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In response to the April 22 Pahalgam terror attack, India conducted 24 precision strikes on terror infrastructure in Pakistan and Pakistan-occupied Kashmir (PoK) under Operation Sindoor, marking a significant escalation in India's counter-terror strategy while emphasizing restraint and responsibility.

Indian forces hit Pakistan terror bases

- 24 precision strikes hit infrastructure across nine sites used to train terrorists in Pakistan and PoK
- Air defence network on 'highest state' of alert in anticipation of counter-response from Pakistan
- Targets destroyed without harming any civilian population, as per plan, says Defence Minister

Dinakar Peri
NEW DELHI

In a swift and decisive military action under Operation Sindoor against terrorist infrastructure in Pakistan and Pakistan-occupied Kashmir (PoK), the Indian armed forces carried out 24 precision strikes on nine different targets within a span of just 25 minutes in the early hours of Wednesday.

Defence Minister Rajnath Singh said India exercised its "right to respond" to an attack on its soil, referring to the Pahalgam attack, and the armed forces "scripted history" by acting with "precision, precaution, and compassion" to destroy the camps used to train terrorists in Pakistan and PoK.

The entire air defence network has been put on the highest state of alert in anticipation of any counter-response from Pakistan.

"India has demonstrated considerable restraint in its response. However, Indian armed forces are fully prepared to respond to Pakistani misadventure, if any, to escalate the situation," Wing Commander Vyomika Singh said at a media briefing during the day, which was led by Foreign Secretary Vikram Misri.

'Non-escalatory action'

Mr. Misri said India exercised its right to act on terror targets, stressing that the actions were "measured, non-escalatory, proportionate, and responsible".

"The action was carried out very thoughtfully and in a measured manner. It was limited only to the camps and other infrastructure used for training terrorists, with the aim of breaking their morale," the Defence Minister said while addressing the 66th Raising Day event of the Border Roads Organisation (BRO).

He asserted that as per plan, the targets were destroyed and no civilian population was harmed.

The strikes were conducted between 1.05 a.m. and 1.30 a.m. on Wednesday, which were announced by the Defence Ministry shortly after that in a statement. "No Pakistani military facilities have been targeted. India has demonstrated considerable restraint in selection of targets and method of execution," the Ministry said, adding, "We are living up to the commitment that those responsible for the Pahalgam attack will be held accountable."

Pakistan Army spokesperson Lt. General Ahmad Sharif Chaudhry said 31 people were killed and 57 injured in the missile strikes.

Of the 21 camps identified in Pakistan and PoK belonging to the terror groups Hizb-ul-Mujahideen, Lashkar-e-Taiba, and Jaish-e-Mohammed, nine were targeted, located at distances ranging from 6 km to 100 km from the border.

The targets in PoK are the Sawai Nala camp and Syedna Belal camp in Muzaffarabad, Gulpur camp and Abbas camp in Kotli, and the Barnala camp in Bhimber. The targets in Pakistan are the Mehmoona Joya camp and Sarjal camp in Sialkot, Markaz Taiba in Muridke, and Markaz Subhan Allah in Bahawalpur.

In remarks at the briefing, Mr. Misri noted that following the Pahalgam terror attack on April 22, the Government of India "naturally" responded with a set of initial measures, referring to the announcements on April 23, and it was deemed essential that the perpetrators and planners of the attack be brought to justice.

"Despite a fortnight having passed since the attacks, there has been no demonstrable step from Pakistan to take action against the terrorist infrastructure on its territory or on territory under its control. Instead, all it has indulged in are denials and allegations. Our intelligence monitoring of Pakistan-based terrorist modules indicated that further attacks against India were impending. There was thus a compulsion both to deter and to preempt," he said.

Mr. Misri said India "exercised its right to respond and pre-empt as well as deter" more such cross-border attacks.

The selection of targets for Operation Sindoor was based on credible intelligence inputs and role of these facilities in perpetrating terror activities, Wing Commander Singh said during the briefing on the operation. "The locations were so selected to avoid damage to civilian installations and loss of civilian lives."

To this, Colonel Sofiya Qureshi, who was also present at the briefing, added that the target selection was done with due diligence.

'Clinical efficiency'

The strikes on the terror camps were undertaken through "precision capability", using niche technology weapons with careful selection of warheads that ensured no collateral damage, Wing Commander Singh stated. "The point of impact in each of the target was a specific building or a group of buildings. All the targets were neutralised with clinical efficiency and the results reiterate the professionalism of the Indian armed forces in planning and execution of operations," she said.

Defence sources said the majority of the targets were hit by the Army and the rest by the Indian Air Force (IAF). Given that the fighter jets did not cross the border, the likely options exercised were Rafale or Mirage 2000 jets with the SCALP long-range missile and HAMMER air-to-ground weapon.

The Army, sources said, used precision-guided munitions and loitering munitions. The Army has the Excalibur precision-guided rounds that can be fired from 155mm artillery guns and has also procured several types of loitering munitions in the past few years. However, sources ruled out any use of missiles by the Army.

An Indian military response has been widely expected, and senior leaders, including Prime Minister Narendra Modi, had reiterated that the perpetrators behind the attack would not be spared.

These are the third such punitive strikes against terror infrastructure in Pakistan and PoK in the past decade following the surgical strikes by the Indian Army in September 2016 after the Uri terror attack and the Balakot air strikes by the Indian Air Force against terror training camp in February 2019 after the Pulwama terror attack.

In a statement following the air strikes, the Director-General of Inter-Services Public Relations said that all planes of the Pakistan Air Force were airborne.

"All strikes were made by India from its own airspace. Pakistan will respond to it at a time and place of its own choosing. It will not go unanswered. The temporary pleasure of India will be replaced by enduring grief," it stated.

Last week Mr. Modi had given "complete operational freedom" to the forces to decide on the mode, targets, and timing of the Indian response.

(With inputs from PTI)

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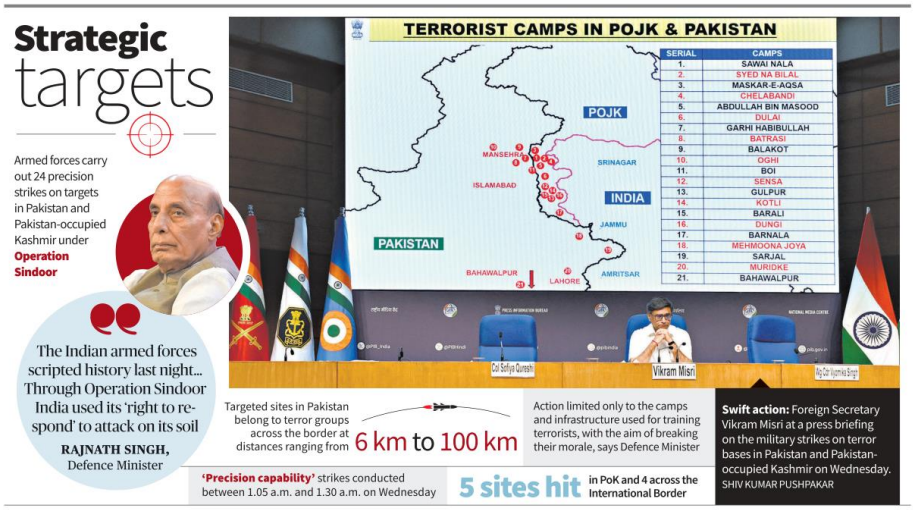

12 J&K civilians, one soldier killed in Pak. shelling

SRINAGAR/JAMMU

One soldier and at least 12 civilians, three women and three children among them, were killed and 51 injured as the Pakistan Army resorted to heavy mortar shelling and firing in four districts close to the Line of Control in Jammu and Kashmir on Wednesday. Residents living close to the border areas were gripped with a sense of fear as casualties rose, with the authorities setting up temporary shelters in Poonch, Rajouri, Baramulla, and R.S. Pora. Officials said the shelling impacted Balakote, Mendhar, Mankote, Krishna Ghati, Gulpur, Kerni, and Poonch town, and left 42 injured. Indian Army said it was responding in a "proportionate manner". » PAGE 5

Strategic Significance of the Operation

- **Assertion of Sovereignty and Strategic Autonomy:**
  - India exercised its right to self-defence, reinforcing its stance of zero tolerance towards terrorism originating from across the border.
  - The operation sends a strong message that India will not remain passive in the face of terrorist provocations.
- **Deterrence and Pre-Emptive Strategy:**
  - The strikes were both retaliatory and preventive, aimed at dismantling terror infrastructure and deterring future attacks.
  - Intelligence inputs indicated impending threats, necessitating a pre-emptive move to protect national security.
- **Precision, Professionalism, and Ethical Warfare:**
  - The strikes were described as measured, proportionate, and non-escalatory, showcasing India's ability to conduct operations with surgical precision while avoiding civilian harm.
  - The use of advanced weaponry (e.g., SCALP, HAMMER, Excalibur rounds) and non-intrusive methods (not crossing airspace boundaries) emphasizes India's adherence to international norms and humanitarian considerations.
- **Civil-Military Coordination and Political Backing:**
  - The operation had high-level political clearance, with PM Modi giving "complete operational freedom" to the military.
  - It reflects strong civil-military synergy and decisive leadership in national security matters.

Diplomatic and Regional Implications

- **Highlighting Pakistan's Inaction:**
  - Despite international scrutiny and past assurances, Pakistan's failure to dismantle terror networks on its soil has been exposed.
  - India diplomatically framed the operation as a necessary, restrained response rather than a war-like provocation.
- **Reinforcing India's Global Image:**
  - India's approach combines military firmness with diplomatic responsibility, enhancing its image as a mature regional power capable of handling cross-border threats without reckless escalation.
- **Possible Strategic Escalation:**

- Pakistan's statement on reserving the right to retaliate indicates a tense and volatile security environment.
- India's heightened air defence alert signals readiness to manage any counteraction, avoiding surprise elements as seen in post-Balakot skirmishes.

Continuity in India's Counter-Terror Doctrine

- This is the third major counter-terror operation after the 2016 Uri surgical strikes and 2019 Balakot air strikes, suggesting an emerging template:
  - Quick, targeted, high-impact operations
  - Use of advanced precision technology
  - Avoidance of collateral damage
  - Public and diplomatic messaging to justify action as self-defence

Ethical and Security Considerations

- India's emphasis on "precision, precaution, and compassion" reflects a shift towards just warfare principles—where operations are discriminate, proportional, and morally defensible.
- It aligns with international humanitarian law, potentially strengthening India's global support, especially among Western democracies.

Conclusion

- Operation Sindoor reflects a calibrated evolution in India's security doctrine, combining firm military resolve, strategic communication, and diplomatic maturity. It underscores the nation's capacity to respond to non-state actors across borders without full-scale war, positioning India as a responsible power confronting terrorism through controlled force.

UPSC Mains Practice Question

Ques : In the backdrop of Operation Sindoor, evaluate India's stance on state responsibility in harbouring terrorism and its implications on Indo-Pak relations.

Following the precision military strikes under Operation Sindoor, India undertook an extensive diplomatic outreach, briefing 13 of the 15 members of the United Nations Security Council (UNSC) about the rationale behind the operation. This move comes amid rising geopolitical attention on the Pahalgam terror attack and India's efforts to counter Pakistan's narrative at international forums such as the UNSC 1267 Committee and the FATF.

India briefs envoys of 13 Security Council members

Foreign Secretary conveys details of military strikes to them as part of a larger strategy to counter Pakistan at the UNSC 1267 terror listing and FATF; Misri denies that India has escalated tensions

Suhasini Haidar
NEW DELHI

India's strikes on Pakistan were not an escalation, but a "response" to the Pahalgam terror attack, Foreign Secretary Vikram Misri told envoys of 13 of 15 countries in the United Nations Security Council.

Pakistan's envoy was not invited to the briefing held at South Block hours after India's action, but included China's envoy Xu Feihong. Sierra Leone was not present at the meeting as it does not have an envoy here.

In New York, the Indian Permanent Mission is reaching out to the UNSC members, government sources said.

During the meeting, Mr. Misri reiterated that India's response to the "barbaric" Pahalgam terror attack in which 26 were killed were "targeted, measured and non-escalatory", and aimed at deterring and pre-empting more attacks being planned against India. He said that by "shielding" The Resistance Front (TRF), by insisting on its omission from the UNSC resolution released last week, Pakistan had itself escalated the situation. India would respond to any military escalation by Pakistan at this point, he added.

Foreign Secretary Vikram Misri says India will respond to any military escalation by Pakistan after Operation Sindoor. FILE PHOTO

According to sources, the Foreign Secretary was asked a number of questions about the operations in the early hours of Wednesday, from the envoys of countries such as China, France, Russia, the U.K., and the U.S. and non-permanent members Algeria, Denmark, Greece, Guyana, Panama, South Korea, Slovenia and Somalia.

He denied suggestions that India had "escalated tensions" as the strikes were a response, and said India's objectives of targeting nine sites had been met.

In particular, when asked by U.K. High Commissioner Lindy Cameron about whether Indians had targeted civilians in mosques that were damaged, Indian officials said that the targets were terror camps that were inside larger complexes.

According to diplomatic sources, Mr. Misri was also asked about damage to Indian military and civilian infrastructure, to which he replied that it was "too early to tell".

The special briefing is believed to be a part of a larger strategy to reach out at the UN's top body, to thwart moves by Pakistan, a non-permanent elected member for 2025-26, that has permanent member China's support, from holding any meetings or issuing statements that hurt India's interests, and to hold the TRF and other groups in Pakistan to account on UN forums, including the 1267 committee for terrorist designation, and the Financial Action Task Force (FATF) that looks into terror-financing and money laundering among member States.

Earlier, briefing the media at Delhi's National Media Centre, Mr. Misri had recounted in detail how India had raised the issue of Pakistan's support to the Lashkar-e-Taiba and the TRF, its front outfit, at various UN-linked forums.

As *The Hindu* had reported, Pakistan, with support from China, had ensured the UNSC statement draft on the Pahalgam attack issued on April 25 was watered down, and insisted on omitting reference to the TRF, and changed a sentence that asked members to cooperate with the "Government of India" to "all relevant authorities" for the investigation into the attack in Jammu and Kashmir.

"Pakistan's pressure to remove references to TRF in the April 25 UN Security Council Press Statement is notable in this regard," Mr. Misri said.

Key Strategic Dimensions of India's Diplomatic Outreach

- **Diplomacy Post-Action – A Measured Narrative:**

  - India positioned its military operation as non-escalatory and proportionate, aimed solely at deterring terrorism, not provoking conflict.
  - By engaging UNSC members immediately after the strike, India aimed to control the narrative and emphasize its right to self-defence under international law.
- **Pre-empting Pakistan's Counter-Narrative:**
  - As Pakistan is a non-permanent member of the UNSC (2025–26) and enjoys China's support, India's strategy was to blunt any diplomatic retaliation by clarifying facts to influential stakeholders.
  - The exclusion of Pakistan and Sierra Leone from the briefing underscores India's selective and targeted engagement.
- **Highlighting Pakistan's Role in Protecting Terror Outfits:**
  - India directly accused Pakistan of shielding terrorist groups like the TRF (The Resistance Front) by objecting to their naming in UNSC resolutions.
  - This is a continuation of India's long-term effort to establish Pakistan's complicity in cross-border terrorism at multilateral forums.
- **Strategic Use of International Mechanisms:**
  - India reiterated its push to hold TRF and other Pakistan-based groups accountable through the UNSC 1267 Sanctions Committee (which designates global terrorists) and the FATF (which monitors terror financing).
  - This reflects India's commitment to institutional, rule-based multilateralism, even while exercising military self-defence.

India's Broader Counter-Terror Diplomacy

- **India's approach showcases a dual-pronged doctrine:**
  - Military action to neutralize imminent threats.
  - Diplomatic maneuvering to isolate Pakistan and reinforce international legitimacy for its actions.
- By briefing countries like the U.S., Russia, France, and the U.K. (all P5 members), along with others such as Denmark, South Korea, and Algeria, India sought a broad-based consensus on the legitimacy of its operations.
- Mr. Misri's denial of targeting civilian structures, especially in response to questions on damaged mosques, highlights India's sensitivity to religious and humanitarian concerns, which is vital for maintaining credibility at global forums.

Implications for India's Foreign Policy

- **Reinforcing India's Image as a Responsible Power:**India's emphasis on measured and accountable responses bolsters its image as a responsible democracy committed to global norms.

- **Navigating China's Resistance:**With China opposing India's moves at the UNSC and shielding Pakistani entities, India's diplomatic efforts aim to build counter-pressure via like-minded nations.
- **Strengthening India's Global Counter-Terrorism Role:**India's actions and diplomacy together portray it as a nation actively contributing to global counter-terrorism norms, not merely reacting to threats.
- **Maintaining Strategic Messaging:**Statements that India would respond to any military escalation by Pakistan help maintain deterrence without inviting accusations of aggression.

Conclusion:

- India's post-strike diplomatic initiative highlights a calibrated foreign policy strategy—where hard power is complemented by soft power engagements. By proactively briefing UNSC members, India aimed not only to justify its military action but also to influence global perception, secure support for counter-terror efforts, and pre-empt hostile narratives in international forums. This marks a mature and integrated approach to national security and diplomacy, setting a precedent for future statecraft.

UPSC Mains Practice Question

Ques : Strategic communication is as critical as strategic action in counter-terror operations. Examine in light of India's briefing to UNSC members after its precision strikes.**(250 words)**

The Hindu Huddle to shine the light on rising tide of non-communicable diseases in India

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Let us look at some sobering facts: India has the highest number of people living with diabetes in the world, with an estimated 212 million cases in 2022.

According to the World Health Organization, there are an estimated 77 million people in India above the age of 18 who are suffering from diabetes (type 2) and nearly 25 million are pre-diabetic (at a higher risk of developing diabetes in near future). That is probably the largest part of the non-communicable diseases (NCD) pie. Add to this the number of people with hypertension, stroke, cancer, cardiovascular disease and chronic lung disease and the actual position is truly staggering.

NCDs occur because of a combination of factors – primarily changing lifestyles, environmental factors, and genetics – and have grown to a huge proportion in the country. The messaging, therefore, is that interventions have to be immediate, and effective, both in terms of launching treatment as well as prevention strategies.

A session at *The Hindu* Huddle, which will be held in Bengaluru on May 9 and 10, titled "Non-communicable diseases: Trojan horse of India's health", seeks to discuss the multiple dimensions of India's NCD 'epidemic' and evaluate strategies that may be deployed by the public and private health sectors to ensure that the tide is stemmed and that all those who already have NCDs have access to treatment and affordable healthcare. On the panel are three key experts from India who stand at various points of the care paradigm. They will share real-time experiences, and possible solutions for the way forward.

While Preetha Reddy, executive vice-chairperson, Apollo Hospitals, comes armed with the experience of being at the head of cutting-edge private care in the country, Anoop Mishra, chairman, Fortis C-DOC Hospital for Diabetes and Allied Sciences, brings to the table avant-garde research in the sector and experiences from close patient interactions. Chandrakanth Lahariya wears many hats, but will participate as someone who keenly watches the health systems of the country and a sagacious policy adviser. The session will be moderated by Ramya Kannan, Health Editor and Chief of Bureau, Tamil Nadu, *The Hindu*.

If you have any questions that you would like the moderator to ask the panellists, write to huddle@thehindu.co.in

***The Hindu* Huddle 2025 is presented by Sami-Sabinsa Group**

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Definition:

- Non-Communicable Diseases (NCDs) are medical conditions that are not infectious or transmissible, and generally of long duration and slow progression.

Facts & Data:

- India has the highest number of diabetics globally – approx. 212 million cases in 2022.
- **WHO estimates:** 77 million Indian adults have Type-2 diabetes; 25 million are prediabetic.

- **Other major NCDs:** Hypertension, stroke, cancer, cardiovascular diseases, chronic respiratory illnesses.

Key Factors behind NCD rise:

- Sedentary lifestyle, unhealthy diets, tobacco & alcohol consumption, stress.
- Environmental pollution, urbanisation, and genetic predispositions.
- Insufficient focus on preventive healthcare.

Important Bodies:

- WHO, National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) by MoHFW.
- Involvement of both public and private healthcare sectors is crucial.

Mains Keyways:

1. **Magnitude of the Challenge:**
   - India is facing a public health crisis due to a steep rise in NCDs.
   - NCDs now contribute to over 60% of all deaths in India (as per recent health surveys).
   - Disproportionate impact on urban poor, elderly, and lower-middle-income groups due to limited access to care.
2. **Health System Implications:**
   - Increased burden on secondary and tertiary care hospitals.
   - NCDs account for a major share of out-of-pocket expenditure in healthcare.
   - Existing health infrastructure is more curative than preventive.
3. **Policy and Strategic Responses Needed:**
   - Integration of NCD screening and early detection into primary health care services.
   - Behavioral change communication (BCC) campaigns for diet, exercise, and tobacco cessation.
   - Partnerships with the private sector (e.g., Apollo, Fortis) for scaling affordable, innovative solutions.
   - Enhanced public investment in preventive care and universal health coverage (UHC).
   - Inclusion of traditional knowledge (like yoga, Ayurveda) for preventive health models.
4. **Role of Stakeholders:**
   - Private healthcare leaders (like Preetha Reddy) contribute via advanced infrastructure and innovations.
   - Clinical researchers (like Dr. Anoop Mishra) drive evidence-based interventions.
   - Public health policy advisors (like Dr. Chandrakanth Lahariya) ensure systemic reforms.
5. **Way Forward:**

- A multi-sectoral approach combining policy, community engagement, tech-driven health monitoring, and insurance coverage.
- Localised action plans tailored to urban-rural disparities.
- Regular surveillance and national health data audits to track disease patterns and policy outcomes.

Conclusion:

- India's NCD burden is no longer a looming threat — it is a present-day health emergency. While treatment infrastructure is vital, emphasis must shift towards prevention, early detection, affordability, and equity in healthcare access.

UPSC Mains Practice Question

Ques: The rising burden of non-communicable diseases (NCDs) in India poses a major challenge to achieving universal health coverage.Discuss with suitable policy and structural reforms needed. (150 Words)

Climate change is now impacting human health not just externally but internally by disrupting gut microbiota.

- Rising temperatures, poor nutrition, and environmental degradation are causing gut dysbiosis linked to diseases like diabetes and malnutrition.
- This impact is more severe in low- and middle-income countries like India due to food insecurity and climate vulnerability.
- It highlights the urgent need for integrating climate, health, and microbiome research into public policy.

Climate change is disrupting the human gut in a new path to illness

Research has already found that high atmospheric carbon dioxide levels can diminish the quantity of plant micronutrients like phosphorus, potassium, zinc, and iron, along with protein concentrations in vital crops; these effects add to the complexities that affect the gut microbiota

Sharmila Vaidyanathan

Climate-driven food shortage and undernourishment could affect the composition of the human gut microbiota, exacerbating the effects of climate change on human health, according to a new review article published in *The Lancet Planetary Health*.

The article comes on the heels of a growing number of studies that highlight the key role food and nutrition play in maintaining a healthy microbial population in the human gut, leading to better metabolic and intestinal health.

Diversity disrupted

According to the review, climate-induced changes in the yield and nutritional quality of plants, seafood, meat, and dairy could disrupt this microbial diversity, tipping the balance towards microbial strains associated with malnutrition and particular diseases.

The review also warns that these effects will be more pronounced in low and middle-income countries (LMICs) since these regions face the brunt of climate stressors, including higher temperature and atmospheric carbon dioxide, which affect their agricultural output and increase render deficiencies in these areas more common.

Indigenous communities that depend more than other demographic groups on local food sources and that have been shown to have greater gut microbial diversity may also be more susceptible to climate-related changes, the review reads.

Research has already found that high atmospheric carbon dioxide levels can diminish the quantity of plant micronutrients like phosphorus, potassium, zinc, and iron, along with protein concentrations in vital crops such as wheat, maize, and rice. These effects add to the complexities that affect the gut microbiota.While the effects of food and nutrition are direct, the review also examined the role of changes in water, soil, and other environmental microbiota as a result of climate change.

A fine balance

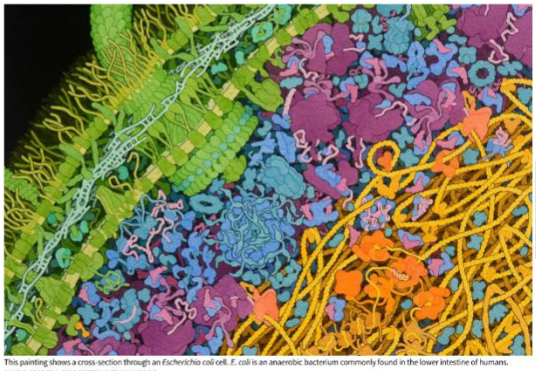
In another recent review, published in *Dialogues in Health*, researchers from the Indian Institute of Public Health, Gandhinagar, analysed the impact of heat on human and animal health in India. They found that reports of foodborne and waterborne infectious diseases and malnutrition increase with heat.

Although these findings mirror common knowledge about food and water-related illnesses in warmer weather, the resulting implications for gut dysbiosis – the imbalance in gut microbial populations – also need to be considered for future heat-related mitigation efforts, *The Lancet* review said.

"While we know and research various effects of climate change on human health, one aspect remains understudied – the effects of changing climate on the microbial communities in the human gut," Elena Litchman, author of the review in *The Lancet* and the MSU Foundation professor of aquatic ecology at Michigan State University, said. "This, in part, could be explained by the fact that researchers studying human microbiota do not necessarily think about it in a climate change context."

The human gut is home to about 100 trillion bacteria, fungi, protozoa, and viruses. Bacteria are this group's predominant members. The microbes' overall diversity in the gut influences several aspects of human well-being, including immunity, maintaining glucose levels, and metabolism.

According to a 2018 analysis in *The BMJ*, lower bacterial diversity has been observed in atopic eczema, types I and II diabetes, and inflammatory bowel disease, among other conditions. Researchers are also exploring how gut dysbiosis changes the central nervous system and leads to neurological disorders.



This painting shows a cross-section through an *Escherichia coli* cell. *E. coli* is an anaerobic bacterium commonly found in the lower intestine of humans.

DAVID S. GOODSELL, RCSB PROTEIN DATA BANK (CC BY)

More research attention

The gut microbiome – the collective genome of the microbes in the gut – has far more genes than the human genome, producing thousands of metabolites that affect the individual's health and development.

"Our understanding of the gut microbiota's role in human health is still evolving. While climate change is a growing concern in this context, establishing cause and effect is difficult as there are many confounding factors," Sachit Anand, a paediatric urologist and assistant professor at AIIMS, New Delhi, said. In his research, Mr. Anand examines the role of gut microbiota in congenital anomalies of the kidney and urinary tract.

He added that understanding the interactions between the microbiota, the host, and the environment is now gaining more research attention, especially when evaluating an individual's susceptibility to specific diseases. As climate change becomes a key influencing factor in this 'triad,' its impact cannot be ignored moving forward, he said.

It may be tempting to examine these interdependencies in a linear manner: i.e., that climate-induced changes in crops affect the diet and thus the gut microbiota, or that climate-induced

> What we need right now is to generate more data to understand how the so-called good bacteria interact with each other and benefit the host. Data generation must go hand-in-hand with connecting this information to climate change, so we know what is happening

increases in temperatures make enteric infections more prevalent, ultimately disrupting the gut's microbial population. But both Ms. Litchman and Tarini Shankar Ghosh, assistant professor at Indraprastha Institute of Information Technology Delhi, warned that many of these stressors are often playing out simultaneously.

As a computational biologist, Mr. Ghosh is interested in patterns in data about the human gut microbiome.

"If you take the example of low-income groups residing in urban environments, you are looking at the impacts of temperature, pollution, lack of quality food, and water supply," he explained. "There are multiple factors that are disrupting the gut microbiota at the same time."

A new science

Mr. Ghosh also said dysbiosis has been found to be a diagnostic signature in many disease states. According to him, this means it is not just the tipping of the balance towards unfavourable microbial populations that is concerning: dysbiosis also signals a loss of interdependence between "normal" microbial strains, leading to a loss of several metabolic functions in the host.

"What we need right now is to generate more data to understand how the so-called good bacteria interact with each other and benefit the host. Data generation must go hand-in-hand with connecting this information to climate change, so we know what is happening," Ghosh said.

Thus, Ms. Litchman said, a multidisciplinary approach with researchers from disparate fields coming together is vital to understand the effects of climate change on human gut microbiota. But along with a lack of awareness of climate change's effects, a paucity of funding programmes to enable such interdisciplinary and international research is a major impediment to future research of this nature, she added.

On the flip side, with advances in computational biology and metagenomics – analyses of the genetic makeup of microorganisms in a given environment – researchers are inching closer to unearthing some of the gut microbiota's secrets. For example at the Indian Institute of Science Education and Research, Bhopal, professor Vineet Kumar Sharma has developed an open-access database named GutBugBD. It provides information about how the gut microbiome can interact with and alter specific nutraceuticals and drugs, paving the way for therapeutic approaches to modulate gut microbiota in response to various changes.

This is just the start, according to Mr. Sharma: "At the moment, we are merely doing broader surveys of the gut microbiota to understand what is there and how they are functioning. Even if we introduce healthy microbiota through, say, probiotics, we cannot know if the response will be the same between two individuals. Each person's gut microbiota is unique, and understanding this uniqueness is important for the way forward."

(Sharmila Vaidyanathan is an independent writer from Bengaluru. sharmila.vaidyanathan@gmail.com)

KeyConcepts and Terms:

- **Gut Microbiota**: Community of microorganisms (bacteria, fungi, viruses, protozoa) living in the human digestive tract.
- **Gut Dysbiosis:** An imbalance in the gut microbial population associated with metabolic, immunological, and neurological disorders.
- **Metagenomics:** The study of genetic material recovered directly from microbial communities in environmental samples.
- **Nutraceuticals:** Food-derived products with potential health and therapeutic benefits.
- **GutBugBD:** Indian database tracking microbiota-drug-nutrient interactions developed at IISER Bhopal.

Impact of Climate Change on Human Health (New Dimension):

- Climate change affects nutrition quality, especially protein, iron, zinc, phosphorus in staple crops like wheat, rice, maize.
- This nutritional decline influences gut microbial diversity, especially in low- and middle-income countries (LMICs).
- Elevated temperatures and environmental stressors lead to increased prevalence of foodborne diseases, worsening gut health.

Mains Analysis:

1. **New Scientific Understanding: Climate Change → Nutrition → Gut Health**
   - Climate change is no longer just an environmental issue, but a public health concern that is affecting humans internally—through the disruption of gut microbiota.
   - This disruption can contribute to:
     - Malnutrition
     - Diabetes, inflammatory bowel disease, neurological disorders
     - Immune system weakness and reduced metabolic efficiency
2. **Climate Impact on Vulnerable Populations:**
   - LMICs and indigenous communities are most at risk due to:
     - Dependency on local, seasonal food.
     - Greater exposure to climate-induced agriculture shocks.
     - Poor access to healthcare and sanitation.

- Urban low-income groups face multi-pronged stressors—pollution, heat, poor diet, unsafe water—worsening gut health.

3. **Challenges in Research and Policy Response:**
   - Lack of interdisciplinary collaboration among climate scientists, microbiologists, and healthcare providers.
   - Poor integration of gut health in climate-health policy frameworks.
   - Funding gaps for advanced research and real-time data collection.
   - Limited understanding of individual gut microbiome variations—hurdle for universal solutions.
4. **Way Forward – Multidisciplinary Action:**
   - **Invest in Gut Microbiota Research:**
     - Expand metagenomic surveillance to track microbiome changes over time.
     - National biobanks and open databases (like GutBugBD) should be supported.
   - **Policy Integration:**
     - Include microbial health in National Health Missions, especially under nutrition programs and climate-resilient agriculture planning.
     - Link gut health to nutritional security, especially for children and the elderly.
   - **Public Health Outreach:**
     - Promote personalized nutrition, gut-friendly diets, and probiotic awareness.
     - Link sanitation and hygiene schemes (like Swachh Bharat Mission) with gut health initiatives.
   - **Global Research Collaboration:**
     - Encourage cross-border, interdisciplinary research on climate and gut microbiota links.
     - Include microbiome health indicators in climate vulnerability assessments.

Conclusion:

- Climate change is silently altering not just our external ecosystems but also the inner ecology of the human body. Gut microbiota — long neglected in climate-health discourse — must now be central to public health policies, food security planning, and climate resilience frameworks. A systems-based, data-driven, and collaborative approach is the need of the hour to safeguard microbial health and, by extension, human health.

UPSC PrelimsPractice Question

Ques : Consider the following statements regarding the impact of climate change on gut microbiota:

1. Gut microbial diversity is unaffected by environmental stressors like heat or pollution.

2. Indigenous and low-income communities are more vulnerable to climate-induced gut health disruptions.

3. Climate change may indirectly affect the gut through changes in food and water quality.

Which of the statements is/are correct?

a) 1 only

b) 2 and 3 only

c) 1 and 3 only

d) 1, 2 and 3

Ans: b)

UPSC Mains Practice Question

Ques: Climate change is emerging as a silent disruptor of human health through its impact on gut microbiota. Discuss the implications for public health policy in India. (150 Words)

Page 10: GS 3: Internal Security

The April 2025 Pahalgam attack, linked to Pakistan-based terror groups, once again exposed the entrenched terror infrastructure supported by Pakistan's security establishment. This analysis, grounded in declassified intelligence, OSINT, and academic research, reveals the state-sponsored nature of terrorism in Pakistan and its evolving threat to regional and global stability.

Pakistan's complex web of terror networks

Pakistan's terror infrastructure has survived for decades within its security establishment, which views these forces as strategic assets. Pakistan has been placed on and off the Financial Action Task Force 'grey list' since 2008 for failing to dismantle terror financing networks

FULL CONTEXT

Brijesh Singh

The Soviet-Afghan War of 1979 was the inflection point when Pakistan's Inter-Services Intelligence (ISD, backed by U.S. funding, systematically cultivated jihadi infrastructure that evolved into today's sophisticated terror network. This deliberate cultivation created fighters with diverse objectives – Kashmir-focused aggression, control in Afghanistan, sectarian violence, and ideological warfare. Recent data has confirmed a resurgence of Pakistan-sponsored terrorism across the region. This analysis examines Pakistan's entrenched terror ecosystem through OSINT, declassified records, and academic research.

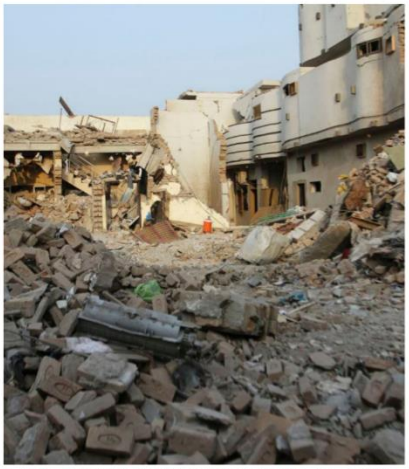
Terrorist outfits which are said to have Pakistan support

A key outfit is the Lashkar-e-Taiba (LeT). The LeT emerged in the 1990s as Pakistan's premier proxy organisation against India; it operates under Hafiz Muhammad Saeed – a designated terrorist operating in Pakistan despite international sanctions. Its rigid command structure includes Zafar Iqbal, Muhammad Yahya Mujahid, and Zakiur Rehman Lakhvi who was one of the masterminds of the Mumbai attacks in 2008 (he was 'arrested' but protected within Pakistan's judicial system).

LeT's infrastructure centres around its 200-acre headquarters complex, the Markaz-e-Taiba, near Lahore, with additional bases strategically positioned across Pakistan-occupied Kashmir (PoK) and around urban centres including Lahore, Peshawar, and Karachi. Ideologically, the outfit adheres to the virulent Ahl-e-Hadith doctrine (a conservative faction with a strict adherence to the Koran) specifically targeting India, which it propagates through its network of 300+ madrassas across Pakistan. Intelligence confirms at least 16 documented training camps of the LeT across Pakistan and occupied territories. The group's operational sophistication is demonstrated through attacks such as the 2008 Mumbai attacks where 166 people were killed; the 2006 Mumbai train bombings (209 killed); and an indirect hand in the 2010 German Bakery bombing in Pune (17 killed), orchestrated by the Indian Mujahideen (SIMI). LeT maintains transnational reach with recruitment networks identified in 21 countries, with dedicated cells both in Bangladesh and Nepal facilitating operations against India. Its financial architecture combines direct ISI funding, estimated to be around $25-50 million annually; gulf-based private donors from Saudi Arabia and the UAE; Pakistani diaspora contributions through Islamic charitable fronts; and business operations including commodity trading and real estate.

Then there is the Jaish-e-Mohammed (JeM). Established in 2000 by Masood Azhar following his 'release' during the IC-814 hijacking, the JeM represents Pakistan's suicide terrorism capability. Azhar maintains direct control over the outfit along with his brother, Abdul Rauf Asghar, by handling operations through specialised wings – the *Askari* (military) wing for direct operations; *Dawati* (missionary) wing for recruitment and radicalisation; and the intelligence wing for reconnaissance.

JeM's infrastructure centres around its fortified headquarters in Bahawalpur, Punjab, with satellite facilities. It also has seven major training camps in the Khyber Pakhtunkhwa (KPK) province, four in PoK, and has recently re-established camps in Taliban-controlled Afghanistan. The Balakot training complex, targeted by Indian airstrikes in 2019 but subsequently rebuilt, specialises in suicide attack training. Its ideology combines Deobandi fundamentalism (a movement within Sunni Islam) with an apocalyptic worldview glorifying martyrdom operations.



Breaking point: A building that was hit by an Indian missile, near Bahawalpur, Pakistan on May 7. AP

JeM's operational history includes the 2001 Indian Parliament attack, and the 2019 Pulwama suicide bombing where 40 security personnel were killed. The group pioneered *fidayeen* (suicide) attacks in Kashmir and have demonstrated sophisticated capabilities with respect to vehicle-borne Improvised Explosive Devices (IED) and military installation infiltration.

JeM's financing includes the Al-Rehmat Trust front charity, which collects $10-15 million annually; trading companies and commodity businesses; protection rackets in Bahawalpur and surrounding areas; documented ISI funding through intermediaries; and real estate holdings valued over $30 million.

Supporting players and state support

Some of the less mainstream players in Pakistan's terror network include the Haqqani Network which operates as a semi-autonomous ISI extension along the Afghanistan-Pakistan border. Led by Sirajuddin Haqqani – now Afghanistan's interior minister despite a $10 million U.S. bounty – the network serves as both an ISI proxy in Afghanistan and a facilitator for anti-India operations.

Then there is the Islamic State-Khorasan (ISIS-K), which emerged from Tehrik-i-Taliban Pakistan (TTP) defectors, with operational bases in eastern Afghanistan and Pakistan's tribal areas. Though ideologically opposed to Pakistani objectives, evidence suggests elements within Pakistan's security establishment tacitly allow certain ISIS-K operations.

The Harakat ul-Mujahidin (HUM) also functions as a specialised recruitment pipeline for Pakistani proxy groups, maintaining extensive networks within Pakistan's religious seminary system, with over 60% of recruits channelled to LeT and JeM operations.

Therein, Pakistan's relationship with terrorist organisations transcends allegations – it is documented through concrete evidence, defector testimonies, international intelligence assessments, and financial tracking. The ISI has operationalised terrorism as state policy through a three-tiered system – strategic direction and funding through specialised "S-Wing" units; operational support via retired military personnel; and by providing material assistance such as weapons, training infrastructure, and intelligence. Despite officially joining the 'War on Terror' post the 9/11 tragedy in the U.S., Pakistan has maintained a calculated policy distinguishing between 'good terrorists' (serving Pakistani interests) and 'bad terrorists' (targeting Pakistani assets). The consequences have been devastating – over 45,000 lives lost due to Pakistani hand in terrorism since 1990.

Pakistan's persistent appearance on the Financial Action Task Force (FATF) "grey list" (2008-2010, 2012-2015, 2018-2022) is international recognition of its systemic failure to dismantle terror financing networks. The most damning evidence comes from Pakistan itself – former President Pervez Musharraf openly admitted to training terrorists for Kashmir operations, while former Prime Minister Nawaz Sharif confirmed state support for terrorist groups. Recently, the current Pakistani minister for foreign affairs said that they have been doing the "dirty work" for Western powers for a long time. A similar statement was also recently made by Bilawal Bhutto.

Funding and radicalisation

The funds sustaining this infrastructure operate through sophisticated mechanisms designed for plausible deniability. Religious charities serve as the primary collection points, with 40+ identified front organisations raising $150-200 million annually. Other sources include state funding through classified budget allocations (estimated $100-125 million annually); money laundering operations through *hawala* networks, with major hubs in Dubai, Karachi, and Peshawar; narcotics trafficking along the Afghanistan-Pakistan-India corridor generating an estimated $75 million annually; and cryptocurrency, with inputs indicating $15+ million moved through crypto channels in 2023.

Despite FATF pressure forcing some regulatory changes, Pakistan has preserved these financial pipelines by simply renaming organisations while maintaining core networks.

Apart from the financial infrastructure, Pakistan's terror network also relies on a sophisticated radicalisation apparatus. Pakistan has over 30,000 madrassas, with 10-15% of them directly linked to extremist organisations. Other modes through which terrorism is encouraged include curriculum in religious schools which often promote violent jihad, particularly against India; publications, websites, and social media channels disseminating extremist ideology; and a targeted recruitment of vulnerable youth from economically disadvantaged regions. This creates a self-sustaining radicalisation pipeline continuously replenishing terrorist ranks.

Evolution of the network

Pakistan's terror infrastructure demonstrates remarkable adaptability. It first made its appearance in the 1990s through direct insurgency in Kashmir through the LeT and HUM. Then by the early 2000s, the JeM had also emerged as a specialised suicide attack outfit.

However, post-9/11, operations of such terror groups became more sophisticated with greater plausible deniability; they started integrating cyber capabilities and information warfare. The Taliban's 2021 return to power in Afghanistan significantly emboldened this infrastructure. There has been a re-establishment of training facilities in Taliban-controlled Afghanistan; an increase in infiltration attempts along the Line of Control (2023-2024); and enhanced operational coordination between LeT, JeM, and Taliban-affiliated groups.

Thus, Pakistan's terror infrastructure represents a deliberate, state-supported system that has survived for decades through deep institutional support within Pakistan's security establishment, which views these proxy forces as strategic assets rather than terrorist threats. The April 2025 Pahalgam attack, killing 26 civilians and forensically linked to LeT operatives trained in Pakistan, demonstrates the enduring threat.

Such an infrastructure poses immediate danger to regional stability, particularly to India, which continues bearing the human cost of Pakistan's proxy warfare. This is not merely a bilateral issue but a global challenge which threatens the rules-based international order. Effectively addressing this threat requires unwavering international pressure on Pakistan to permanently dismantle – not merely rebrand or temporarily restrain – these terrorist organisations and the state apparatus that sustains them.

Brijesh Singh is a senior IPS officer and author of 'The Cloud Chariot'. Views are personal.

THE GIST

- The LeT emerged in the 1990s as Pakistan's premier proxy organisation against India; it operates under Hafiz Muhammad Saeed — a designated terrorist operating in Pakistan despite international sanctions.
- The Jaish-e-Mohammed's operational history includes the 2001 Indian Parliament attack, and the 2019 Pulwama suicide bombing where 40 security personnel were killed. The group pioneered *fidayeen* (suicide) attacks in Kashmir and have demonstrated sophisticated capabilities.
- The April 2025 Pahalgam attack, killing 26 civilians and forensically linked to LeT operatives trained in Pakistan, demonstrates the enduring threat.

Key Issues and Themes:

- **Historical Evolution of Terror Networks:**
  - Rooted in Soviet-Afghan War (1979), Pakistan's ISI, with U.S. and Gulf backing, institutionalized jihadist infrastructure.
  - Developed proxy forces with distinct goals — anti-India (LeT, JeM), Afghanistan control (Haqqani Network), and ideological warfare.
- **State Sponsorship and Strategic Depth Doctrine:**
  - Pakistan's military-intelligence establishment uses terror outfits as "strategic assets" to advance geopolitical aims, especially in Kashmir and Afghanistan.
  - **Institutional support involves:**
    - Funding through ISI's S-Wing
    - Safe havens and training camps
    - Judicial protection of designated terrorists (e.g., Lakhvi, Hafiz Saeed, Masood Azhar)
- **Major Terrorist Organisations Supported by Pakistan:**
  - **Lashkar-e-Taiba (LeT):** 300+ madrassas, 200-acre HQ, international reach in 21 countries; involved in 26/11, 2006 Mumbai train blasts.
  - **Jaish-e-Mohammed (JeM):** Specialises in suicide attacks; Pulwama 2019, Parliament 2001; headquarters in Bahawalpur.
  - **Haqqani Network & ISIS-K:** Operating along the Af-Pak border with tacit ISI tolerance or indirect support.
- **Radicalisation and Recruitment:**
  - ~30,000 madrassas in Pakistan; 10-15% linked to terror outfits.
  - Radical content in religious curriculum, social media propaganda, and economic targeting of vulnerable youth drive self-sustaining recruitment.
- **Terror Financing Infrastructure:**
  - Charity fronts (Al-Rehmat, Jamaat-ud-Dawa), commodity trading, hawala, narcotics trade, and even cryptocurrency channels.
  - Despite FATF grey-listing (2008–10, 2012–15, 2018–22), terror financing continues under renamed entities.

Implications for India and the Region:

- **India's Security Threat:**

- Pakistan-based groups pose the most persistent threat to India's internal security, as evident from Pahalgam, Pulwama, Uri, and Parliament attacks.
- Increasing infiltration attempts, use of IEDs, cyberterrorism, and suicide attacks signify growing operational sophistication.

- **Regional Instability:**
  - The nexus between Taliban, JeM, and LeT post-2021 has emboldened attacks across Kashmir and Afghanistan, destabilising the entire region.
  - The Af-Pak-Taliban corridor now functions as a terror safe zone.
- **Global Implications:**
  - Pakistan's duplicity — aligning with the West while supporting terror groups — threatens global counter-terror architecture.
  - The continued survival of such state-sponsored networks violates UNSC resolutions and international conventions on terrorism.

Policy Imperatives and Recommendations:

- **Global Diplomatic Pressure:**
  - Sustained push at FATF, UNSC 1267 Committee, and other forums to impose sanctions and restrict financial flows.
  - Push for designation of Pakistan as a state sponsor of terrorism unless verifiable dismantling is undertaken.
- **Strengthening India's Counter-Terror Capabilities:**
  - Enhance cross-border intelligence and precision strike capabilities (e.g., Balakot, Operation Sindoor).
  - Expand counter-radicalisation programmes and cyber-monitoring units.
- **Regional and Multilateral Engagement:**
  - Build stronger anti-terror cooperation through Quad, SCO, G20, and bilateral dialogues with Afghanistan, Central Asia, and West Asia.
  - Promote anti-radicalisation content and alternative narratives through civil society and digital campaigns.

Conclusion:

- Pakistan's terror ecosystem is not a shadowy, decentralized threat — it is a state-nurtured and strategically employed proxy mechanism. The global community must reject superficial reforms and

demand concrete dismantling of this apparatus. For India, continued strategic, diplomatic, and kinetic pressure combined with international alignment is the only sustainable route to ensuring regional peace and national security.

UPSC Mains Practice Question

Ques : Discuss the evolving nature of cross-border terrorism in India with reference to the operational strategies of Lashkar-e-Taiba and Jaish-e-Mohammed.

The building blocks of an India-U.S. energy future

United States Vice-President J.D. Vance recently highlighted the U.S.'s willingness to cooperate with India more closely on energy and defence. India's foreign policy establishment outlined the need for cooperation on energy, defence, technology and the mobility of people. The developments may have been news, but the issues are not new. These topics have increasingly defined India-U.S. relations over the years despite changes in administration, but with some change in emphasis. There is an opportunity now for renewed investment in them.

India's energy security will be guided by three imperatives: having sufficient energy resources at predictable prices, minimal disruptions in supply chains, and progress towards an increasingly sustainable energy mix. Nuclear energy and critical minerals will matter in these respects and can be the bedrock of further deepening energy and technology partnership between Washington and New Delhi.

Arunabha Ghosh

is the CEO of Council on Energy, Environment and Water (CEEW)

Nuclear energy and critical minerals can be the bedrock of a deepening energy and technology partnership

A critical minerals compact

The energy transition will unfold not only via electrons but also with elements. China's restrictions in April on exports of rare earths were just the latest move in periodic disruptions for more than a decade. On the one hand, China controls nearly 90% of global rare earth processing capacity. On the other, it leverages this market power to serve its strategic purposes. The result: the minerals needed for new energy technologies, advanced electronics or defence equipment are contingent on fragile global supply chains.

In 2024, India and the U.S. signed a memorandum of understanding to diversify these supply chains. Three principles must now guide India-US cooperation on critical minerals.

First, critical minerals must be viewed as the pillar of multiple sectors, and not just as a mining silo. They are needed across the economy – and in the strategic sectors on which India and the U.S. wish to collaborate. This broad framing prioritises long-term strategy and enables cross-sectoral skills and technology exchange.

Second, policies for critical minerals must play out at bilateral and plurilateral levels. They must establish guarantees of supply and frameworks for cooperation. Demand creation, not supply coercion, must drive this relationship. An India-U.S. critical minerals consortium could look into joint exploration and processing. India, with its emerging mineral exploration base, and the U.S., with its deep capital and technology, should co-invest in third-country projects across Africa, South America, and Southeast Asia.

Beyond the bilateral relationship, the Quad (including Japan and Australia) can be a capability multiplier. This includes collaboration on minerals processing technology. Further, data transparency and traceability of these minerals are crucial. For this, establish a dedicated India-U.S. Mineral Exchange – a secure digital platform for real-time trade, investment, and collaboration on critical minerals. This can especially help vulnerable industries such as electric vehicles, aerospace, and semiconductors. India and the U.S. should also co-develop a blockchain-based traceability standard for critical minerals, inspired by the EU's Battery Passport.

Moreover, India and the U.S. should build joint strategic stockpiles of key minerals to safeguard supply chains against geopolitical or trade disruptions, leveraging existing storage infrastructure in both countries (such as India's Strategic Petroleum Reserves or the US National Defense Stockpile) for cost-effective deployment.

India has made early moves – becoming the first non-G-7 member of the Mineral Security Partnership – and it will host the Quad summit later this year. It is an opportunity to formalise these specific approaches. The Quad countries are also exploring joint engagement with mineral-rich nations.

Third, patience will be key. While a battery plant may take two years to build, exploration of mines and building processing facilities take between 12 to 16 years. A durable India-U.S. critical minerals partnership must be structured with a 20-year horizon and interim targets, consistent with the initial goals of India's own Critical Minerals Mission. To realise these ambitions, India and the U.S. must also invest in the 'plumbing' of the energy partnership: data-sharing protocols, investment tracking, workforce development, and innovation corridors under platforms such as the U.S.-India Initiative on Critical and Emerging Technology (iCET).

Nuclear energy as next frontier of linkages

As India's electricity demand surges, we need a reliable source that complements the intermittency of solar and wind to build a stable, secure grid. Even as battery costs have fallen dramatically, nuclear power offers another firm, low-carbon source essential to achieving India's net-zero goals.

India has an ambitious goal of achieving 100 GW of nuclear power capacity by 2047. Converting this into action will need a shift in momentum. Currently, nuclear energy contributes just over 8 GW, or about 2% of India's installed capacity. To meet the 2047 target, India must commission approximately 5GW-6 GW annually from the early 2030s. Studies by institutions, including the Council on Energy, Environment and Water (CEEW), suggest that achieving net zero by 2070 could require nuclear capacity exceeding 200 GW under certain scenarios.

To realise this vision, India must implement three pivotal reforms. First, shorten deployment timelines to ensure scale. Reducing the build time of nuclear projects from, say, nine to six years could cut the levelised cost of electricity by 8%. This calls for standardised designs, faster approvals, and skilled project delivery.

Second, enable private sector participation. That means having credible offtakers to reduce risks, structure competitive bids, and offer long-term purchase commitments. Small Modular Reactors, with their lower capex and flexibility and lower land requirement, become bankable only when private capital has clear incentives and predictable returns. Applications include the use of nuclear energy for green steel or to service rapidly rising demand for Artificial Intelligence. The overall capital requirement for 100 GW of nuclear power is enormous: up to $180 billion by 2047. The exposure of domestic banks and non-banking financial companies to the power sector is approximately $200 billion. We must rewire our financial system to support this transition. The growth of nuclear as a viable source of energy and international cooperation rests on assurances of clear policies and offtake and payment guarantees, collaboration with global firms for tech transfer and co-creation, and rules and standards for waste management.

Issue of safety

Third, amend the Civil Liability for Nuclear Damage Act, 2010 to enable private investments in nuclear power plants. India's indigenous reactor designs can be modularised. The recent approval for Holtec International to transfer SMR technology to Indian companies, including Larsen & Toubro and Tata Consulting Engineers, is an example of the potential of India-U.S. collaboration in this direction. However, India should always prioritise nuclear safety by adopting advanced waste handling and decommissioning technologies, especially as it could lead the manufacturing of Small Modular Reactors (SMRs). With smaller emergency zones and air-cooling capability, SMRs suit water-scarce regions but demand robust, centralised waste management and repurposing strategies from the start.

The IMF's World Economic Outlook report (April 2025) shows concerning levels of global uncertainty amid trade and tariff tensions. For India's energy security and sustainable economic development, bilateral relations between India and the U.S. must offer greater assurance in strategic and shared interests. India's continued growth story and the U.S.'s technological prowess and capital are mutually complementary. A resilient energy future needs a long-term vision, not just the pursuit of short-term wins, a road map, and a resilient architecture of cooperation.

The views expressed are personal

Paper 02:International Relations

UPSC Mains Practice Question:Critical minerals are the new oil in the geopolitics of clean energy. Examine the significance of India–U.S. cooperation on critical minerals in the context of India's strategic and energy interests.(250 words)

Context :

The evolving strategic partnership between India and the United States now places renewed emphasis on energy security, especially in the domains of critical minerals and nuclear energy. As highlighted by Arunabha Ghosh, this partnership is pivotal not just for bilateral ties, but for achieving India's long-term sustainable energy goals, particularly in the face of global supply chain disruptions, climate imperatives, and emerging technological challenges.

Key Themes and Strategic Highlights:

India's Energy Security Imperatives:

- India's energy future is being shaped by:
  - Predictable access to diverse and secure energy sources
  - Minimal supply chain disruptions
  - Transition to a sustainable and low-carbon energy mix
- This necessitates greater integration with global energy ecosystems — particularly via U.S. capital, technology, and innovation.

Critical Minerals Partnership: A Strategic Priority

- **Why It Matters:**
  - Critical minerals like lithium, cobalt, rare earth elements are essential for:
    - Electric vehicles
    - Semiconductors
    - Clean energy technologies
    - Defence equipment and aerospace
- **Challenges:**
  - China's dominance (90% of rare earth processing) leads to supply risks and geopolitical leverage.
  - India's exploration capacity is nascent, while global supply chains are fragile.
- **India–U.S. Collaboration Strategy:**
  - Bilateral MoU signed in 2024 to diversify supply chains.
  - Proposal for an India–U.S. Critical Minerals Consortium for joint:
    - Exploration

- Processing
- Third-country investments (Africa, South America, Southeast Asia)

- Build joint strategic stockpiles, develop traceability tech (e.g. blockchain-based mineral exchange), and enable Quad cooperation.

Nuclear Energy: Low-Carbon Backbone for India's Net-Zero Vision

a) Current and Future Status:

- Target: 100 GW of nuclear capacity by 2047 (from ~8 GW today)
- Potential requirement: 200+ GW by 2070 under some net-zero pathways

b) Reforms Needed:

- Faster Deployment:
  - Standardised designs, reduced build timelines (from 9 to 6 years)
  - Can reduce costs and improve return on investment
- Private Sector Participation:
  - Incentivise investments via:
    - Competitive bidding
    - Long-term purchase agreements
    - Bankable off-take frameworks
  - Small Modular Reactors (SMRs) seen as flexible, capital-efficient options
- **Legislative Reforms:**
  - Amend Civil Liability for Nuclear Damage Act, 2010 to allow private investments
  - Encourage U.S.–India collaboration on SMR tech (e.g., Holtec-L&T tie-up)

c) Safety and Sustainability:

- Prioritise advanced nuclear waste handling, decommissioning technologies, and air-cooled SMRs for water-scarce regions

Institutional Mechanisms and Long-Term Vision

- Strengthen iCET (U.S.–India Initiative on Critical and Emerging Technology) for coordinated energy R&D
- Promote workforce development, investment tracking, and data-sharing protocols
- Build a 20-year roadmap with interim benchmarks, aligned with India's Critical Minerals Mission

Conclusion:

The India–U.S. energy partnership is at a transformative moment, driven by converging needs — India's rising energy demand, sustainability goals, and U.S. strategic interest in counterbalancing China's mineral and technological dominance. A well-structured collaboration on critical minerals and nuclear energy can serve as the backbone of a secure, sustainable, and resilient energy architecture. The challenge lies in maintaining long-term commitment, institutional coherence, and balancing economic growth with environmental stewardship.