India’s Path to Sustainable Air Quality

This editorial is based on “NCAP 2.0 must focus on industrial reform to ensure cities have clean air” which was published in The Indian Express on 24/07/2025. The article brings into picture the stark gap between industrial contributions to air pollution and the minimal NCAP funding allocated to address them, highlighting the need for a comprehensive strategy that treats clean air as an environmental and economic priority.

For Prelims: Air pollutants, National Clean Air Programme, PM2.5 concentrations, Flue Gas Desulfurization systems, Carbon monoxide,Ujjwala Yojana, Heatwaves, Central Pollution Control Board, Happy Seeder.

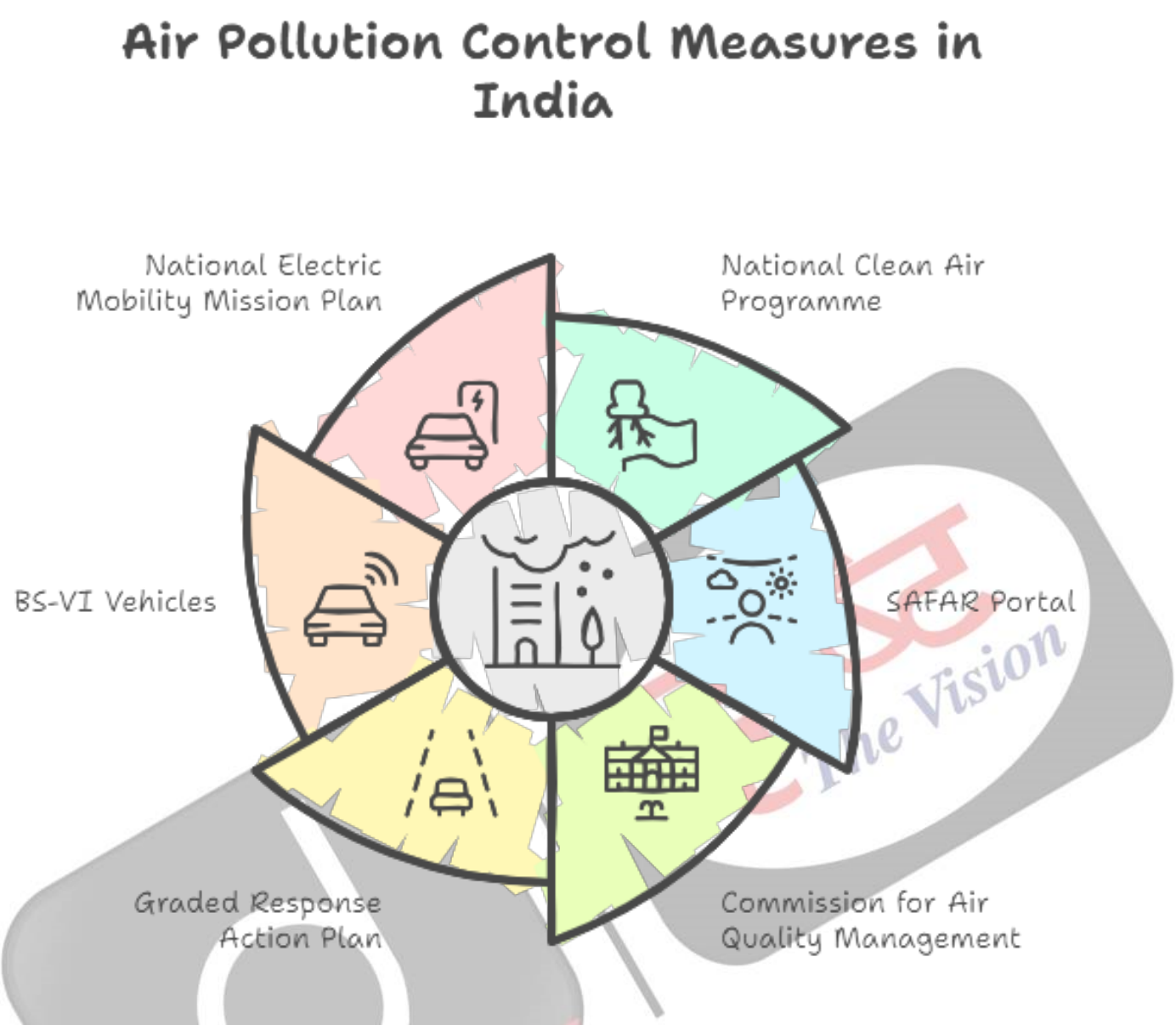
For Mains: Key Factors Contributing to Rising Air Pollution in India, Key Shortcomings limiting the Effectiveness of India's Air Pollution Control Initiatives, Key Implications of Rising Air Pollution in India.

India's air pollution crisis is deeply intertwined with industrial emissions, as nearly 37% of the country's most polluted cities are flanked by large industries like thermal power plants and manufacturing units. Despite industries being primary polluters in 20 percent of these cities, only **0.6 percent of National Clean Air Programme funds are allocated to control industrial emissions,** revealing a critical mismatch between problem identification and resource allocation. As India prepares for **NCAP 2.0,** beyond sectoral fixes and regulatory measures, **India must commit to a comprehensive national effort that prioritizes air quality control** as both an environmental imperative and economic necessity for sustainable development.

What are the Key Factors Contributing to Rising Air Pollution in India?

- **Persistent Vehicular Emissions:** Vehicular emissions are one of the largest contributors to the growing air pollution crisis in India.
    - As cities expand and the number of vehicles increases, the release of harmful pollutants, **particularly PM2.5 and nitrogen oxides**, **becomes more pervasive.**
        - For instance, the annual **air quality report by IQAir** ranked Delhi as one of the most polluted capital cities globally with **PM2.5 concentrations reaching 108.3 µg/m³**, far exceeding the **WHO's safe limits.**
    - These high pollution levels are exacerbated by the growing dependence on private cars over public transportation, increasing vehicular emissions.
- **Unchecked Growth in Manufacturing and Power Sectors:** Industrial emissions are another significant cause of air pollution, particularly in **states with dense manufacturing hubs.**
    - **Thermal power plants, cement plants, and steel smelters** release large quantities of particulate matter (PM), sulfur dioxide (SO_2), and nitrogen oxides (NO_x).

    - Despite regulations, industrial units often lack effective pollution control technologies, contributing heavily to the air quality crisis.
        - About **78% of India's 537 or so thermal power plant units do not have to install machinery** to reduce **SO2 emissions called Flue Gas Desulfurization systems (FDGs).**
    - The **World Bank** estimates that air pollution costs India's economy **$95 billion annually** in lost productivity and premature deaths.
- **Crop Residue Burning- Seasonal Spike in Air Pollution:** The seasonal practice of crop residue burning though reduced recently in northern states like Punjab and Haryana **still exacerbates air pollution during the harvest season.**
    - This practice releases significant amounts of **carbon monoxide, PM2.5, and black carbon into the atmosphere,** contributing to smog formation.
    - Though stubble burning cases have declined in Punjab, **Uttar Pradesh has, conversely, witnessed a 25% rise in such incidents.**
- **Residential Biomass Burning:** Biomass burning for cooking and heating remains a common practice in rural and urban households, contributing to indoor and outdoor air pollution.
    - Despite efforts like the **Ujjwala Yojana**, which has provided LPG connections to millions, many households still rely on **coal, wood, and crop residues**, which release harmful particulates into the air.
    - In cities like **Varanasi** and **Kanpur**, residential emissions account for more than **30% of PM2.5 pollution**.
    - Multiple studies show that air pollution in rural areas is as severe as in urban areas, and about **70% of premature deaths from air pollution happen in villages, largely contributed by household pollution.**
- **Meteorological and Geographic Factors**: Meteorological conditions significantly impact the dispersion and concentration of air pollutants, especially in winter when temperature inversions trap pollutants close to the ground.
    - **Satellite-based data** from NASA also showed that **aerosol pollution** has a significant role in exacerbating local temperature, highlighting a complex challenge where efforts to control pollution may inadvertently worsen heat risks, further complicating air quality management.
    - This phenomenon leads to **higher concentrations of PM2.5 in cities like Delhi,** which often experience pollution spikes during November and December.
        - During the **2024 episode**, Delhi recorded a PM2.5 concentration of 104.08 micrograms per cubic metre, leading to **severe air quality crises**.
- **Poor Waste Management:** The improper disposal of waste, particularly in urban areas, contributes significantly to air pollution.
    - **Open burning of waste, including plastic**, leads to the release of harmful pollutants like dioxins, furans, and particulate matter.
    - Studies suggest that depending on the city, **2% to 24% of the municipal solid waste (MSW) generated in cities gets burned,** adding to the local air pollution.
    - This practice is responsible for a large portion of the **PM2.5 pollution** in urban centers, adding to the deteriorating air quality.
- **Climate Change Exacerbating Pollution Problem:** India's vulnerability to climate change is intricately linked with the growing air pollution levels, creating a feedback loop.
    - India's greenhouse gas emissions reached their highest global share of 7.8% **since 1970.**
        - More worryingly, the **rate of emissions growth has accelerated in recent years,** rising by **nearly 1% point between 2020 and 2023 alone.**
    - **Increased temperatures due to climate change** can intensify the formation of ground-level ozone and increase the frequency and severity of **heatwaves.**This, in turn, worsens air quality and increases the health burden.



What are the Key Shortcomings Limiting the Effectiveness of India's Air Pollution Control Initiatives?

- **Lack of Stringent Enforcement of Environmental Regulations:** Although India has regulations in place to curb emissions, the lack of stringent enforcement and monitoring results in ineffective air quality control.
    - Many industries, particularly in **small-scale sectors, do not comply with pollution control guidelines.**
    - The **Central Pollution Control Board's (CPCB) guidelines** for fugitive dust from stone crushers and brick kilns **are often ignored,** leading to high particulate matter levels in cities like **Greater Mumbai**.
- **Inadequate Monitoring Coverage**: Out of 130 NCAP cities, **28 still lack continuous ambient air quality monitoring stations.**
    - In cities with monitoring infrastructure, interruptions and incomplete data coverage reduce the ability to fully assess air pollution trends and enforce regulations effectively.
- **Lack of Focus on PM2.5 and Missed PM10 Targets:** Although India's air quality management efforts have gained momentum, there is an ongoing **focus on PM10 particles**, which are less

harmful than PM2.5.
    - Also, despite focus on PM10, **only about 41 of 97 monitored cities have achieved the initial NCAP goal of 20–30% PM10 reduction,** and many cities still report PM10 levels exceeding National Ambient Air Quality Standards (NAAQS).
- **Insufficient Focus on Informal and Small-Scale Industries:** The bulk of air pollution in India is not solely from large industries but also from small-scale, informal sectors like **brick kilns**, **rice mills**, and **stone crushers**.
    - These industries often use outdated technologies and lack basic pollution control mechanisms.
    - About **10-15% of total emissions from the industrial sectors are emitted through the MSME's operations,** but the focus of national initiatives like NCAP remains on larger sources.
        - Without addressing the informal sector and incentivizing small industries to adopt cleaner technologies, such as **zigzag technology** for brick kilns or **biomass gasifiers** for rice mills, pollution levels will remain high.
- **Underutilization of Technology in Pollution Monitoring and Management:** While India has made strides in **monitoring air pollution**, the use of advanced technologies, such as **low-cost sensors** and **satellite data**, remains underdeveloped.
    - Despite the **Indian Institute of Technology Kanpur (IIT-K)** developing low-cost sensors for pollution monitoring, these innovations are not widely adopted in policymaking.
    - The **National Clean Air Programme** lacks the integration of real-time monitoring systems, which would enable more **data-driven interventions**.
        - Furthermore, the **underutilization of satellite-based remote sensing** to track vehicle emissions and industrial pollution in real-time limits the ability to target pollution sources effectively.
- **Over-Reliance on Short-Term Solutions:** India's initiatives often focus on **short-term solutions** that do not address the long-term structural causes of air pollution.
    - For example, the use of **mechanized street sweepers** and **aerosol seeding** to reduce dust in cities like **Delhi** has proven ineffective in the long run.
    - While these interventions offer temporary improvements, they fail to address **root causes** such as **vehicular emissions**, **biomass burning** and **industrial pollution**.

What are the Key Implications of Rising Air Pollution in India?

- **Air Pollution as a Public Health Crisis:** Rising air pollution in India is causing a severe public health crisis, leading to increased incidences of respiratory and cardiovascular diseases.
    - **Fine particulate matter (PM2.5)** is particularly harmful, causing illnesses such as asthma, stroke, and heart disease.
    - Air pollution took the **lives of 2.1 million in India in 2021,** including over 1.6 million children under 5.
- **Economic Loss and Productivity Decline:** The economic cost of air pollution is staggering, impacting productivity, healthcare costs, and overall economic growth.
    - Air pollution leads to reduced **labor productivity**, directly affecting the workforce.
    - In 2019, air pollution was estimated to cause a loss of **$36.8 billion**, which accounts for **1.36% of India's GDP**.
        - A study suggests that **if India had achieved safe air quality levels, its GDP would have increased by $95 billion in 2019,** illustrating the significant economic opportunity lost due to poor air quality.
- **Declining Urban Air Quality and Liveability:** Rising air pollution makes urban living increasingly difficult, particularly in megacities like **Delhi**, **Kolkata**, and **Mumbai**. Air pollution decreases **quality of life** by reducing visibility, causing smog, and limiting outdoor activities.
    - In **M.C. Mehta vs. Union of India**, the Supreme Court treated the **right to live in a pollution free environment** as a part of fundamental right to life under Article 21 of the Constitution.
    - Such hazardous levels directly **affect the mental and physical well-being of urban dwellers,** causing stress, reducing the appeal of city living, and leading to migration from affected areas.
- **Disproportionate Impact on Vulnerable Populations:** The rising levels of air pollution in India disproportionately affect **vulnerable populations**, including children, the elderly, and low-income

groups.
    - Studies show that **women and children** are particularly vulnerable to indoor pollution caused by **biomass burning**.
    - Exposure to indoor air pollution increases the risk of **acute respiratory infections (ARIs)** in children under five years of age
- **Threat to Ecosystems and Biodiversity:** Rising air pollution is also contributing to significant environmental degradation, affecting ecosystems and biodiversity.
    - Pollutants like **sulfur dioxide (SO_2)** and **nitrogen oxides (NO_x)** lead to **acid rain**, which damages forests, aquatic ecosystems, and crops.
    - Acid rain leaches essential nutrients like **calcium and magnesium from soils, weakening plant defenses** and making them more susceptible to environmental stressors such as drought, disease, and pests.

What are the Technology-Based Innovations to Curb Air Pollution in India?

- **WAYU Air Purification Units at Traffic Intersections:** These localized air purifiers help mitigate the effects of vehicular emissions, significantly improving air quality in high-traffic areas.
- **Ionisation Technology for Pollution Reduction: Ionization technology** was tested to neutralize pollutants in the air through ionization processes. The technology holds potential for further reducing ambient air pollution in targeted regions.
- **Medium/Large-Scale Smog Towers: Smog towers**, large-scale air purifiers, were deployed to reduce particulate matter and pollutants over a broader area, improving air quality in densely polluted urban zones.
- **Retrofitting Emission Control Devices in Old Vehicles:** A project was launched to **retrofit older vehicles (BS III standard) with emission control devices**, aiming to reduce the pollution from vehicles adhering to outdated emission standards.
- **Indigenous Photonic System for Air Quality Monitoring:** The **Department of Science and Technology (DST)** developed an indigenous **photonic system** for real-time, remote air quality monitoring, enhancing the accuracy of pollution data and supporting better decision-making.
- **Advancements in Electric Vehicle (EV) Autonomous Technology:** The **DST National Mission** on **Interdisciplinary Cyber Physical Systems (NM-ICPS)** supported the integration of **autonomous navigation technology in EVs**, aiming to reduce traffic congestion and lower **greenhouse gas emissions** through optimized driving patterns.

What Measures can India Adopt to Effectively Address the Issue of Air Pollution?

- **Expanding Low-Cost, Real-Time Air Quality Monitoring Technologies:** India should prioritize the widespread adoption of **low-cost, real-time air quality sensors** in urban and rural areas, including industrial zones and transportation corridors.
    - These sensors, paired with **satellite data** and **advanced analytics**, can help identify pollution hotspots and provide continuous monitoring to inform local policies.
    - Real-time data can be used to trigger immediate interventions, such as **traffic regulation** or **industrial shutdowns**, when pollution levels reach hazardous thresholds.
        - Implementing dynamic **Air Quality-Based Tolling** based on real-time air quality data to discourage driving on high-pollution days in critical zones.
- **Transitioning to a Circular Economy for Waste Management:** To address the massive contribution of waste burning to air pollution, India should adopt a **circular economy model** that focuses on reducing waste generation, improving recycling, and reducing the reliance on open burning.
    - Encouraging **waste segregation** at the household level, alongside building efficient **waste-to-energy** plants, can drastically reduce the burning of plastic, wood, and other harmful materials.
    - **Municipalities should incentivize composting and recycling initiatives (e.g, Indore Model)** through subsidies, and stricter penalties should be imposed on

unauthorized waste burning to ensure compliance.

- **Integrating Urban and Regional Air Quality Action Plans:** India should adopt an **airshed-based management approach**, where air quality policies are developed at the **regional level** rather than merely at the city level.
    - This would involve designing **regional air quality action plans** that account for cross-jurisdictional pollution sources such as **agricultural residue burning**, industrial emissions, and transboundary pollution.
    - Researching and implementing biological air purification systems, **such as large-scale bio-filters and "living walls"** or vertical gardens in urban areas, which can naturally absorb pollutants.
    - Recent emphasis on **Performance-based funding, where cities are incentivized to achieve targets like a 15% annual pollution reduction,** is a noteworthy initiative by the Indian government.
        - This approach should be scaled up and enforced more rigorously.
- **Accelerating the Adoption of Clean Transport Infrastructure:** India must fast-track the transition to **electric vehicles (EVs)** by strengthening the **EV charging infrastructure**, offering attractive **subsidies**, and introducing **tax incentives** for EV manufacturers and consumers.
    - Alongside this, promoting **public transport** systems powered by **electricity** or **alternative fuels** will reduce pollution from the transportation sector, which is a major contributor to air quality deterioration.
    - Integrating **non-motorized transport infrastructure** (e.g., **dedicated bicycle lanes** and **pedestrian-friendly streets**) will also reduce dependence on private vehicles, helping to further cut down emissions.
- **Enforcing Stringent Industrial Retrofit and Modernization Policies:** India must implement stringent policies to ensure industries adopt **cleaner technologies** and **energy-efficient processes**.
    - Mandatory **retrofitting** of old industrial units with advanced pollution control devices like **electrostatic precipitators (ESPs)**, **fabric filters**, and **wet scrubbers** can significantly cut emissions.
    - Additionally, offering **financial incentives** such as low-interest loans or tax breaks for industries to switch to **sustainable fuel sources** and **energy-efficient systems** will motivate private sector participation.
- **Phasing Out Subsidies for Fossil Fuels:** To drive a long-term reduction in air pollution, India must phase out **subsidies for fossil fuels** and reallocate funds toward supporting **renewable energy technologies** like **solar, wind**, and **bioenergy**.
    - Policies should encourage the adoption of **distributed solar generation** at the household and industrial levels, along with promoting **energy storage systems** to reduce dependency on coal-based power plants.
    - A robust **carbon pricing mechanism**, along with **taxation on carbon-intensive industries**, can shift the economic landscape towards clean energy, making it more competitive and appealing to investors.
- **Expanding and Upgrading Green Urban Spaces:** India should invest in creating and upgrading **green spaces** within urban areas to act as natural **carbon sinks** and reduce ambient pollution levels.
    - Expanding **urban forests**, **green roofs**, and **vertical gardens** can help absorb **PM2.5 particles** and other pollutants.
    - Government policies should focus on incorporating **green planning** into city designs and incentivizing **private sector participation** in developing public parks and green belts.
- **Strict Regulation of Crop Residue Burning with Technological Support:** To curb the widespread practice of **crop residue burning**, India should provide **targeted subsidies** for **modern farming equipment** like **stubble management machines** (e.g., **Happy Seeder)** and **biomass gasifiers** that help farmers efficiently manage crop residue without burning.
    - At the same time, **enabling rural communities, especially women's self-help groups, to produce biochar from agricultural waste** can promote cleaner fuel alternatives and enhance soil health by sequestering carbon.
- **Strengthening Public Awareness and Community Engagement Initiatives:** Effective pollution control requires **active public participation** and a culture of environmental responsibility.

- India should expand **public awareness campaigns** focused on the **health risks of air pollution** and the **role individuals play** in reducing emissions, especially in the **residential sector**.
- Community-driven initiatives to promote **clean cooking fuels**, **green transport alternatives**, and **waste reduction** can be incentivized through rewards or recognition programs.

Conclusion:

To address India's air pollution crisis, the country must adopt a comprehensive approach that **integrates cleaner technologies, stricter enforcement, and public awareness, aligning with the SDGs of Good Health and Well-being (SDG 3), Sustainable Cities and Communities (SDG 11), and Climate Action (SDG 13).** The balance between **3Ps—Profit, Planet, and People—must** guide India's air quality management strategies to ensure economic growth, environmental sustainability, and improved public health for all.

Drishti Mains Question:

Discuss the major causes of air pollution in India and evaluate the effectiveness of the National Clean Air Programme (NCAP). Suggest additional measures to improve air quality management.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. In the cities of our country, which among the following atmospheric gases are normally considered in calculating the value of the Air Quality Index? (2016)

1. Carbon dioxide
2. Carbon monoxide
3. Nitrogen dioxide
4. Sulfur dioxide
5. Methane

Select the correct answer using the code given below:

(a) 1, 2 and 3 only

(b) 2, 3 and 4 only

(c) 1, 4 and 5 only

(d) 1, 2, 3, 4 and 5

Ans: (b)

Mains

Q. Describe the key points of the revised Global Air Quality Guidelines (AQGs) recently released by the World Health Organisation (WHO). How are these different from its last update in 2005? What changes in India's National Clean Air Programme are required to achieve revised standards? **(2021)**