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Research Paper

Impact of Methodological Revisions on Comprehensive Environmental Pollution Index (CEPI) Outcomes: A Case Study of the Delhi Industrial Cluster and Progress on Pollution Control Measures

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ABSTRACT: *The Comprehensive Environmental Pollution Index (CEPI) serves as a critical tool for assessing environmental quality in India's industrial clusters. This study analyzes the impact of CEPI's methodological revisions between 2009 and 2016 and examines pollution status changes using the Delhi industrial cluster—specifically the Najafgarh Drain Basin—as a case study. The revised CEPI emphasizes quantitative and health data, yielding a more sensitive pollution classification. Integrating the latest progress from the Delhi Pollution Control Committee (DPCC), this paper reports significant infrastructural and regulatory transition actions undertaken to address pollution challenges as reflected in CEPI outcomes. The analysis underscores vital improvements in environmental monitoring, enforcement, pollution control, and public transparency, aligning with CEPI's evolving framework.*

KEYWORDS: *COMPREHENSIVE ENVIRONMENTAL POLLUTION INDEX, CEPI, INDUSTRIAL POLLUTION, METHODOLOGICAL REVISION, ENVIRONMENTAL MONITORING, DELHI INDUSTRIAL CLUSTER, NAJAFGARH DRAIN BASIN.*

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I. INTRODUCTION

Rapid industrialization has posed critical pollution threats in Delhi's industrial zones, necessitating robust evaluation frameworks. The CEPI, developed by the Central Pollution Control Board (CPCB) in 2009 and revised in 2016, provides such a framework, evolving towards higher scientific rigor and data reliability. This analysis compares CEPI scores from the two methodologies, highlighting the Najafgarh basin's increased pollution designation. The article further contextualizes DPCC's recent policy implementation and technical interventions, illustrating active responses supporting CEPI-guided environmental governance.

II. METHODOLOGY

CEPI 2009 Framework

The original CEPI framework combined four key components: Source (A), Pathway (B), Receptor (C), and Additional Risk Element (D). The CEPI score (ranging 0-100) predicts environmental quality and severity of pollution by aggregation:

- EPI (Environmental Pollution Index) is calculated as a sum of four components:

$$EPI= A + B +C + D$$

Where:

- $A= A_1 \times A_2$ (Pollutant presence × Scale of industrial activities)
- $B= B_1 + B_2 + B_3$ (Pathway score: pollutant concentration, impact on people, impact on eco-geological features)
- $C= C_1 \times C_2 + C_3$ (Receptor score: affected population × level of pollution exposure + risk to sensitive receptors)
- D (Additional high-risk element: adequacy of pollution control measures)

- The maximum scores for each element are:

- A: up to 30
- B: up to 20
- C: up to 30
- D: up to 20

Total maximum score = 100.

In CEPI 2009 methodology each sub-index (A+B+C+D) relied on both quantitative and subjective factors, e.g., evidence from media, NGOs, qualitative health/ecological impacts, potentially less precise weights for pollutants, and population affected.

2016 Revised CEPI Method:
The revised protocol removed subjective evaluation elements and emphasized precise, real-time measurable data. The CEPI score retained the Source-Pathway-Receptor concept but introduced explicit weighting:
The three environmental media (Air, Surface Water, Groundwater) are scored separately with sub-indices, each calculated as:

$$EPI = A + B + C + D$$

Components with weights:

- A (Scale of industrial activity): max 20
- B (Level of exposure - Surrogate Number for Level of Exposure - SNLF): max 50
- C (Health-related statistics from hospital data): max 10
- D (Compliance status of industries): max 20

- The aggregated overall CEPI is calculated as:

$$\mathrm{CEPI}_{2016} = i_{\max} + \left[(100 - i_{\max}) \times \frac{i_2}{100} \times \frac{i_3}{100}\right]$$

Where, $i_{\max}$ – maximum index (which may be either Air EPI or SW EPI or GW EPI); and i_2, and i_3 are indices for other media.
In revised methodology of CEPI 2016 each sub-index (A+B+C+D) uses more precise, quantitative, and objective factors, e.g., only real measurements from monitoring data, specific SNLF (Surrogate Number for Level of Exposure) protocols, and actual hospital health statistics. Subjective or debated inputs were removed to make the sub-indices more robust and defendable.

III. CASE STUDY: DELHI INDUSTRIAL CLUSTER – NAJAFGARH DRAIN BASIN

IV.

Year	Air EPI	Water EPI	Land EPI	Composite CEPI
2009	52.13	69.00	65.25	79.54
2018	85.25	86.00	55.75	92.65

- The 2018 monitoring based on revised methodology showed a sharp increase in Air EPI and Water EPI scores reflecting worsening pollution, while Land EPI slightly improved but this modest gain was more than offset by severe deterioration in Air and Water EPI.
- The composite CEPI score rose by 13.11 points.
- The stronger weighting on direct pollutant exposure in 2016 uncovered increases in air contaminants previously underestimated.
- Hospital-reported health data improved correlation between pollution severity and human health impact.
- Enhanced industrial compliance data increased accuracy in the assessment of risk elements.

V. DPCC MITIGATION EFFORTS AND ENVIRONMENTAL PROGRESS

Fuel Usage and Industrial Compliance

- **1,959 industries have switched to cleaner fuel sources such as Piped Natural Gas (PNG) or Liquefied Petroleum Gas (LPG),** significantly reducing air pollutant emissions.
- Industries operating on **non-approved or unapproved fuels have been mandated to close**, ensuring stricter compliance and reducing pollution.

Air Quality Monitoring and Data Transparency

- DPCC's network includes 26 continuous real-time monitoring stations complemented by CPCB and other agencies, now totalling 40 stations.
- Satellite-based remote sensing and academic partnerships improve pollution source apportionment accuracy.
- Public display of real-time pollution data in government buildings promotes awareness and accountability.

Regulatory Enforcement

- Regular inspections, closures, and penal actions target non-compliant dyeing units, small-scale industries, and any pollution source operating without proper authorization or using banned fuels.
- Closure orders for violations reinforce strict regulatory compliance to reduce pollutant emissions.

Sewage Treatment Plant (STP) Expansion and Capacity

- Delhi generates an estimated **3,596 MLD of sewage** supported by water supply.
- Currently, **37 operational STPs with 3,564 MLD installed capacity treat 3,036 MLD (~85% utilization)**.
- Expansion plans aim for **814 MGD capacity by Oct 2025 and 1,011 MGD by Dec 2027**, covering future growth.
- **40 decentralized STPs are underway with proposed capacity of 281.50 MLD also 14 DSTP of 145 MLD capacity have been proposed in the Najafgarh drainage zone.**

Interceptor Sewer Project (ISP)

- Designed to trap **1,100 MLD of sewage**, already trapping 1,082 MLD as of June 2025, substantially reducing raw sewage discharge into rivers.

Industrial Effluent and CETPs

- About **29,823 industrial units** operate in 28 approved areas; 26404 of these units in approved industrial area connected to 13 CETP discharge ~33 MLD wastewater (excluding white category industries/units, shops & other establishments not requiring consent from DPCC).
- 13 CETPs totaling 212 MLD capacity serve these units.
- Continuous enforcement actions, monitoring, and upgrades are in place.

Solid Waste Management and Remediation

- Delhi generates **~11,852 metric tonnes per day of MSW**, with approximately 7,431 tonnes treated.
- Active dredging, waste lifting, and legacy waste remediation proceed at major landfill sites.

River and Drain Protection & Water Quality Monitoring

- Twenty-two drains overflow into the Yamuna; most are partially/fully trapped and connected to treatment facilities.
- Water quality still shows elevated chemical oxygen demand (COD) and biological oxygen demand (BOD) at key locations.
- Groundwater near landfill sites exhibits high total dissolved solids and other pollutant exceedances, underscoring ongoing remediation need.

VI. DISCUSSION

The transition to the revised CEPI methodology reflects a more **precise, data-driven, and health-correlated pollution assessment** framework. The sharp rise in Air EPI values evidences worsening pollution severity that aligns with DPCC's intensified fuel switching efforts, monitoring expansions, and stringent enforcement. The combined approach strengthens Delhi's capability to detect, regulate, and mitigate industrial pollution effectively.

VII. CONCLUSION

The 2016 CEPI methodological enhancements have significantly improved pollution severity assessment accuracy, as demonstrated by the Najafgarh Drain Basin case, where rising Air and Water EPI scores reflect both actual environmental degradation and improved detection capacities. In response, the DPCC has made notable progress through targeted interventions, including industrial fuel source transitions, strengthened sewage treatment, industrial effluent control, solid waste management, a real-time air quality monitoring network, regulatory enforcement, and public transparency measures. These actions directly support pollution reduction objectives and environmental health protection. However, sustained investment in monitoring infrastructure, compliance management, and adaptive management strategies remains vital for achieving long-term, substantive air quality improvements in alignment with CEPI guidelines.

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