Air Pollution Crisis in North India: Challenges and Solution through Technology

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Abstract

Indian cities are reeling under multiple problems, including environmental issues that they must contend with. Most pressing of them all is the issue of air pollution. The poor air quality that citizens are forced to breathe- especially in the heavily polluted cities- has a detrimental impact on their health and well-being.

In 2016, a World Health Organisation (WHO) study found that fourteen of the twenty world's most polluted cities belonged to India. Kanpur, in Uttar Pradesh, emerged as the city with the highest PM2.5 level, standing at 173 (17 times higher than the limit set for safety). It is estimated that in 2016, over 9 lakh deaths were caused due to air pollution in India. Present research paper focusses on the underlying causes of the crisis and the reasons of the failure of the efforts to tackle it with special emphasis on Delhi.

Keywords :

AQI : An air quality index is used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become.

An AQI between 0-50 is considered 'good', 51-100 'satisfactory', 101-200 'moderate', 201-300 'poor', 301-400 'very poor' and 401-500 'severe'. Above 500 falls in the 'severe-plus emergency' category.

PM2.5 : Particulate matter, that are 2.5 micrometres or less in diameter measurements.

The particle size, less than 2.5 micro-meter, is small enough to enter our lungs and blood stream, and stay there for a long time. There are more studies linking PM 2.5 to various health risks than any of the other pollutants.

Introduction

India has the world's highest rate of death from respiratory disease, according to the World Health Organisation, with 159 deaths per 100,000 people in 2012, about five times that of the UK and twice that of China.

Air quality in the Indian capital is one of the world's most polluted cities. A 2015 study found about half of Delhi's 4.4 million school children had compromised lung capacity and would never completely recover.

Bad air has also become a permanent winter fixture in Delhi. Last year, the National Air Quality Index ranked the city's air as "severe" on 20 days in November. Immediately after it was ranked poorly by the air quality index, Delhi received another admonition with the Supreme Court describing the city as a "gas chamber".

Air Pollution

The pollution of air goes unnoticed most of the time. All human activity from domestic cooking to highly mechanised industries contribute to air pollution.

Primary pollutants are those which are emitted directly into the atmosphere, like sulphur dioxide, nitric oxides and carbon monoxide.

Secondary pollutants are pollutants formed by the photochemical reaction of primary pollutants. For example, "smog" is a combination of smoke and fog. Smoke consists of carbon particles and fog is an emulsion of water vapour in air. Smog has become very common in large cities, especially during winter. Similarly acid rain is formed by the combination of sulphur dioxide and water vapour present in the air.

Impact

Air pollution in India is estimated to kill 1.5 million people every year. It is the fifth largest killer in India. According to the WHO, India has the world's highest death rate from chronic respiratory diseases and asthma. According to air quality data compiled by the World Health Organisation (WHO), Delhi is the world's most polluted city. Air pollution also impacts the environment through reduced visibility, acid rain, and formation of ozone at tropospheric level. Here are some impacts in detail :

- **Health:** Most common symptoms associated with this pollution are irritation in the eyes and throat, dry skin, skin allergies, chronic cough and breathlessness. In the longer run increased burden of non-communicable diseases such as cancer, cardiac diseases, COPD etc. is the direct consequence of rise in air pollution. It reduces the overall productivity of nation and increases the healthcare burden especially on the poor.

- **Environment:** Pollution affects not only health of humans but of environment too. Birds and plants are affected by air pollution and phenomenon like urban heat island resulting from it.

- **Economy:** Increased healthcare costs, reduced productivity, diversion of resources towards responding to air pollution are some of the economic costs. According to a World Bank estimate, air pollution might have cost India 8.5% of GDP.
- **Politics:** Air pollution has caused major political conflict in last few years, most prominent of which is the recurring conflict among Punjab, Haryana and Delhi.

Causes of air pollution in India :

- **High dependence on coal for power:** Share of coal in power generation in India continues to be around 80%. Power plants with poor technology and efficiency continue to be the major source of pollutants like CO and oxides of nitrogen and sulphur.
- **High levels of poverty:** Dependence on fuelwood and kerosene for the purpose of lighting and cooking leads to high level of pollutants being released in rural and urban periphery.
- **Over exploitation of commons** like forests, grazing lands and mindless deforestation reduces the natural capacity to absorb pollutants.
- **Poor governance:** The issue of environment and pollution is still to get the policy priority it deserves. While agencies liked CPCB and SPCBs continue to be under-resourced and under-staffed, multiplicity of the state authorities at the ground level leads to poor coordination, lax enforcement of rules and lack of accountability. Absence of environmental governance continues to be a major challenge.
- **Access to technology:** India's industrial landscape continues to be dominated by MSMEs which lack access to cleaner technologies. Agricultural waste burning is also the result of poor access to farm technologies
- **Unplanned urbanization**: Haphazard growth of urban areas has led to proliferation of slums and poor public transport has increased the burden of personal vehicles on the road. Landfills used for waste management also releases pollutants in the air. The rapid urbanization of the recent years if left unmanaged will further exacerbate the problem.
- **Continentality:** Problem of pollution in the landlocked northern states gets exacerbated due to unfavourable winds and phenomenon of temperature inversion during winters.

Air pollution in Delhi's National Capital Region (NCR) is comprised of a complex mix of pollution from human activities (vehicle emissions, industry, construction and residential fuel burning) as well as natural sources like dust and sea salt. The heavy concentration of particulate matter is greatly affected by a number of different factors. Let's examine them briefly:

- **Stubble Burning:** National capital shares its border with the states of Haryana and Uttar Pradesh. One of the main reasons for increasing air pollution during the month of October-November is crop burning by the farmers in these states. Farmers burn rice stubbles in Punjab, Haryana and Uttar Pradesh. The wind carries all the pollutants and dust particles, which have got locked in the air.
- **Vehicular Emission:** The Central Pollution Control Board (CPCB) and the National Environmental Engineering Research Institute (NEERI) have declared vehicular emission as a major contributor to Delhi's increasing air pollution. Delhi has more than 9 million registered vehicles. These are the second largest source of particulate matter, particularly PM2.5. In winter, on average vehicles can contribute 25 per cent to PM2.5 and at certain locations this could be above 35 per cent. There is a significant contribution of diesel vehicles to PM10.
- **Weather:** During the winter months, cool air stagnates over the city, keeping pollution close to the ground where people breathe. Delhi's persistent winter fog only worsens the problem. Stagnant air explains why pollution levels vary less widely over the day in winter than in spring, In spring, warm, rising air moves pollution out, so the average pollution at ground level follows more closely the profile of polluting activities throughout the day. During the afternoon when people are at work, it drops, only to rise again with the evening rush hour. It stays relatively high overnight, likely due to the practice of trucking goods, not only in and out but through Delhi.
- **High Population Density:** With more than 11000 people per square kilometre, Delhi is among the most densely populated cities in the world. Over-population adds up to the various types of pollution.
- **Lack of Infrastructure:** In India, investment in public transport and infrastructure is low which leads to congested roads, and hence air pollution.
- **Road dust:** The silt load on some of Delhi's roads is very high and silt can become airborne with the movement of vehicles. Soil from open fields too gets airborne in summer. In some parts of the city, roads are broken, poorly maintained and partially paved surfaces and the study found that movement of vehicles may cause non-exhaust road dust emission in significant amounts. The estimated PM10 emission from road dust is over 65 tonnes per day. PM10 and PM2.5 emission from road dust is 79,626 kg/day and 22,165 kg/day respectively.
- **Construction Activities and Concrete batching :** Large-scale construction in Delhi-NCR is another culprit that is increasing dust and pollution in the air. These activities require concrete batching. It was assumed that there will be 40 concrete batching plants of 120 cubic-metre/hr capacities operating for 16 hours. Several medium and small construction activities were also observed in the city. PM10 and PM2.5 emissions from concrete mix plants is estimated at 14.37 tonnes/day and 3.5 tonnes/day respectively. A few hundred plants in NCR may contribute to this.
- **Open waste burning:** Delhi also has landfill sites for dumping of waste, burning of waste in these sites also contributes to air pollution.
- **Thermal Power Plant and Industries:** Industrial pollution and garbage dumps are also increasing air pollution and building-up smog in the air.

- **Firecrackers:** Despite the ban on cracker sales in 2017, firecrackers were a common sight in Diwali. It is the major reason for smog in Delhi after Diwali.
- **Diesel generators:** A large number of housing societies and businesses resort to using diesel generators as alternate for power supply during cuts. Diesel generators contribute approximately 15 percent to the city's air pollution.
- **Dust Storm from Gulf countries:** During the smog in the year 2017, the dust storm from Gulf countries was also the reason which enhanced already worse condition.
- **Hotels and Restaurants:** The average consumption of coal in tandoors based on the survey was 30 kg/day. The number of hotels and restaurants was 36,099 (Delhi Statistical Handbook, 2014). The study assumes 25% of these enterprises use tandoors for food preparation.

Steps taken to curb the air pollution : Government has taken a series of incremental steps as the quality of the air deteriorates:

- **Green India mission:** Part of NAPCC it aims at protecting, restoring and enhancing India's diminishing forest cover which is crucial to reduce pollution.
- **Electric vehicle:** The govt is pushing for EVs as a cleaner alternative to vehicles run on fossil fuels with schemes like FAME to incentivizing purchase of EVs.
- **UJJWALA Yojana:** The scheme providing subsidized LPG connections to BPL families will curb emissions from fuelwood used for cooking.
- **Renewable energy plans**: The aim of government to increase RE capacity by 175GW by 2022 and share of RE in total power generation to 40% by 2030 will be crucial in reducing pollution from power generation.
- **Smart city, AMRUT:** The urban development scheme which seeks to ensure planned urban growth including public transport and waste management will address emission from urban areas

Specific Steps for Delhi NCR :

- **Odd-even scheme:** Under the scheme, vehicles with odd last digit in the registration number will ply on odd days and those with even last digit on even days.
- Imposition of Environment Compensation Charge (ECC) at toll plazas.
- **Graded Response Action Plan** (GRAP) is an emergency action plan in Delhi to tackle rising air pollution. It was prepared by the Ministry of Environment, Forests & Climate Change (MoEFCC) after the order of Supreme Court of December 2016. Measures announced under GRAP- Severe+ or Emergency- (PM 2.5 over 300 μg/cubic metre or PM10 over 500 μg/cu. m. for 48+ hours).
- **Stop entry of trucks into Delhi** (except essential commodities). Stop construction work. Schools are shut down till the air quality remains severe. It works only as an emergency measure.

As such, the plan does not include action by various state governments to be taken throughout the year to tackle industrial, vehicular and combustion emissions.

When the air quality shifts from poor to very poor, the measures listed have to be followed since the plan is incremental in nature.

To tackle Stubble burning :

The government is giving subsidy to farmers for buying Turbo Happy Seeder(THS) which is a machine mounted on a tractor that cuts and uproots the stubble and also drill wheat seeds. Punjab and Haryana procure stubble and straw for biofuel plants and in the waste-to-energy power generation plants.

Forecasting :

Recently, the government has also launched a pollution forecast system for New Delhi.

AQI: The central government released the National Air Quality Index (AQI) for public information under the aegis of the Central Pollution Control Board. AQI has been developed for eight pollutants— PM2.5, PM10, Ammonia, Lead, nitrogen oxides, sulfur dioxide, ozone, and carbon monoxide.

BS VI: The April 2020 deadline for the country to implement BS-VI (Bharat Stage-VI is the Indian equivalent to Euro VI) grade fuels was advanced for Delhi to April 1, 2018, because of the extremely high levels of air pollution in the city.

Construction of Eastern and Western Expressways for by-passing non-destined traffic to Delhi.

The government's proposal to vacuum-clean roads is also promising, given that the IIT Kanpur study attributed 38% of pollution to road dust.

Agencies Involved

The Supreme Court : Environment Compensation Charge (ECC) is a Supreme Court directed green tax. Green Taxes are one of a variety of policy measures formulated by the government to control activities that affect the environment.

Environment Pollution (Prevention and Control) Authority: EPCA was constituted under section 3 of the Environment (Protection) Act, 1986 for the National Capital Region in compliance with the Supreme Court order dated January 1998. It has the power suo-moto, or on the basis of complaints made by any individual, representative body or organization functioning in the field of environment. It takes all necessary steps to for controlling vehicular

pollution, ensuring compliance of fuel quality standards, monitoring and coordinating action for traffic planning and management.

Central Pollution Control Board: The Central Pollution Control Board (CPCB) of India is a statutory organisation under the Ministry of Environment, Forest and Climate Change. It was established in 1974 under the Water (Prevention and Control of pollution) Act, 1974.The CPCB is also entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

Effects of the steps taken : Has the efforts been helpful?

The SC has created a step-by-step plan for the entire Delhi-NCR region and getting on board several agencies including pollution control boards, industrial area authorities, municipal corporations, regional officials of the India Meteorological Department, and others. This has been successful in fixing accountability and deadlines. For each action to be taken under a particular air quality category, executing agencies are clearly marked. Coordination among as many as 13 agencies from four states is simplified to a degree because of the clear demarcation of responsibilities.

Three major policy decisions that can be credited to EPCA and GRAP are the closure of the thermal power plant at Badarpur, bringing BS-VI fuel to Delhi before the deadline set initially, and the ban on Pet coke as a fuel in Delhi NCR.

What else can be done ? It requires a system approach to understand pollution levels regularly and take action.

- The first step in the direction is having a robust monitoring of air quality across the country to know information in real time and using the data to arrive at strategies that would protect public health and reduce pollution levels. The strategies to reduce pollution should become an action plan which is time bound and has targets and penalties.
- Governments of India should adopt time-bound national and regional action plans, which have clear targets for regions and penalties for non-compliance. This should include providing transparent data to the public on air quality, short term and long term measures to reduce air pollution.
- Public participation is critical in reducing air pollution. Our choices for electricity and transportation could play a major role in managing pollution levels in many parts of the country.
- Governments, both at the Central and state level, need to reassess their production and consumption of energy and work with partners for a low-carbon future — one that is more efficient, has more natural gas and a growing share of renewable energy, such as solar and bio-gas.
- A robust public transport system is one of the bare essentials. Several studies have shown that public transport provides more than 65% of Delhi's commuting needs but occupies less than five per cent of road space.

But also, public transport in itself, however, might not be enough. Economists believe that the middle classes are likely to remain enamoured with cars unless there are strong disincentives to using personal transport. They advocate a combination of pollution taxes, car free days/areas, robust public transport and better urban planning. Congestion tax can also be considered. London, Milan, Oslo, Stockholm and Singapore have introduced congestion taxes to curb cars.

- **Green cover:** Increasing green cover especially in the urban areas must be an indispensable part of urban planning. Other initiatives such as afforestation, greening of highways etc. must also pick up.
- **Push to renewables:** addressing the problem of intermittence by adopting smart grid technology, incentives for decentralised power production via biogas, rooftop solar and push to EVs as has been done in Norway (exemptions on tax, toll, parking fee, environment tax on other vehicles, charging stations powered by renewable).
- **Urban governance:** Better urban planning based on models like transit oriented development (TOD), integrated and accountable transport authority, empowered local bodies, scientific waste management etc. can help bring down pollution footprints of urban areas.
- **Market for agricultural waste**: The problem of crop burning can be resolved only through financial and technological support and incentives for farmers. Access to technologies like super seeder machines and development of market for crop stubble will push farmers to a cleaner method of waste disposal.
- **Better planning and coordination:** A single body on the lines of EPCA as mandated by SC with clear targets and accountability mechanisms is necessary for effective environmental governance
- **Forecasting systems for better response:** China has shown the way in controlling the pollution by an effective pollution forecasting (2-3 days in advance) and monitoring systems. Its permanent odd-even policy during severe pollution levels, early warning systems, strict enforcement of GRAP like action plan has significantly brought down the pollution levels in Beijing.
- **Healthcare for pollution related diseases:** Pollution and its health burden are inevitable in the near future. Therefore, it is necessary to equip public healthcare systems with adequate resources for facing this emerging challenge and shield poor from catastrophic healthcare expenditures.
- **Coherent environmental policies:** Since air pollution knows no boundaries, states and centre have to harmonize their strategy to deal with it. Platforms like inter-state council apart from serving this objective can also help resolve pollution related disputes among states.
- An odd-even trial in the summer months might be more useful to isolate its impact.
- CSIR's proposal 'mid-week work-from-home' can be a game changer too. According to this formula, instead of commuting to work and school, employees and students could work and study from home for a day.

- **Strict enforcement of lower pollution norms:** Trucks and buses mixing kerosene and diesel should be impounded, and fined.
- Buses from other states should be allowed to enter Delhi only if they meet certain pollution norms.
- Constant monitoring of garbage dumps such as those in Bhalswa and New Ashok Nagar and any fire incidents at these places need to proactively put out.
- Complete ban on burning of leaves in Delhi through the year.
- All construction activity in Delhi should be done with draping, to ensure that dust and dirt doesn't fly into the air. This is done everywhere else in the world.
- Dustoppers can be run through Delhi roads regularly, every morning.
- To prevent burning of wood etc during peak winters, build shelters for the homeless to sleep at night in the winters.
- Move Brick kilns out of Delhi within 3 years. This was done with tanneries almost 20 years ago.

A new way out through technology:

Here are some of the technological solutions that can make a big impact:

Letting Citizens Test their Own Air Quality:

One of the best tools in the fight against air pollution is education. By educating people on the importance of clean air, what they can do to lower their own emissions, and how to be aware of the air quality in their area, the problem of pollution can be better addressed. Friends of the Earth is an environmental charity in the UK supplying citizens with testing kits, so they can learn more about the quality of the air in their local areas. The kits include a monitoring tube and an easy-to-follow guide, so that concerned citizens can get accurate answers about the air they're breathing.

AIR-INK: Printing With Inks Made From Polluted Air:

Some of the most interesting projects seeking to combat air pollution are also looking to utilize the pollutants drawn from the air in creative ways. One such project is AIR-INK, an ink made from carbon emissions. The product is made by Graviky Labs and was funded via Kickstarter. People simply have to connect the KAALINK device to their car exhaust pipe, and within 45 minutes of driving, they'll have 1 fluid ounce of ink. The captured pollutants are then purified in a lab and manufactured into usable ink.

The Smog-Free Tower: Transforming Smog Into Jewellery:

The Smog-Free Tower uses relatively little energy, sending positive ions into the air which connect themselves to dust particles. A negative ion in the vacuum then draws the positive ions back inside, bringing the particles with them. Though the tower first debuted in Rotterdam in 2015, it is now being used in other cities around the world.

The World's Largest Air Purifier: Cleaning the Air With a Skyscraper:

In January of this year, work began on the world's largest air purifier in Xian, China. The massive structure measures 328 feet (100 meters) and can improve the air quality within an almost 4-mile radius (10 square kilometers).The tower is just one of a number of Chinese efforts to combat air pollution. The coming months will be crucial in determining how effective the tower is, and if the results are positive it won't be surprising to see similar towers erected across the country.

Pollution Vacuum Cleaners: Sucking Up the Air's Contaminants:

What if we could place giant vacuum cleaners on top of buildings, that could clean the surrounding air? That question is what spurred the Evinity Group, a Dutch collective of inventors, into action. In 2016 they debuted an enormous, industrial vacuum that can remove airborne contaminants. The vacuum removes fine particles and ultra-fine particles, which have been identified as carcinogenic risks by the World Health Organization. The inventors claim that the vacuum can eliminate 100% of fine particles, and 95% of ultra-fine particles, within a 984-foot radius (300 meters).

City Tree: Purifying Urban Areas the Natural Way:

Urban areas are the worst-hit when it comes to air pollution. The lack of green areas and trees in cities means that there's little opportunity for carbon dioxide to be absorbed, leaving the air quality poor. That's why German start-up, Green City Solutions, created the CityTree. The CityTree is a vertical unit, not unlike a billboard, that incorporates moss and lichen. Thanks to these hard-working plants, each unit can absorb as much as 240 tons of carbon dioxide a year. This means they can perform the task of 275 trees while demanding a fraction of the space and cost.

Fuel from Pollutants: Creating Hydrogen Fuel from Air Pollution:

Today's pollution could very well become tomorrow's fuel. This is thanks to research from the University of Antwerp and KU Leuven. In May of last year, scientists struck upon a startling new method that allowed them to purify the air, and create hydrogen fuel from the extracted pollutants. The researchers created a device containing a thin membrane. On one side of the membrane, the air was purified. On the other side, hydrogen gas resulting from the degradation of the contaminants was collected. The gas could then be used as fuel. The device was powered by solar energy, making it entirely clean.

Anti-Smog Guns: Shooting Pollution Down from the Air:

Government of Delhi tested the anti-smog guns last year to bring down dangerous levels of smog in Anand Vihar. The guns work by spraying water vapor into the air, which absorbs the pollutants before falling to the ground like rain. While it doesn't remove the pollutants entirely, it's an effective short-term solution for smog-heavy days where breathing the air could present a serious health risk to residents.

Conclusion

While the issue of air pollution has managed to capture public imagination, the problem of growing question of growing population density in cities continues to be at best- an afterthought. High human density hinders the successful implementation of positive initiatives. The volume of polluting activities continue to multiply, as the space to counteract them physically shrinks. The question of decentralising urbanisation needs to be addressed in a meaningful way, for it holds the key to improving the quality of urban life.

With the multiplicity of sources, modes of exposure and complexity of outcomes associated, there is no easy solution to address the problem of air pollution in India. Addressing it will require an evidence informed, multi-sectoral approach to policymaking that aims to maximize exposure reductions. While several aspects of a health-centric air pollution policy are currently under consideration, there are aspects of the issue that require more creative thinking and solution development.

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