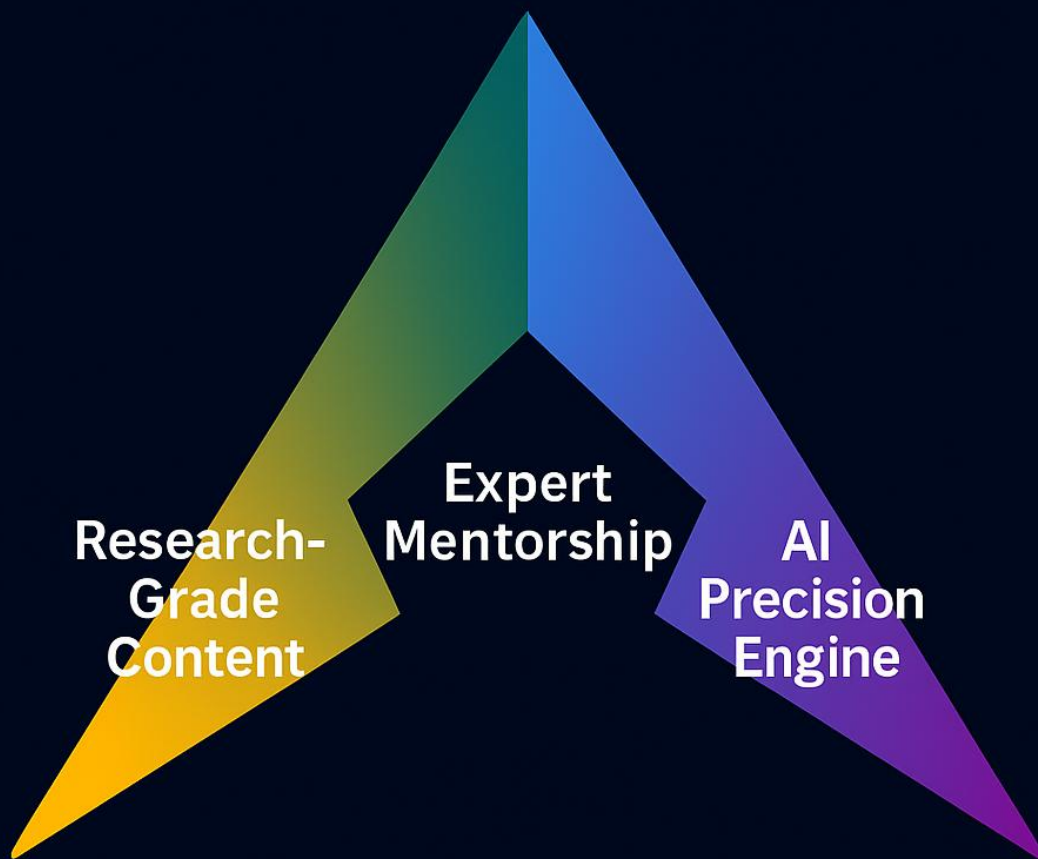


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GS Paper II: International Relations

1. India–Myanmar Security Cooperation

a. Introduction

Myanmar occupies a central place in India's eastern neighbourhood strategy. It is India's only Association of Southeast Asian Nations neighbour with which India shares a land boundary, and it functions as a geographical bridge between India's Northeast and Southeast Asia. Recent discussions between Prime Minister Narendra Modi and Myanmar President U Min Aung Hlaing have again brought India–Myanmar security cooperation into focus. During his visit to India, Myanmar assured that its territory would not be allowed to be used against India's security interests.

This assurance is significant because India has long been concerned about Northeast insurgent groups operating from sanctuaries across the India–Myanmar border. The discussions also covered defence cooperation, connectivity, critical minerals and rare earths, showing that the relationship is not limited to border security but also extends to economic and strategic interests.

The issue connects with India's neighbourhood policy, Act East Policy, insurgency in the Northeast, border management, connectivity projects, internal security and India's wider strategic engagement with Southeast Asia.

Thus, India–Myanmar security cooperation should be understood as a link between foreign policy and internal security, where developments across the border directly affect peace, connectivity and stability in India's Northeast.

India–Myanmar Security Cooperation Framework



b. Strategic Importance of Myanmar for India

- **Bridge Between Northeast India and Southeast Asia:** Myanmar is vital for India because it connects India's Northeast with Southeast Asia. Without stability in Myanmar, India's Act East Policy remains geographically and strategically incomplete. The country is important for trade, connectivity, energy cooperation, border stability and regional influence.
- **Sensitive Border Geography:** India shares a long and sensitive border with Myanmar. This border passes through difficult terrain and is inhabited by communities with ethnic and kinship links across both sides. While these links have historical and social importance, they also create complex security challenges.
- **Security Complexity of the Border:** Porous terrain, limited state presence, illegal movement, arms trafficking, narcotics routes and insurgent mobility make the border difficult to manage. Therefore, peace and stability in Myanmar are directly linked with India's internal security, especially in the northeastern States.

This strategic context explains why India cannot treat Myanmar only as an external neighbour; it is also directly tied to India's border governance and internal security architecture.

c. Security Concerns Along the India–Myanmar Border

- **Insurgent Sanctuaries:** India has historically faced security concerns from insurgent groups in the Northeast using Myanmar's territory for shelter, movement, training or regrouping. These groups have exploited the difficult terrain, ethnic networks and weak administrative presence in border regions.
- **Significance of Myanmar's Assurance:** The assurance that Myanmar's territory will not be used against India is therefore important. It signals a willingness to cooperate on counter-insurgency, intelligence sharing and coordinated border management.
- **Need for Operational Cooperation:** However, such assurances must translate into sustained operational cooperation. Border security requires regular intelligence exchange, action against insurgent camps, coordinated patrolling and mechanisms for preventing cross-border movement of armed groups.
- **Wider Criminal-Security Nexus:** The challenge is not limited to insurgency. The same border region is also vulnerable to arms smuggling, narcotics trafficking, illegal trade and refugee flows. These issues often overlap and create a broader internal security challenge for India.

Thus, India–Myanmar security cooperation must address both insurgency and the wider ecosystem of illicit cross-border networks.

d. Myanmar's Internal Instability and Its Impact on India

- **Political Instability in Myanmar:** Myanmar's internal political instability directly affects India. Since the military takeover in Myanmar, the country has witnessed political uncertainty, armed resistance, ethnic conflict and weakening of central authority in several regions. This has created humanitarian, diplomatic and security complications for India.
- **Refugee and Security Spillovers:** Instability in Myanmar can lead to refugee inflows into India's border States, especially Mizoram and Manipur. It can also enable insurgent groups, criminal networks and arms traffickers to exploit the governance vacuum. In addition, conflict zones can disrupt India's connectivity projects and economic engagement.
- **India's Policy Dilemma:** India's policy therefore faces a difficult balance. On one side, India needs working engagement with the ruling authorities in Myanmar for security, border management, connectivity and strategic interests. On the other side, India must remain sensitive to humanitarian concerns, democratic aspirations and the need for peace and stability in Myanmar.
- **Pragmatic Engagement:** This makes India's Myanmar policy one of pragmatic engagement rather than simple alignment.

In this sense, India's approach must combine realism with sensitivity, ensuring that security cooperation does not ignore humanitarian and regional stability concerns.

e. Connectivity and the Act East Policy

- **Connectivity as a Strategic Pillar:** Connectivity is one of the most important pillars of India–Myanmar relations. Projects such as the Kaladan Multimodal Transit Transport Project and the India–Myanmar–Thailand Trilateral Highway are central to India's Act East Policy.
- **Kaladan Multimodal Transit Transport Project:** The Kaladan project seeks to connect India's eastern coast with Myanmar's Sittwe port and further link it to Mizoram through inland waterways and road transport. This can reduce the geographical isolation of the Northeast and provide an alternative route for trade and movement.
- **India–Myanmar–Thailand Trilateral Highway:** The India–Myanmar–Thailand Trilateral Highway aims to connect India with Southeast Asia through road connectivity. If completed effectively, it can promote trade, tourism, investment and regional integration.
- **Impact of Instability on Connectivity:** However, instability in Myanmar has slowed progress. Conflict zones, security risks, weak administrative capacity and delays in implementation have affected these projects. Therefore, security cooperation is necessary not only for counter-insurgency but also for protecting India's connectivity ambitions.

This shows that infrastructure diplomacy and internal security are closely interconnected in India's Myanmar policy.

f. Critical Minerals and Rare Earths

- **Strategic Relevance of Myanmar's Resources:** Myanmar also has growing relevance for critical minerals and rare earths. These resources are essential for clean energy technologies, electronics, batteries, defence systems, electric vehicles and advanced manufacturing.
- **Relevance for India's Supply-Chain Resilience:** For India, cooperation with Myanmar in this sector can support strategic autonomy and supply-chain resilience. As global competition over critical minerals intensifies, India needs diversified and reliable sources.
- **Need for Responsible Cooperation:** However, cooperation in this field must be pursued carefully. Mining in conflict-affected or ecologically fragile regions can create risks of illegal extraction, conflict financing, environmental damage and local displacement.
- **Sustainable Mineral Supply Chains:** Therefore, India should promote transparent, responsible and sustainable mineral supply chains with safeguards for environment and communities.

This resource dimension adds a strategic economic layer to India-Myanmar relations, but it must be managed with environmental and governance caution.

g. China Dimension

- **Myanmar in Regional Geopolitics:** Myanmar's strategic location makes it important in the regional balance of power. China has deep economic, infrastructural and strategic interests in Myanmar, including ports, energy corridors and access to the Indian Ocean.
- **Need for Sustained Indian Engagement:** For India, sustained engagement with Myanmar is therefore necessary to avoid strategic marginalisation in its immediate neighbourhood. If India disengages, it may allow other powers greater influence over Myanmar's infrastructure, resources and security environment.
- **Beyond China-Centric Framing:** However, India's approach should not be framed only as a response to China. It must be grounded in India's own interests: securing the Northeast, building connectivity, supporting regional stability, expanding trade and strengthening Act East engagement.

Thus, the China factor adds urgency to India's Myanmar policy, but India's engagement must remain rooted in its independent regional priorities.

h. Governance and Border Management Challenges

- **Security-Humanitarian Balance:** Managing the India-Myanmar border is complex because it involves both security and humanitarian considerations. Border communities share ethnic, cultural and familial ties across the boundary. Any policy that focuses only on hard security may create local resentment and disrupt traditional social relations.
- **Risks of Weak Border Monitoring:** At the same time, a completely open or weakly monitored border can be misused by insurgents, traffickers and criminal networks. Therefore, India needs a balanced border management approach.
- **Components of Better Border Management:** This requires better infrastructure, improved surveillance, coordinated patrols, humane refugee management, stronger policing, community engagement and consultation with State governments.
- **Role of Northeastern States:** The concerns of northeastern States must be included in policy decisions because they face the direct consequences of instability across the border.

This makes border management a multi-level governance challenge involving the Union, States, local communities and security agencies.

i. Way Forward

- **Strengthen Security Cooperation:** India and Myanmar should deepen intelligence sharing, coordinated border patrols and action against insurgent camps. Security cooperation must be regular, institutionalised and focused on preventing the use of Myanmar's territory against India.
- **Stabilise Border Management:** Border management should balance security concerns with humanitarian realities. Traditional community links, refugee situations and local livelihoods must be handled sensitively, while preventing illegal movement, trafficking and insurgent activity.
- **Protect Northeast Interests:** India's Myanmar policy should be closely linked with development and peace-building in the Northeast. Improved infrastructure, livelihood generation, border trade and local consultation can help reduce vulnerability to insurgency and illegal networks.
- **Accelerate Connectivity Projects:** The Kaladan Multimodal Transit Transport Project and the India-Myanmar-Thailand Trilateral Highway should be implemented in a time-bound manner. Security safeguards, better project monitoring and coordination with local authorities are necessary for completion.
- **Engage Pragmatically but Carefully:** India should maintain working ties with Myanmar's ruling authorities because security and connectivity interests require engagement. At the same time, India should continue to support peace, stability, humanitarian sensitivity and inclusive political dialogue.
- **Cooperate on Critical Minerals Responsibly:** India should explore cooperation in critical minerals and rare earths through transparent and sustainable mechanisms. Environmental safeguards, social responsibility and checks against illegal mining should be built into such cooperation.
- **Improve Centre-State Coordination:** Northeastern States must be consulted on border, refugee, trade and connectivity policies. Their local knowledge and administrative experience are essential for designing realistic and acceptable policies.

A durable way forward must therefore combine security cooperation, border sensitivity, connectivity implementation, responsible resource engagement and Centre-State coordination.

Conclusion

Myanmar is vital for India's security, connectivity and Act East ambitions. The assurance that Myanmar's territory will not be used against India's security interests is important, especially in the context of Northeast insurgency and cross-border threats.

However, durable gains will require more than diplomatic assurances. India needs sustained security cooperation, stable border management, faster connectivity implementation, responsible resource engagement and a calibrated approach to Myanmar's internal political realities. A balanced policy must protect India's security interests while supporting stability, development and regional connectivity in the eastern neighbourhood.

In this sense, India-Myanmar relations represent a classic case where neighbourhood diplomacy, internal security and regional connectivity converge.

GS Paper II: International Relations

2. IMEC Between Commerce and Geopolitics

a. Introduction

The India-Middle East-Europe Economic Corridor has emerged as one of the most ambitious connectivity initiatives linking Asia, West Asia and Europe. It was announced at the G-20 Summit in New Delhi in September 2023 and is designed to connect India with Europe through the Gulf and the eastern Mediterranean.

The ongoing Iran conflict has brought renewed attention to this corridor. The crisis has exposed the vulnerability of global trade routes, especially narrow maritime choke points such as the Strait of Hormuz. It has also shown that connectivity projects in West Asia cannot be understood only in commercial terms. They are deeply shaped by geopolitics, regional rivalries, energy security and strategic competition.

For India, the India–Middle East–Europe Economic Corridor is important because it connects trade diplomacy with energy security, supply-chain resilience, West Asia policy and India’s ambition to become a major connectivity power.

Thus, IMEC should be understood not merely as an infrastructure project, but as a strategic corridor where commerce, energy security and geopolitics intersect.

IMEC Components		
Leg	Route	Purpose
 Eastern	India → UAE	 Maritime Link
 Central	UAE → Saudi Arabia → Jordan → Israel	 Rail & Logistics
 Western	Haifa → Europe	 Maritime Trade
 Cross-cutting	Energy & Digital Networks	 Future Connectivity

b. Background of IMEC

- **Basic Structure of the Corridor:** The India–Middle East–Europe Economic Corridor seeks to create a new multimodal trade and connectivity route between India and Europe. It is designed to combine sea routes, railways, highways, energy pipelines, undersea data cables, green hydrogen corridors and transnational electricity grids.
- **Eastern Leg:** The eastern leg connects India with the United Arab Emirates through sea links. This gives India a direct maritime connection to the Gulf and provides the starting point for the corridor’s wider westward movement.
- **Central Leg:** The central leg moves from the United Arab Emirates through Saudi Arabia and Jordan towards Israel by overland transport. This part is crucial because it converts the corridor from a sea-only route into a multimodal trade and logistics network.
- **Western Leg:** The western leg connects Haifa port in Israel with European ports through sea routes. This gives the corridor its final link with Europe and makes it a proposed alternative or supplement to existing trade routes.
- **Larger Connectivity Platform:** The corridor is therefore not only a trade route. It is a larger connectivity platform that seeks to integrate commerce, energy, digital infrastructure and strategic cooperation across regions.

This background shows why IMEC has significance beyond transport logistics; it represents a new model of inter-regional economic connectivity.

c. Why the Iran Conflict Matters

- **Fresh Doubts About Viability:** The Iran conflict has created fresh doubts about the pace and viability of the corridor. The Gaza war had already slowed progress because of instability around Israel and the eastern Mediterranean. The Iran conflict has further complicated the situation by raising risks around Israel, Gulf ports and the Strait of Hormuz.
- **Vulnerability of the Strait of Hormuz:** The Strait of Hormuz is one of the world's most important energy choke points. A major share of global oil trade passes through this narrow passage. Any disruption in this area can sharply affect global energy prices, shipping costs and energy security. India is particularly vulnerable because it depends heavily on imported crude oil.
- **Necessity and Vulnerability of IMEC:** This crisis strengthens the strategic logic behind the corridor because it shows why countries need diversified trade and energy routes. At the same time, it also exposes the difficulty of building such a corridor through a region marked by recurring conflict and competing strategic interests.

Thus, the conflict shows both the necessity and the vulnerability of the India–Middle East–Europe Economic Corridor.

d. Commercial Logic of IMEC

- **Trade and Logistics Benefits:** Economically, the corridor has strong potential. It can reduce transit time between India and Europe, lower logistics costs, expand trade flows and attract new investments in ports, railways, industrial corridors and digital infrastructure.
- **Benefits for India:** For India, the corridor can improve access to European markets and strengthen its role in global supply chains. It can also support Indian exporters by creating faster and more reliable routes for high-value goods, manufactured products and services-linked trade.
- **Future-Oriented Sectors:** The corridor can also promote new sectors such as green hydrogen, renewable energy transmission and digital connectivity. If energy pipelines, electricity grids and data cables are integrated into the project, the corridor can become more than a physical trade route. It can become a platform for future-oriented economic cooperation.
- **Changing Nature of Connectivity:** In this sense, the corridor reflects the changing nature of global connectivity. Modern corridors are no longer limited to roads, ports and railways. They increasingly include energy, data, finance, logistics and technology networks.

This commercial logic explains why IMEC remains attractive despite geopolitical risks.

e. Geopolitical Reality of IMEC

- **West Asian Instability:** Despite its commercial promise, the corridor faces serious geopolitical challenges. It passes through West Asia, one of the world's most conflict-prone regions. Its success depends on stable cooperation among the United Arab Emirates, Saudi Arabia, Jordan, Israel, European partners and India.
- **Risks from Escalation:** Any escalation involving Iran, Israel or Gulf states can disrupt planning, financing, insurance, shipping and logistics. Continued instability around Israel also raises concerns about the use of Haifa port as a major transit hub.
- **Corridor Between Commerce and Strategy:** The project is therefore caught between commercial logic and geopolitical reality. Economically, it offers faster trade and diversified supply chains. Strategically, it provides an alternative to China's Belt and Road Initiative and strengthens India's position in West Asia and Europe. Politically, however, it requires constant diplomatic coordination among countries with different threat perceptions and regional priorities.
- **Diplomatic and Security Project:** This makes the corridor not merely an infrastructure project, but a diplomatic and security project.

Therefore, IMEC's success will depend as much on political stability and diplomatic coordination as on engineering and finance.

f. Saudi Arabia–United Arab Emirates Dynamic

- **Importance of Gulf Coordination:** The relationship between Saudi Arabia and the United Arab Emirates is particularly important for the corridor. Both are central partners in the project, and seamless connectivity depends on coordination between them.
- **Cooperation and Competition:** However, both countries also have their own strategic ambitions, energy policies and regional alignments. They may cooperate on many issues but also compete for investment, logistics leadership, regional influence and future economic hubs.
- **Impact on Central Leg:** Any major divergence between them could slow the development of the central leg of the corridor. For the India–Middle East–Europe Economic Corridor to succeed, it will need not only formal agreements but also practical coordination on customs, standards, rail connectivity, port handling, security protocols and financing.

This makes Gulf coordination one of the most important political preconditions for IMEC's operational success.

g. Security Concern Around the Israeli Leg

- **Importance of Haifa Port:** The Israeli leg, especially Haifa port, is a critical component of the proposed western route. However, continuing instability in and around Israel has created commercial and security concerns.
- **Investor and Logistics Uncertainty:** If the eastern Mediterranean remains unstable, shipping companies, insurers, investors and logistics operators may hesitate to depend heavily on the route. This does not mean that the Israeli leg is permanently unviable, but it does mean that short-term implementation may require flexibility.
- **Need for Alternate or Supplementary Routes:** Therefore, India and its partners may need to explore alternate or supplementary routes. An Egypt-linked Mediterranean route or additional ports in the Gulf could provide resilience until the security situation stabilises.

This flexibility is necessary because a strategic corridor cannot depend entirely on one vulnerable node.

h. Energy Security Dimension

- **Reducing Dependence on Choke Points:** The corridor has a major energy security dimension. It can help India and its partners reduce overdependence on vulnerable maritime choke points. It can also support the development of green hydrogen corridors, electricity grids and renewable energy supply chains.
- **India's Expanding Energy Security Needs:** For India, energy security is not limited to crude oil imports. It increasingly includes access to clean energy technologies, green hydrogen, electricity transmission infrastructure and critical minerals. If properly designed, the corridor can support India's long-term energy transition.
- **Need for Redundancy:** However, the Iran conflict shows that energy routes in West Asia remain vulnerable to geopolitical shocks. India must therefore build redundancy, which means having multiple routes, multiple suppliers and multiple infrastructure options.

Thus, IMEC should be integrated into India's wider energy-security strategy rather than treated as a stand-alone solution.

i. IMEC and India's Strategic Autonomy

- **Diversification of Connectivity Options:** The corridor supports India's strategic autonomy by diversifying trade routes and expanding India's options in global connectivity. It gives India a chance to deepen ties with the Gulf, Europe and the Mediterranean without becoming dependent on any single route or power bloc.
- **Complementarity with Other Corridors:** It also complements India's broader connectivity strategy, including the International North-South Transport Corridor, Chabahar port, Indo-Pacific maritime routes and partnerships with the Gulf Cooperation Council countries.
- **Need for Corridor Diversification:** India should therefore avoid treating any one corridor as a complete solution. A diversified network of corridors will give India greater resilience in times of conflict, sanctions, supply-chain disruption or maritime instability.

This makes IMEC an important component of strategic autonomy, but not a substitute for a multi-corridor approach.

j. Comparative Perspective: IMEC, INSTC and BRI

- **IMEC:** The India–Middle East–Europe Economic Corridor seeks to connect India with West Asia and Europe, while reducing dependence on the traditional Suez Canal route. Its strategic value lies in strengthening India–Gulf–Europe connectivity and creating a new platform for trade, energy and digital cooperation.
- **INSTC:** The International North-South Transport Corridor connects India with Russia and Europe through Iran and Central Asia. It also reduces dependence on the Suez route, but it faces risks linked to Iran, sanctions and geopolitical tensions.
- **BRI:** China's Belt and Road Initiative is a China-led transcontinental connectivity strategy that expands Beijing's economic and strategic influence. It seeks to reduce China's dependence on maritime choke points while creating infrastructure-linked influence across Asia, Africa and Europe.
- **India's Balanced Connectivity Strategy:** India should not view these corridors in isolation. A balanced connectivity strategy combining the India–Middle East–Europe Economic Corridor, the International North-South Transport Corridor, Chabahar, Gulf partnerships and Indo-Pacific maritime routes can strengthen India's strategic autonomy.

This comparative view shows that India's connectivity policy should be diversified, flexible and geopolitically aware.

k. Challenges Before IMEC

- **Regional Instability:** The first major challenge is regional instability. West Asia's political and security environment remains uncertain, and recurring conflict can delay project implementation.
- **Route Vulnerability:** The second challenge is route vulnerability. Heavy reliance on any single port or transit point, especially in conflict-prone zones, can weaken the corridor's reliability.
- **Multi-Country Coordination:** The third challenge is coordination among multiple countries. The corridor requires harmonisation of customs, railway standards, logistics systems, investment rules, security arrangements and digital infrastructure.
- **Financing:** The fourth challenge is financing. Large infrastructure corridors require long-term investment, risk-sharing and bankable project design.
- **Strategic Competition:** The fifth challenge is strategic competition. The corridor will operate in a landscape already shaped by China's Belt and Road Initiative, regional rivalries and competing energy interests.

These challenges underline that IMEC will require sustained political management, not merely project-level planning.

1. Way Forward

- **Adopt Flexible Routing:** India and its partners should explore alternate entry and exit points instead of depending only on one route. Ports in Oman such as Salalah, Duqm and Muscat can be considered as additional options to reduce exposure to conflict-prone zones.
- **Use Egyptian Alternatives:** Until the Haifa route becomes more secure and commercially predictable, an Egypt-linked Mediterranean route may provide a practical western spur. Such flexibility would improve investor confidence and logistical resilience.
- **Strengthen Diplomatic Balancing:** India should use its good relations with the United Arab Emirates, Saudi Arabia, Israel, Europe and Iran to support corridor stability. India's ability to speak with multiple sides can become an important diplomatic asset.
- **Institutionalise IMEC Coordination:** A regular coordination mechanism should be created for security review, infrastructure planning, customs facilitation, financing, dispute resolution and technical standards. Without institutional follow-up, the corridor may remain a diplomatic announcement rather than an operational reality.
- **Integrate Energy and Digital Corridors:** The corridor should not remain only a trade route. It should include green hydrogen, power grids, data cables, digital platforms and clean energy supply chains. This will make it more relevant to future economic needs.
- **De-Risk Supply Chains:** Redundancy must be built into ports, routes, logistics systems, energy networks and digital infrastructure. A resilient corridor should be able to operate even when one route or node faces disruption.
- **Coordinate Closely with Europe:** European partners such as Italy and France should play a stronger role in financing, implementation, technology support and risk-sharing. Their active participation will give the corridor greater commercial credibility and geopolitical balance.

A practical way forward must therefore combine flexibility, redundancy, diplomatic balance, institutional coordination and future-oriented infrastructure planning.

Conclusion

The Iran conflict has shown why the India–Middle East–Europe Economic Corridor is necessary, but also why it is difficult. The corridor can help India and its partners diversify trade routes, reduce dependence on vulnerable choke points, deepen India–Gulf–Europe connectivity and support future sectors such as green hydrogen and digital infrastructure.

However, the project's success will depend on managing West Asia's geopolitical complexities. It requires flexible routing, sustained diplomacy, security coordination, institutional mechanisms and strong economic planning. For India, the corridor should be treated not merely as an infrastructure project but as a long-term strategic instrument linking commerce, energy security and regional diplomacy.

In this sense, IMEC represents the future of connectivity politics, where trade routes are also instruments of resilience, influence and strategic autonomy.

GS Paper III: Environment

3. Summer Air Pollution in Indian Cities

a. Introduction

Air pollution in Indian cities is no longer only a winter crisis. Recent developments in Delhi and other major urban centres show that summer pollution has emerged as a serious environmental and public health concern. The Commission for Air Quality Management revoked winter pollution restrictions under the Graded Response Action Plan in March, but Stage 1 restrictions had to be reimposed in April and May when Delhi witnessed fresh pollution episodes.

Unlike winter smog, which is dominated by fine particulate matter and stagnant atmospheric conditions, summer pollution has a different character. It is driven mainly by coarse dust particles, known as PM₁₀, and ground-level ozone. This makes the problem scientifically different and administratively more complex.

Thus, summer air pollution must be understood not as a temporary seasonal disturbance, but as an emerging urban governance and public health challenge.



b. Understanding the Pattern of Summer Pollution

- **Meteorological Conditions**

Summer pollution is shaped by heat, strong sunlight, dry winds, dust movement and urban emissions. During summer, the atmosphere generally has better dispersion than winter because warmer air and stronger winds help pollutants spread out. However, the same winds can also lift dust from roads, construction sites, open land and dry surfaces.

- **Dominant Pollutants**

The dominant pollutants in summer are PM10 and ground-level ozone. PM10 refers to particulate matter with a diameter of 10 micrometres or less. These particles are larger than PM2.5, but they can still enter the respiratory system and cause health problems. Ground-level ozone is different from the protective ozone layer in the upper atmosphere. It is a harmful pollutant formed near the Earth's surface through chemical reactions under sunlight.

- **Recent Pattern in Delhi and Other Cities**

Between April 1 and May 31, 2026, Delhi recorded 54 days when PM10 levels exceeded the national daily standard. On 40 days, at least one monitoring station in Delhi breached the hourly ozone standard. Similar concerns have also been observed in cities such as Mumbai, Chennai, Hyderabad, Bengaluru and Kolkata.

This shows that summer pollution is not a Delhi-only problem. It is becoming a wider urban governance challenge.

c. How Summer Pollution Differs from Winter Pollution

Nature of Winter Pollution

Winter pollution in north Indian cities is largely associated with low temperatures, weak winds and atmospheric inversion. Atmospheric inversion is a condition in which a layer of warm air traps cooler air and pollutants near the ground. This leads to the accumulation of fine PM2.5 particles from vehicles, industries, biomass burning, construction dust and other sources.

Nature of Summer Pollution

In contrast, summer pollution is shaped by stronger winds, high temperatures and intense sunlight. These conditions disperse some pollutants, but they also create two major problems.

- Dry winds lift and transport dust, raising PM10 levels.

- Strong sunlight accelerates chemical reactions that produce ground-level ozone.

Need for Separate Strategy

Therefore, the summer pollution problem cannot be addressed by simply applying the same strategy used for winter smog. It requires separate attention to dust control, ozone-forming gases, heat-related risks and local meteorological conditions.

This distinction is important because pollution control policies must be designed according to seasonal source profiles rather than applying one uniform model throughout the year.

d. Ground-Level Ozone: An Emerging Urban Pollutant

- **Formation of Ground-Level Ozone:** Ground-level ozone is one of the most important summer pollutants. It is not directly emitted from vehicles, industries or power plants. Instead, it is formed when nitrogen oxides and volatile organic compounds react in the presence of strong sunlight.
- **Sources of Ozone Precursors:** Nitrogen oxides mainly come from vehicles, power plants, industrial combustion and diesel generators. Volatile organic compounds are released from fuels, paints, solvents, industrial processes and certain household products. When these gases interact under hot and sunny conditions, ozone forms near the ground.
- **Why Cities Are Vulnerable:** This is why hotter and sunnier days are more favourable for ozone formation. Cities with high traffic, industrial activity and rising temperatures are particularly vulnerable. Delhi and Chennai, for example, can experience ozone episodes during summer because they combine heat with large volumes of vehicular and industrial emissions.
- **Health Impact:** Ozone pollution is especially concerning because it can worsen asthma, cause lung inflammation, reduce lung function and create breathing difficulties. It is also harmful to children, elderly persons, outdoor workers and people with pre-existing respiratory illness.

Thus, ozone pollution represents a new-generation urban air quality challenge linked with heat, emissions and atmospheric chemistry.

e. Dust Storms and PM10 Pollution

- **Pre-Monsoon Dust Activity:** Dust storms are another major driver of summer pollution. In north-west India, dust storms are common during the pre-monsoon months when heat, dryness and wind activity increase. Hot winds such as the loo can carry dust from dry regions, including the Thar Desert and parts of West Asia, across northern India.
- **Local Dust Storms:** Local dust storms, commonly known as *andhi* in north India, can also occur when thunderstorm winds lift loose soil, road dust and dry particles from exposed surfaces. These events can sharply raise PM10 levels for several hours or even days.
- **Human Contribution to Dust Pollution:** The problem becomes worse when natural dust is combined with human-generated dust. Broken roads, uncovered construction material, demolition debris, dry roadside soil, open dumping of waste and vehicular movement over dusty surfaces all contribute to resuspension of particles. Resuspension means that dust already settled on the ground is lifted again into the air due to wind or vehicle movement.
- **Urban Mismanagement:** Thus, summer dust pollution is not purely a natural phenomenon. Urban mismanagement significantly increases its intensity.

This makes dust control a core municipal responsibility rather than only a meteorological concern.

f. Role of Construction, Transport and Industry

- **Construction and Demolition Dust:** Human activities intensify summer pollution in multiple ways. Construction and demolition activities often resume after winter restrictions

are lifted. If construction sites are not properly covered, barricaded or sprinkled with water, large quantities of dust enter the air.

- **Road Dust and Transport:** Road dust is another major contributor. Poorly maintained roads, dry road shoulders, unpaved stretches, open soil and heavy vehicle movement create continuous dust resuspension. In cities with high traffic congestion, vehicular movement not only generates emissions but also lifts settled dust.
- **Industrial Emissions and Secondary Pollutants:** Industrial emissions and fuel combustion add another layer of complexity. They release nitrogen oxides and volatile organic compounds, which contribute to ozone formation. Therefore, controlling summer pollution requires attention not only to dust but also to gases that create secondary pollutants.

This shows that summer air pollution is a combined outcome of dust, transport, industry, construction and heat-driven chemical reactions.

g. Governance Gap in Air Pollution Management

- **Winter-Centric Policy Approach:** Indian air pollution policy has remained heavily winter-centric, especially in Delhi-National Capital Region. The Graded Response Action Plan has been useful for responding to severe pollution episodes, but it is largely reactive. It imposes restrictions after pollution levels rise.
- **Need for Anticipatory Governance:** Summer pollution needs anticipatory governance. This means forecasting pollution episodes before they become severe, issuing timely health advisories, regulating construction dust, managing road dust, reducing ozone-forming gases and enforcing industrial and transport standards throughout the year.
- **Beyond Seasonal Crisis Response:** The reimposition of Stage 1 measures in April and May shows that pollution governance cannot be limited to winter months. Cities need permanent clean air systems, not seasonal crisis response.

Therefore, India's urban air quality governance must shift from emergency-based intervention to year-round, science-based management.

h. Public Health Implications

- **Respiratory Impact of PM10:** Summer pollution creates a serious public health burden. PM10 particles can irritate the nose, throat and lungs. They can worsen asthma, bronchitis and other respiratory conditions.
- **Health Impact of Ozone:** Ground-level ozone is also harmful because it inflames airways, reduces lung capacity and increases breathing difficulties.
- **Heat-Pollution Double Burden:** The risk becomes more severe when pollution combines with heatwaves. Heat stress and air pollution together create a double burden for vulnerable groups. Children, elderly persons, outdoor workers, traffic police personnel, construction workers, street vendors and people with respiratory or cardiovascular diseases face the highest risk.

This makes summer pollution not only an environmental issue but also a public health, occupational safety and labour welfare concern.

i. Way Forward

- **Adopt Year-Round Clean Air Planning:** Cities must treat air pollution as a multi-season problem. Clean air plans should include separate strategies for winter PM2.5 pollution, summer PM10 dust episodes and ozone formation. Seasonal source profiles should guide policy action.
- **Strengthen Forecasting and Public Alerts:** Air Quality Early Warning Systems and India Meteorological Department forecasts should be used to predict dust storms, heat-linked ozone episodes and poor air quality days. Public advisories should be issued in advance, especially for schools, hospitals, outdoor workers and vulnerable groups.

- **Control Construction and Demolition Dust:** Construction material should be covered, sites should be barricaded, regular sprinkling should be enforced and debris disposal must be regulated. Large construction sites should be monitored through inspections and digital compliance systems.
- **Manage Road Dust:** Cities need mechanised road sweeping, repair of broken roads, greening of road shoulders, paving of dusty stretches and control of heavy vehicle movement on vulnerable roads. Road dust management should become a routine municipal responsibility.
- **Reduce Ozone Precursors:** Ground-level ozone cannot be controlled by dust management alone. Cities must reduce nitrogen oxides and volatile organic compounds through cleaner public transport, stricter industrial compliance, better fuel standards and regulation of paints, solvents, diesel generators and combustion sources.
- **Improve Traffic Management:** Vehicular idling contributes to emissions. Behavioural campaigns such as “Red Light On, Gaadi Off” can help, but they must be combined with better traffic flow, public transport expansion, parking management and stricter emission checks.
- **Prepare City-Specific Summer Action Plans:** Delhi’s summer air pollution plan should be adapted by other cities according to local conditions. Mumbai, Chennai, Hyderabad, Bengaluru and Kolkata require their own source mapping, ozone monitoring, dust control measures and health advisories.

A strong way forward must therefore combine forecasting, municipal dust control, ozone precursor reduction, traffic management and public health preparedness.

Conclusion

Summer air pollution in Indian cities is driven by a combination of dust, heat, sunlight and urban emissions. While winter smog is dominated by PM_{2.5} and stagnant air, summer pollution is marked by PM₁₀ spikes and ground-level ozone formation.

The policy response must therefore move beyond seasonal crisis management. India’s cities need year-round, science-based and health-sensitive air quality governance. This requires forecasting, dust control, ozone precursor reduction, public advisories, stronger municipal action and better integration between environmental policy and urban planning.

In this sense, summer air pollution is a reminder that clean air governance must become permanent, preventive and city-specific rather than episodic and winter-centric.

Reader's Note — About This Current Affairs Compilation

Dear Aspirant,

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While every effort has been made to balance depth with brevity, please keep the following in mind:

1. Orientation & Purpose

This compilation is curated primarily from the UPSC Mains perspective — with emphasis on conceptual clarity, analytical depth, and interlinkages across GS papers.

However, the PrepAlpine team is simultaneously developing a dedicated Prelims-focused Current Affairs Series, designed for:

- factual coverage
- data recall
- Prelims-style MCQs
- objective pattern analysis

This Prelims Edition will be released separately as a standalone publication.

2. Content Length

Some sections may feel shorter or longer depending on topic relevance and news density. To fit your personal preference, you may freely resize or summarize sections using any LLM tool (ChatGPT, Gemini, Claude, etc.) at your convenience.

3. Format Flexibility

The formatting combines:

- paragraphs
- lists
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- visual cues

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