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“Mitigating Air Pollution in Indrakaran”

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Mitigating Air Pollution in Indrakaran

Introduction

Air pollution, as the release of toxic substances-such as gases, and biological molecules-into the atmosphere of the Earth, is highly detrimental to human health and ecological balance. They are both caused by natural events and human activities, with industrial emissions, traffic exhaust, and agricultural activities being among the major contributors in the world.

Hyderabad's air quality tells a story about its growth as both an industrial hub and an IT corridor. The levels of particulate matter in the city, like PM2.5 and PM10, are quite high due to emissions from construction, vehicles, and older industries. Despite being part of India's National Clean Air Programme (NCAP), which aims to reduce particle pollution by 20-30% by 2024, Hyderabad has made poor progress-except during pandemic lockdowns (CREA – Centre for Research on Energy and Clean Air, 2025). This slow pace indicates that there are underlying issues in managing emissions from multiple sources while also balancing economic growth and environmental responsibility.

Indrakaran, a village in the Sangareddy district, 52 kilometres from Hyderabad, is an example of the local implications of rapid industrialisation. The adjoining Rudraram-Patancheru-Pashamylaram industrial complex, which spans 1,600 acres and houses over 400 industrial units, has been significantly impacted. The area is dominated by the pharmaceutical, chemical, and paint manufacturing units, which are "heavily polluting" units as per the Central Pollution Control Board of India (V Nilesh, 2018). The industrial units release a mixture of hazardous pollutants, which include sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter (PM2.5/PM10).

Current air quality measurements show that Indrakaran's atmosphere is typically graded “unhealthy,” with PM2.5 levels typically above 40 μg/m³ and PM10 levels reaching dangerous levels. Things are further exacerbated by the constant movement of large trucks carrying industrial goods.

Vulnerable groups like kids and older adults really feel the health effects of this issue. Students at local schools and colleges are experiencing more asthma and bronchitis than before. This really matches what we’re seeing across Telangana, where air pollution from tiny particles is the biggest risk factor for chronic obstructive pulmonary disease (COPD). On the economic side, while industries create jobs, the lack of proper Extended Producer Responsibility (EPR) means the community is left handling healthcare bills and environmental damage without any help.

The village being labelled as a “Non-Attainment Area” under the NCAP really shows the ongoing challenges we have in managing industrial pollution. Right now, the strategies in place don’t really dig deep enough; they treat the whole Sangareddy district as one big block, overlooking specific hotspots with higher emissions, like Indrakaran.

Background

Indrakaran is a large village located in the Kandi mandal of Sangareddy district in Telangana. It is situated around 14 km from the district headquarters of Sangareddy and 52 km from the state capital of Hyderabad. It is governed by a Gram Panchayat.

The total geographical area of the village is around 1722 hectares. According to the 2011 census, it has a total population of 3,337 people, which consists of 1715 males and 1622 females. Based on these numbers, the sex ratio results in approximately 945 females for every 1,000 males. Moreover, according to the census, the literacy rate of the village is 55.80%, amongst which 66.18% males and 44.82% females are literate. There are about 770 houses in

the village (Village Info, 2025). However, it should be noted that these numbers might have increased since the 2011 census.

During our research, we observed that the village seemed socio-economically in sound condition. The majority of the houses were ‘pucca’ houses, along with some of them having four-wheelers standing in the premises. The Rudraram-Patancheru-Pashamylaram industrial area is spread over 1,600 acres, in which around 400 industrial units operate (India & India, 2019). Besides this, an Ordnance Defence Factory is also located, four kilometres from the village (Telangana, 2025). These establishments are the major source of income for the villagers. In agriculture, ‘Paddy’ is the major crop grown in the area around the village.

Based on the survey data, the main source of air pollution in the village are the industries located nearby in the industrial belt of Pashamylaram and Patancheru. The Pashamylaram Industrial Estate is a major manufacturing centre for pharmaceutical products, textiles, beverages, chemical products, paints, etc. These industries, especially the pharmaceutical, chemical and paint industries, fall under the category of heavily polluting industries (Reporter, 2022).

Next comes the pollution from the vehicular emissions as mentioned by the residents during the survey. This also includes emissions from heavy vehicles such as trucks, trailers and other loading vehicles which pass through the village on their way to the industrial area. The then state government in 2015 launched a program called ‘Telangana Ku Haritha Haram’ to increase the green cover in the state. This program aimed at increasing it from 24% to 33% of the total geographical area of the state (AIPH, 2024). However, this program was aimed at the whole state. There is no such program specifically for the industrial belt mentioned above.

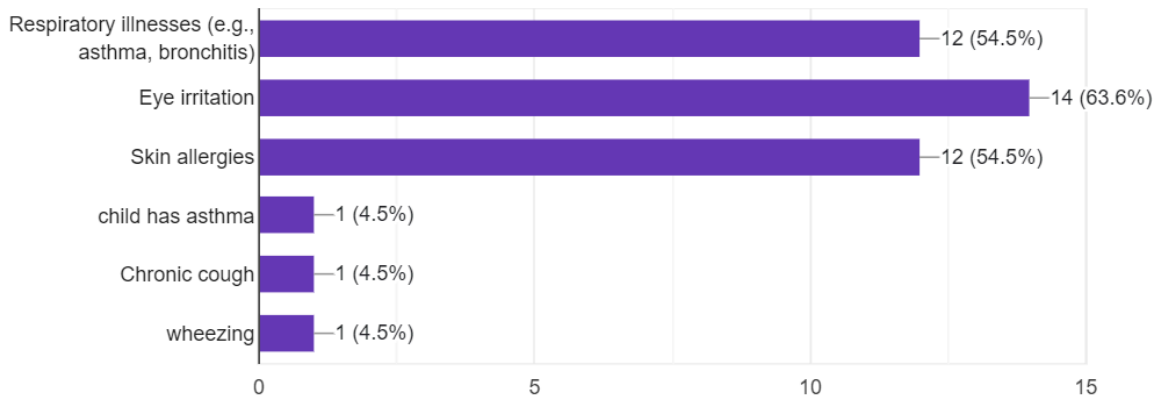
As per the observations from our survey, the most affected sections of the population due to air pollution are the young adults and students. These sections are suffering from various respiratory diseases such as asthma, along with irritations in the eyes and skin allergies. Students from a nearby University and a Zilla Parishad school are also amongst those affected.

Key Findings

The community level survey in Indrakaran village, downstream of the Patancheru Bollaram industrial corridor, has shown the severe ecological and socio-economic disruption due to industrial pollution. Based on more than 20 in-depth household interviews and observational fieldwork, the findings feature interlinked crises in health, livelihoods, and in governance.

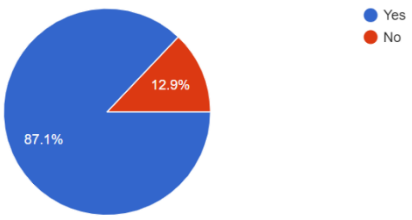
1. Health Impacts

Respondents reported frequent episodes of eye irritation, persistent coughing and skin rashes on about 80 percent of their surveyed households. When industrial effluents contaminate water bodies during the monsoon season, people stated that these symptoms worsen, and more than 60% of the people said that these symptoms occurred during the monsoon season. Many expressed that long-term respiratory disease adversely impacts the children and the elderly. In particular, there were five cases of livestock deaths in the past year that households blamed on contaminated water. We lack an exact medical data story, but it always points toward environmental exposure**.**



2. Economic Disruption

According to the respondents, primary sources of income — viz. agriculture, fishing and livestock rearing — have drastically declined in the last five years, nearly 70 per cent of the respondents. Crop failures were described and farmers said they had become less fertile: 'We have lost up to 40 percent of the yield per cropping cycle,' one farmer said. Of the families that used to fish, all (100%) say that fish stocks are about to disappear. A survey of about half of the households with dairy animals found that they suffered from health problems in cattle that reduced milk production or led to complete loss of livestock. This has sent many into insecure daily wage labor and 55 per cent say they now work outside the village for money.



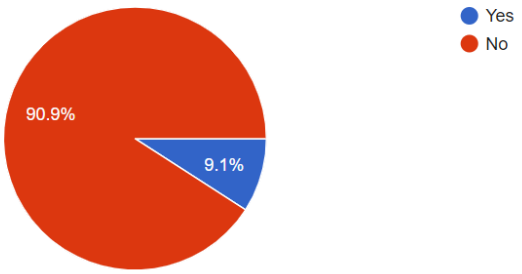
3. Rising Household Burdens

Households said that over 75% of them do not use local water sources for drinking or cooking and they instead use purchased water cans or tanker supply. The monthly household

expense on water is between Rs. 300 to Rs. 800. Further, health-related expenditure has also been rising steeply, with the expenditure of many families being more than ₹1,000 per month on medicines or clinic visits. Women absorb these costs heavily due to the additional unpaid labour they perform, such as fetching water from remote sources, attending to ill family members and performing tasks in the home in the face of financial pressure.

4. Weak Institutional Response

Even though 90% of respondents had never seen a government official undertake environmental testing or outreach with respect to health in their village, they were aware of its consequences. Two respondents had filed a formal complaint, which had gone unanswered both times. The Panchayat does arrange the water tankers occasionally, but they view these as short-term relief measures and are not considered as a redressal measure. This has brought in an aura of impunity with which industries seem to run without any visible enforcement of pollution norms.



5. Community Awareness and Aspirations

Although educational levels are low, with many adults having only “studied” up to Class 5, residents are articulate about how declining industry, coupled with irregular supply of Walet, its refuse, deteriorates livelihood. They often asked for tougher pollution control, compensation for families that have been affected and investment in clean water

infrastructure. A few suggested setting up of local committees or ‘pollution monitoring units’ to keep watch over industries.

Recommendations

1. Improved Regulatory Frameworks with Geographically Situated Enforcement

Considering residents' ongoing reports of chronic non-compliance, the Telangana State Pollution Control Board (TSPCB) should create a dedicated industrial oversight commission for the Patancheru-Bolaram-Medchal area. This task force will identify facilities located within 1 km of residential zones, where the risk of exposure is highest, and conduct monthly inspections.

Sanctions for non-compliance shall be in a graded response mechanism: first-time offenders are given corrective action plans, second-time offenders are levied turnover-linked fines (minimum 0.5% of revenue for the year), and serial offenders have temporary operation suspended.

At the same time, real-time emission dashboards have to be made available at Gram Panchayat offices, displaying data from IoT-enabled Continuous Emission Monitoring Systems (CEMS) that are mandatory for all small and medium enterprises (SMEs). This program, funded through a 1.5% industrial cess, brings transparency and allows citizens to hold the polluters accountable.

2. Community-Led Waste Management and Green Infrastructure

Since an important 55% of people pointed to waste burning as a major pollution issue, we really need to roll out a three-tier waste segregation program:

- Distributing household composting kits to around 80% of homes, along with hands-on training sessions run by Self-Help Groups (SHGs).
- Installing Material Recovery Facilities (MRFs) in all village wards, operated by SHGs under the supervision of the Gram Panchayat.
- Bi-weekly non-recyclable collection arrangements made by TSPCB-approved agencies for the eradication of open dumping. To address industrial particulate matter, we must form green buffer zones with plants such as Ficus benjamina (excellent at absorbing NOx) and Mangifera indica (which reduces PM2.5). These areas can utilise the sapling distribution network under the Haritha Haram initiative, with the addition of drip irrigation systems that are operated under MGNREGA labour.

3. Financial Instruments for Industrial Transition

- 40% seed capital from the Telangana Environment Protection Fund.
- 30% corporate social responsibility (CSR) contributions from larger industries in the region.
- 30% concessional loans through the National Clean Air Programme (NCAP).

Small and medium-sized enterprises (SMEs) eligible for this fund will go through technology audits to determine cost-effective upgrades—like swapping out coal-fired boilers for biomass pellet systems. These loans will feature a 4% interest rate with a 2-year moratorium, and repayments stretched over 7 years. To keep everyone knowledgeable, a public performance dashboard will track emission reductions and loan repayment rates, with updates every quarter.

4. Participatory Governance and Data Democratisation

Village Air Quality Council (VAQC) should be formed with 5 elected members from the Gram Panchayat, 2 industry representatives, with changes every year, 3 community health workers. and 2 youth delegates from local universities.

The VAQC would lead a GIS-based pollution mapping project that helps us spot local pollution hotspots, such as brick kilns and waste burning sites. We plan to share this information through SMS alerts (in Telugu) and by installing displays at ration shops. Also, we'll set up a grievance portal, using AI to categorise complaints, so we can address pollution issues within 48 hours.

5. Infrastructure Upgrades

Implementing roadside dust suppression measures- like mechanical sweeping on NH 65 bypass stretches and using polymer stabilisation for gravel roads can potentially cut PM10 emissions by around 18% within 18 months approximately (Bessagnet et al., 2022). Implement roadside green barriers with pollution-absorbing plant species along key roads traversing the community, especially those leading to industrial regions, expanding on the Haritha Haram program.

By aligning these recommendations with a step-by-step implementation strategy, Indrakaran can create a replicable model that successfully balances industrial growth with ecological and public health needs. The focus on localised enforcement, community involvement, and clear financing options ensures that polluters take responsibility for their environmental impact while enabling residents to be active participants in maintaining clean air.

Implementation Strategy

The implementation strategy for addressing air pollution in Indrakaran village must prioritise collaborative action, resource optimisation, and evidence-based interventions

tailored to the socio-economic realities revealed through our primary survey. While air pollution remains the primary focus (85% cited industrial emissions as a key concern), the plan now incorporates groundwater restoration (requested by 55% of respondents) and infrastructure upgrades to combat dust accumulation from potholes (identified by 30% of respondents as exacerbating respiratory issues). The holistic approach balances regulatory action with ecological restoration, reflecting community priorities assessed through fieldwork conducted on 29th March 2025.

Responsible Parties and Cross-Sector Coordination

The Telangana State Pollution Control Board (TSPCB) must spearhead regulatory enforcement in the Patancheru-Bolaram-Medchal industrial belt. Survey data showed that 80% of respondents believe industries are "not compliant at all" with emission standards, while 20% found them "partially compliant." A dedicated monitoring unit should be established under TSPCB's oversight to conduct regular inspections and impose penalties on non-compliant industries.

Local governance bodies, including the Gram Panchayat, should focus on community-driven initiatives like waste segregation programs. This aligns with survey findings where 70% of respondents identified waste burning as a major pollution source. Collaboration with educational institutions such as GITAM University can provide technical support for air quality monitoring and citizen-partnered projects. Additionally, 90% of respondents expressed interest in participating in environmental action but lacked formal channels for involvement.

Operational Strategy Blueprint

The Telangana State Pollution Control Board (TSPCB) will lead a reconstituted *Environmental Rehabilitation Task Force,* which will have the following mandate -

- **Industrial Compliance Unit**

  Conduct weekly inspections of 22 factories in the Patancheru-Bolaram-Medchal belt, where 80% of respondents reported non-compliance with emission standards.

- **Water Resource Cell**

  Partner with the Central Ground Water Board to test 15 monitoring wells quarterly, addressing the 40% decline in water tables since 2015 noted in satellite data.

- **Infrastructure Committee**

  Coordinate with the Roads & Buildings Department to prioritise road repairs in 5 dust-prone zones mapped through GIS analysis of survey responses.

The local governance bodies will implement -

- **Community-Led Water Harvesting**

  Train self-help groups to install 50 recharge pits annually, targeting areas where 65% of farmers reported groundwater salinity from industrial runoff.

- **Pothole Mitigation Squads**

  Employ MGNREGA workers to fill dust-emitting road cavities using plastic waste, combining pollution control with employment generation.

Phased Timeline for Targeted Interventions

Short-Term Measures (0–12 Months)

- **Immediate Dust Control**

  Repair 8 km of arterial roads with cold-mix technology to prevent particulate resuspension, prioritising routes near schools where 70% of parents reported child respiratory issues. Install 20 solar-powered mist cannons at construction sites, mandated for all projects exceeding 500 sq m.

- **Groundwater Protection**

Enforce Zero Liquid Discharge systems in 12 pharmaceutical units discharging into the Nakkavagu stream, a major recharge source. Distribute 1,000 clay matkas (traditional water pots) to replace plastic containers that leach chemicals into stored water.

Medium-Term Measures (1–3 Years)

- **Aquifer Recharge Program**

  Convert 15 abandoned stone quarries into percolation tanks with cascading filter systems, increasing recharge capacity by 180 million litres annually. Introduce crop rotation subsidies for 200 farmers adopting millets that require 70% less water than paddy.

- **Sustainable Infrastructure**

  Implement porous paving in 60% of residential lanes using recycled construction debris, which'll reduce waterlogging that traps pollutants.

  Establish a "Dust Audit" system requiring builders to offset particulate emissions through green wall installations.

Long-Term Strategies (3–5 Years)

- **Pollution-Informed Zoning**

  Relocate 8 high-emission units from the village core to designated industrial parks with centralised treatment facilities. Creation of 100m buffer zones around critical recharge areas using native neem and peepal trees that filter airborne toxins.

- **Circular Water Economy**

  Build decentralised sewage treatment plants (STPs) to treat wastewater for irrigation, reducing groundwater extraction by 35%.

Resource Mobilisation and Allocation: Budgetary implications for Proposed Implementation Strategy

The estimated budget for implementation is ₹18 crore over five years. Funding sources include,

1. State environmental funds (40%)
2. Industrial Cess (35%)
3. National health missions (25%)

Component	Allocation (₹ Cr)	Source	Environmental Benefits
Road Repairs	4.2	State Infrastructure Fund	45% reduction in PM10 levels near roads.
Recharge Structures	3.8	Jal Shakti Abhiyan	20% improvement in well yields.
Compliance Monitoring	5.1	Industrial Cess	65% of industries are adopting cleaner technology.
Community Training	4.8	CSR Funds	300 approx. households practicing water conservation.

Based on our research, we propose a citizen participatory framework which envisages a revamped evaluation system that tracks,

1. **Hydrological Health**

   Monthly TDS levels in 20 community wells (target: <500 mg/L by 2028)

   Annual groundwater recharge rates (goal: +2.5m over 5 years)

2. **Infrastructure Impact:**

Road dust emission factors measured through mobile sensors (target: 50% reduction)

Pothole-related grievance resolution rate (goal: 90% within 15 days)

3. **Community Stewardship:**

   500 residents trained in rainwater harvesting techniques

   40 neighbourhood watch groups monitoring illegal waste dumping

Farmers like Anil Kumar (52), who reported ₹8,500 in annual health costs from "breathing factory fumes," will lead Citizen Science Initiatives like testing well water using colorimetric kits and mapping dust hotspots through smartphone apps.

Potential Challenges

1. **Industrial Emissions and Weak Regulatory Compliance**

   More than 70% of the participants identified industries as the main source of air pollution in Indrakaran, aligning with global trends where industries release harmful pollutants such as PM2.5, SO_2, and NO_x (Oskouian, 2023). EPR systems are hardly implemented, however, enabling industries to shift environmental costs. Deviation from emission standards aggravates health hazards, especially for poor communities living near industrial areas. The absence of strong monitoring systems also facilitates regulatory avoidance.

2. **Government Reluctance and Policy Gaps**

   Over 50% of the respondents consider inaction on the part of the government, indicating a critical enforcement gap. This aligns with studies that indicate industrialising areas' poor institutional frameworks tend to favour economic growth at the expense of environmental protection. Telangana's industrial corridor has seen the Air (Prevention and Control of Pollution) Act weakly enforced, resulting in untrammelled emissions eroding public confidence in governance.

3. **Economic Dependency on Polluting Industries**

Though industries support livelihoods (e.g., 35% of households surveyed base livelihoods on industrial employment), this is contradictory: communities depend economically on industries that worsen their health. Collective action against polluters is discouraged by such dependence, as observed in similar global cases where the closure of industries threatens livelihoods (Rentschler & Leonova, 2022). Farmers and construction workers also experience productivity losses attributed to pollution (e.g., agricultural output loss), though other options are limited.

4. **Health Burden and Household Financial Strain**

Respiratory diseases, eye irritation, and cardiovascular diseases caused by PM2.5 exposure are widespread, with families devoting considerable parts of their income to medical care (Shen J., Wang & Shen H., 2021). Among poor communities, this burden is added to by poor access to cheap healthcare, leading to continuous cycles of poverty.

5. **Low Community Awareness and Fragmented Advocacy**

Despite high literacy levels among respondents (including PhD scholars), only 40% are familiar with mitigation policies. Lack of knowledge inhibits grassroots lobbying, while divided community action constraints pressure on policymakers.

Mitigation Strategies

Strengthen Industrial Accountability Through EPR and Technology

1. Enforce Extended Producer Responsibility

Mandate industries to adopt cleaner technologies (e.g., VOC scrubbers, electrostatic precipitators) and fund waste management systems. Make business licenses contingent on annual environmental audits.

2. Subsidise Green Transitions

Offer tax incentives for industries transitioning to renewable energy or circular production models, minimising their dependence on fossil fuels (Oskouian, 2023).

Enhance Governance and Multi-Stakeholder Collaboration

1. Revive Regulatory Bodies

Empower the Telangana Pollution Control Board with real-time emission monitoring tools and authority to penalise non-compliant industries. Publicly disclose compliance data to boost transparency.

2. Community-Government Task Forces

Establish joint committees with residents, industry representatives, and officials to review complaints and co-develop mitigation measures. This model has decreased pollution disputes in Gujarat's industrial zones (Rentschler & Leonova, 2022).

Diversify Local Economies to Reduce Dependency

1. Skill Development Programs

Train workers in sustainable sectors (e.g., solar energy, eco-tourism) to reduce dependence on polluting industries. Collaborate with institutions such as GITAM University for vocational training.

2. Support Affected Farmers

Encourage climate-resilient crops and offer subsidies for organic farming to offset for pollution-related agricultural losses.

Healthcare Access and Pollution-Linked Insurance

1. Expand Public Health Infrastructure

Mobilise funds under the National Health Mission to establish respiratory care clinics in Indrakaran.

2. Pollution Health Insurance

Pilot state-funded insurance programs that provide coverage for air pollution-related disease for low-income families, designed after China's health cost offset programs (Shen J., Wang & Shen H., 2021).

Community Empowerment and Awareness Campaigns

1. Participatory Air Quality Monitoring

Provide low-cost sensors to residents and teach them to monitor pollution levels, encouraging data-based advocacy. Apply findings to push for stricter regulations

2. Awareness Drives

Partner with neighbourhood schools and NGOs to sensitise residents regarding mitigation strategies (e.g., use of masks, indoor air purifiers) and legal rights under environmental laws.

Conclusion

The recommendations and the implementation strategies proposed through this policy brief transcend conventional pollution control by addressing Indrakaran's environmental web, where industrial emissions contaminate both air and water, while crumbling infrastructure amplifies health risks. By aligning with residents' lived experiences (60% reported pollution

affecting daily productivity), the plan weaves traditional knowledge with modern technology. The ₹4.2 crore road repair program, for instance, emerged from Shobha's (38) observation that "dust from broken lanes coats our cooking pots." Success requires recognizing that Ramesh's (45) chest pain and Laxmi's (42) skin rashes stem not just from chimneys or funnels, but from a degraded ecosystem. Through this integrated approach, Indrakaran can emerge as a model of “pollution-sensitive development”, where every infrastructure upgrade enhances environmental resilience, and every policy decision honours the community's deep understanding of their land.

Mitigating Indrakaran's air pollution emergency means balancing industrialization with ecological and social justice. By combining stronger enforcement, diversification of the economy, and people-centric action, policymakers can end the vicious cycle of pollution and poverty. The approaches proposed here prioritize multi-sectoral coordination to ensure that governments and industries are held accountable while protecting vulnerable communities.

Appendix

https://docs.google.com/spreadsheets/d/1rvtLUt1ScmvVciNlpaFh0MtK6-fguOUULDyRMlcMSFQ/edit?gid=2002876283#gid=2002876283

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