vulnerable to feedback loops and spillovers which may lead to reigniting of global inflation."

- The RBI highlights India's **resilience to external shocks** such as **global trade tensions**, **financial market volatility**, and **slowing external demand**.
- India's **strong services exports**, **remittances**, and expected **above-normal monsoon** are projected to buffer its economy.

Key Highlights from the RBI Bulletin

1. Global Concerns

- Escalation in **trade and tariff tensions**, impacting global financial stability.
- Weakening **external demand**, which could affect India's **exports**.
- Volatile global financial markets pose risks for **emerging market economies (EMEs)**.

2. India's Strengths

- **Private consumption** and **investment demand** remain strong drivers of domestic growth.
- **Diversified FDI sources** and **supply chain realignments** offer long-term advantages.
- **Services exports** and **remittances** provide a buffer to the **Current Account Deficit (CAD)**.
- **Above-normal monsoon forecast** expected to enhance **agricultural output**, stabilize **food inflation**, and improve **rural incomes**.

3. Inflation and Macroeconomic Stability

- **Headline inflation** has dropped to a **67-month low** (3.3% in March 2025).
- Primary driver: **Reduction in food prices**.
- However, RBI cautions that **EMEs may still face spillover risks** if global inflation resurges.

Critical Dimensions of Analysis

1. India's Macroeconomic Resilience

- India's macroeconomic fundamentals—**foreign exchange reserves**, **fiscal prudence**, and **diversified trade structure**—help mitigate global shocks.
- The domestic economy is now **less export-dependent**, making it relatively **insulated from global demand fluctuations**.

2. Role of Services and Remittances

- India's **IT and professional services exports** have shown strong growth even when merchandise exports fluctuate.
- **NRI remittances**, especially from the Gulf and North America, **stabilize the current account** during external shocks.

3. Agriculture and Monsoon Dependency

- An **above-normal monsoon** in 2025 is critical to contain **food inflation** and support **rural consumption**.
- The rural economy acts as a **cushion against urban demand slowdowns**.

4. Global Spillovers and Volatility

- Despite domestic strengths, **financial contagion**, capital flight, and commodity price spikes can still affect India.
- RBI warns of **feedback loops** from volatile global markets, which may re-ignite **imported inflation**.

Policy Implications and Way Forward

Policy Area	Recommendations
Monetary Policy	Maintain **price stability** while supporting growth
Trade Strategy	Expand into **new markets**, promote **services exports**
Agricultural Policy	Leverage good monsoon for **buffer stock management**, MSP rationalization
FDI & Investment	Continue to attract **resilient global investors** through policy reforms
Data Infrastructure	Monitor **capital flows, inflation trends**, and **external vulnerabilities** proactively

Conclusion

India's **relative immunity to global economic headwinds** stems from its **strong domestic consumption**, **resilient services sector**, and **strategic diversification of trade and investment channels**. However, vigilance is crucial as **global volatility**, especially in financial markets, can quickly spill over into EMEs. A

balanced macroeconomic strategy, integrating domestic strengths with external safeguards, is key to navigating this uncertain global environment.

UPSC Mains Practice Question

Ques :*"India's economy has shown relative immunity to global headwinds owing to its strong domestic fundamentals." Critically examine this statement in the light of recent observations made by the Reserve Bank of India.(250 words)*

In News : SpaDeX (Space Docking Experiment) mission

Recently, The Indian Space Research Organisation (ISRO) has successfully completed the second docking of its two satellites — SDX01 (Chaser) and SDX02 (Target) — under the SpaDeX (Space Docking Experiment) mission.

About the SpaDeX Mission

- SpaDeX (Space Docking Experiment) is a technology demonstration mission developed by ISRO to validate the capability of docking and undocking two small satellites in low-Earth orbit.
- The mission involved two small satellites, each weighing around 220 kg: SDX01 (Chaser), SDX02 (Target)
- These satellites were launched by PSLV-C60 into a 460 km circular orbit with an inclination of 45 degrees.

Objectives of the SpaDeX Mission

- Primary objective: To develop and demonstrate the capability for rendezvous, docking, and undocking of spacecraft in orbit.
- Secondary objectives: To demonstrate the transfer of electric power between docked spacecraft a crucial component for future in-space operations.
- To develop and validate composite spacecraft control systems.
- To test payload operations after undocking - important for deep-space missions.
- With this achievement, India becomes the fourth country after the United States, Russia, and China to successfully conduct satellite docking operations.

UPSC PrelimsPractice Question

Ques :Which of the following statements best describes the SpaDeX mission recently conducted by ISRO?

(a) It is a mission to study space weather phenomena in geostationary orbit.

(b) It is an experimental mission to test the deep-space communication capabilities of India's Moon rover.

(c) It is a technology demonstration mission to validate satellite docking and undocking capabilities in low-Earth orbit.

(d) It is a Mars orbiter mission testing autonomous navigation systems.

Ans : a)

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Daily News Analysis

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Exploring India's potential in the Arctic region

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Global trade is swinging like a pendulum, with potential headwinds from the U.S. nudging each nation to start doubling down on alternate trade strategies. In such a scenario, partnerships around supply chains and trade routes are expanding based not only on the current fracturing of regional blocs, but also on climate change.

The frozen frontier of the Arctic serves as a canary in the coal mines for the impending climate catastrophe. It also serves as the source of great geopolitical leverage as sea levels continue to rise and new trade routes emerge. The Arctic reflects a critical energy source for the Global South in the years to come. While not recklessly exploiting the Arctic reserves, India should also get a say in the commercial opportunity for the unseen future.

The dying canary signals new trade routes

The September Arctic sea-ice is now shrinking at a rate of 12.2% per decade compared to its average extent during the period from 1981 to 2010 (NASA). This melting ice is also opening up access to a new trade route called the Northern Sea Route (NSR) in the Arctic, linking the Atlantic and the Pacific. This will exponentially transform global trade by shifting the flow of cargo and saving time and freight costs. The NSR is being hailed as the shortest route between Europe and Asia. India's long-term approach to exploring new mega ports and new routes – not just from an economic lens, but also from a strategic and geopolitical lens – makes the NSR crucial.

The number of Observers at the Arctic Council outnumbers the number of Arctic states. This indicates the growing recognition of the vulnerability of existing trade routes to geopolitical tensions.

India began its engagement with the Arctic early by signing the Svalbard Treaty in 1920 and is the only developing nation besides China that has an Arctic research base (Himadri). Last year, the Institute for Governance and Sustainable Development and the National Council of Applied Economic Research partnered to model how changes in the Arctic, specifically the loss of sea ice, could influence India's monsoon patterns and agricultural outputs.

> While not recklessly exploiting the Arctic reserves, India should also get a say in the commercial opportunity for the unseen future

But to begin a timely action plan for the NSR, India's Arctic policy released in 2022 needs to be streamlined towards achieving its goals. India will need shipbuilding muscle to sail through the NSR's turbulent waters. The 2025-26 Budget set up a $3 billion Maritime Development Fund for the Shipping Ministry along with promoting shipbuilding clusters to increase the range, categories, and capacity of ships. Shipbuilding suited to Arctic requirements is key given that travel conditions would be quite harsh in the short-term. This means India needs to make adequate investments in ice-breaking fleets and other structural upgrades.

There is an urgent need for India to engage in multilateral dialogue on capacity building, training requisites, and knowledge sharing. Could 2025 to be the year of action?

This year, the Arctic Circle India Forum is taking place on May 3 and 4 in New Delhi. This should help contextualise the dialogue from an Asia- and India-focused lens. The forum should serve as an impetus to move the needle forward on India's well-thought-out Arctic policy with stakeholder consultations, the forging of partnerships, and perhaps the appointment of a 'polar ambassador' to present India's case internationally.

As international cargo shipment on the NSR increased exponentially from 41,000 tonnes in 2010 to almost 37.9 million tonnes in 2024, India also needs to be cognisant of studies surfacing, such as in the scientific journal *Nature Climate Change*, showing that global temperatures in 2024 breached the 1.5°C mark above pre-industrial levels. This suggests that even a single month or year at 1.5°C global warming may signify that Earth is entering a long-term breach of the vital Paris Agreement threshold. How close to the sun should we fly so that we do not lose our commercial vantage point but also do not call for an expedited disaster in one of the most fragile ecosystems on the planet? This presents a pressing policy issue for India and echoes the need for like-minded allies.

Playing with ice and fire

With its vast Arctic coastline, extensive experience in Arctic navigation, and training of personnel, Russia is an obvious partner for India to explore the NSR. The decision to establish a working group on the NSR under the bilateral intergovernmental commission on trade, economic, scientific, technical, and cultural cooperation was made during Prime Minister Narendra Modi's summit meeting with Russian President Vladimir Putin in Moscow in July last year. Also, the Chennai-Vladivostok Maritime Corridor emerges as a potential bridge to the NSR ports such as Pevek, Tiksi, and Sabetta.

However, if India inclines towards the Russian bloc, then it would be implying support to Chinese efforts, such as the Polar Silk Road which China is building as a northern extension of its Belt and Road Initiative. Not only would the NSR help China bypass the Malacca Strait chokepoint completely, but it would also give it much more control over the Arctic route.

If India supports the Western bloc and partners with the U.S., it could lose its perceived potential stake in the massive resources that currently fall under Russian control in the area. The ideal but obviously challenging solution would be to find a way to work with both the U.S. and Russia. Other partners should include Japan and South Korea. Both countries share India's concerns about the growing cooperation between China and Russia in the Arctic and about their businesses losing out on Arctic opportunities to Chinese competitors. The trio should advocate the rectification of disparities within the Arctic Council and promote a more inclusive and equitable Council.

Paper 02 &03:International Relations & Enviroment

UPSC Mains Practice Question:"India's Arctic policy reflects the intersection of science, climate diplomacy, and geopolitical strategy."Critically analyze India's current engagements in the Arctic and suggest steps for strengthening its presence in the region.(250 words)

Context :

- The melting Arctic is reshaping **global geopolitics, trade routes, and environmental discourse**.
- India, through its Arctic Policy (2022), **research base (Himadri)**, and **participation in Arctic Council as an Observer**, has entered this strategic space.
- The **Northern Sea Route (NSR)**, a potential **Asia-Europe shortcut**, is emerging as a game-changer in **global shipping**.
- The upcoming **Arctic Circle India Forum (May 2025)** and India-Russia NSR cooperation reflect India's growing Arctic engagement.

Why is the Arctic Important for India?

1. Strategic and Geopolitical Importance

- The NSR can **reduce shipping time and cost** by up to 40% between Europe and Asia.
- As China builds the **Polar Silk Road**, India must balance its Arctic engagement carefully to maintain **strategic autonomy**.
- **Arctic Council dynamics** require broader participation from developing nations like India.

2. Energy and Mineral Resources

- Arctic reserves hold **13% of the world's undiscovered oil** and **30% of natural gas**.
- India needs long-term partnerships for **energy security**, particularly amid global supply disruptions.

3. Climate and Monsoon Linkages

- Arctic ice melt influences **Indian monsoons**, affecting agriculture and food security.
- Collaborative research (e.g., IITs and IGSD studies) highlights Arctic's role in India's **climate modelling**.

4. Global Trade and Connectivity

- India's **Sagarmala Project** and **Maritime India Vision 2030** complement Arctic shipping routes.
- The **Chennai-Vladivostok Corridor** could link to Russian Arctic ports like Pevek and Sabetta.

India's Current Engagements

Area	Action
Policy	India's **Arctic Policy 2022** focuses on science, climate, cooperation, and governance
Research	**Himadri base** in Svalbard; studies on climate and oceanography

Area	Action
Infrastructure	$3 billion Maritime Fund (2025–26) for shipbuilding and Arctic-ready icebreakers
Multilateralism	Arctic Council Observer since 2013; promoting inclusive governance
Bilateral Ties	India–Russia working group on NSR established in 2024

Challenges in India's Arctic Pursuit

1. Infrastructure Gaps

- Lack of **ice-breaking vessels**, **trained Arctic navigators**, and **cold-weather logistics**.
- Indian ports and shipping need upgrades for Arctic trade.

2. Geopolitical Dilemma

- Alignment with **Russia may alienate the West**, while leaning to the West could limit India's access to **Russian Arctic resources**.
- Strategic autonomy demands **multi-alignment diplomacy**.

3. Environmental Sensitivities

- India must tread carefully to **balance ecological responsibility** with commercial ambitions.
- **Paris Agreement goals** and fragile Arctic ecosystems require **sustainable navigation practices**.

4. Scientific and Human Capital Constraints

- Need for more **polar researchers**, **collaborative institutions**, and **capacity building programs**.

Way Forward

Focus Area	Action Points
Diplomacy	Foster multi-lateral partnerships (Japan, South Korea, EU), push for inclusive Arctic Council reforms
Science & Technology	Invest in polar research, joint expeditions, climate impact assessments

Focus Area	Action Points
Logistics	Build Arctic-class vessels, develop port linkages like Chennai–Vladivostok
Governance	Advocate for **environmentally responsible shipping**, avoid Arctic militarization
Institutional Capacity	Appoint a **Polar Ambassador**, create a **dedicated Arctic mission cell** in MEA or NITI Aayog

Conclusion

India's Arctic engagement reflects a confluence of **strategic foresight, scientific curiosity, and economic opportunity**. As global warming accelerates Arctic access, India must ensure that its footprint is **balanced, multilateral, and environmentally responsible**. The **Arctic Circle India Forum 2025** provides a timely platform to consolidate India's ambitions with global alignment.