

Smog and Deteriorating Life

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Smog is a newly emerged word for the common man in India. Though smog has a long history and coined in early 20 century by Dr. Henry Antoine des Voeux in his paper, “*Fog and Smoke*” in July 1905, when the blanket of smoke and fog was noticed over London in early 1900s. In 1950s, a new type of smog called Photochemical smog was found which is most common these days. The name is constructed from the combination of 2 words i.e. ‘smoke’ and ‘fog’.

Fog shows up when water or water vapour, condenses and water molecules form water droplets or ice crystals in the air near the Earth's surface but when the fog is combined with pollutants like ozone, carbon monoxide and PM10s, nitrogen oxides, sulphur oxides, smoke and other particulates, it becomes smog. In other words, we can say that smog is yellowish or blackish fog with various pollutants and fine dust. It is also known as hazy air that makes breathing difficult.

Creation of Smog

It is a known fact that ozone protects life from the sun’s damaging ultraviolet rays. But at ground level, ozone is an invisible air pollutant. It is created when gases like nitrogen oxides and sulphur dioxide react with volatile organic compounds (VOC) undergo photochemical reaction and combined with sunlight and heat. The volatile organic compounds, SO₂ and Nitrogen oxides are produced through different sources like barbecues, vehicular emissions, construction, untreated industrial smoke, smoke of brick kilns, smoke from untreated garbage, forest & agriculture fires, fireworks, oil-based paints, solvents and cleaners, coal combustion emissions and burning of fuels.

The time that smog takes to form depends directly on the temperature. Temperature inversions are situations when warm air does not rise instead stays near the ground. During situations of temperature inversions, if the wind is calm, smog may get trapped and increase

pollution level near the ground and could remain over a place for days. It is worse during periods of warmer & sunny weather when the upper air is warm enough to inhibit vertical circulation. In mornings when there is less or no air movement, it is often worst. It has been seen that smog is more severe at places beyond the source of pollution since the chemical reactions that create smog generally occurs in the atmosphere while pollutants are drifting in the wind.

In short, we may say that inversion of cold weather, slow moving winds, intense pollution from industrial and vehicular emission, stubble burning, smoke from crackers all mixes well in the environment and form smog every year and has high concentration especially across the Indo-Gangetic Plain.

Scenario of Smog

Worldwide, the most polluted country with worst pollution index is China followed by UK, Mexico & Iran. The studies with the NASA Socioeconomic Data and Applications Centre, UN, European Commission and Joint Research Centre mentions that if we look at the time lapse between 1998-2016, though China always remained in news for its poor air quality, India is now in a far worse position than its neighbouring countries. As per WHO safe limits, 140 million Indians were breathing 10 times or more polluted air.

AQI Category	Concentration Range*							
	PM 10	PM 2.5	NO2	O3	CO	SO2	NH3	Pb
Good (0-50)	0-50	0 – 30	0-40	0 - 50	0-1.0	0-40	0-200	0- 0.5
Satisfactory (51-100)	51-100	31 – 60	41-80	5 1 – 100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very Poor (301-400)	351-430	121-250	281-400	209-748	17-34	801-1600	1200-1800	3.1-3.5
Severe	430 +	250 +	400 +	748+*	34+	1600+	1800+	3.5+

* CO in mg/m³ and other pollutants in µg/m³ ; 2h-hourly average values for PM10, PM2.5, NO2, SO2, NH3, and Pb, and 8-hourly values for CO and O3.

In 2015, the Central Pollution Control Board (CPCB) identified 102 non-attainment cities across the country that fail to meet ambient air quality standards. It classified annual average pollution levels in terms of low, moderate, high and critical and found that the PM10 level in critical category i.e. more than 1.5 times the standard has increased to 79 percent cities in 2017 from 56 percent in 2007. The gaseous pollution with nitrogen dioxide levels exceeding the annual average standards in cities has also increased from 13 percent in 2007 to 23 percent in 2017 and is contributing more in formation of harmful ozone.

According to World Health Organisation list of cities on the basis of their annual average particulate matter concentration in 2018, 14 of the world’s most polluted cities out of 20 were in India. A study from AirVisual and Greenpeace mentioned that in 2018, at least 22 of the world’s 30 worst most polluted cities were in India. In 2019, 21 out of 30 most polluted cities were in India. As per the study of Central Pollution Control Board, on 4 November 2019, Delhi stands at 14 position out of the 15 cities having an average AQI above 400. The districts of Haryana and UP found to have most toxic air quality. Jind was in first position with AQI of 448 followed by Baghpat & Gaziabad with AQI of 440. In India, only 4 cities were found with good air quality named Eloor, Thane, Thiruvananthapuram and Kota.

Top Ten Most Polluted Cities of India As on 4 November 2019		
Rank	City	AQI
1	Jind	448
2	Baghpat	440
3	Ghaziabad	440
4	Hapur	436
5	Lucknow	435
6	Moradabad	434
7	Noida	430
8	Greater Noida	428
9	Kanpur	427
10	Sirsa	426
<i>Source: Central Pollution Control Board</i>		

On 15 November 2019, as per data by Air Visual, Delhi became most polluted major city in the world with an AQI of 527. According to study by CSE, till 30 November 2019, the average and maximum PM2.5 concentration of Hisar was 794, Gaziabad it was 693 and Jind had 655 µg/m3. Even the year 2018 was not different. According to a fellow in Natural Resources Defence Council, pollution levels were effectively off the charts and the measurement capabilities are exceeding. The UN report also mentioned that the air pollution related diseases causes death of about 7 million people worldwide prematurely each year. The average pollution PM2.5 level across India in 2017 was nine times the annual mean measure recommended by WHO, according to study in Lancet Planetary Health.

Though the presence of Himalayas and Aravallis form a natural barrier to air pollution. But the increasing desertification of Aravalli belt and strong north-westerly or westerly winds blowing from Punjab and Haryana also contribute in pollution through dust.

Impact of Smog

Children, infants, elderly, and those who stays out doors for longer periods could be worst affected with smog along with patients of heart and respiratory problems like asthma, emphysema, chronic bronchitis, people with susceptibility to ozone. Heavy smog reduces the production of vitamin D among humans causing rickets. Inhaling of smog for longer time can inflame the breathing passage and give rise to pain in chest. Inflamed lungs secrete interleukin – 6 which can cause blood clots in people with cardiac and respiratory disorders, leading to heart attacks or strokes. It also causes eye and nose irritation. Besides, it could also be the reason of high number of accidents due to low visibility.

Smog can dry the protective membranes of nose and throat and interferes the body's ability to fight infection. Exposure to PM_{2.5} damages the lungs and nitrogen oxides can cause bronchitis. Carbon monoxide (CO) reduces the oxygen carried by blood around the body and affects the coordination of brain, heart and nervous tissues. It can also decrease the working capacity of lungs and the toxins of NO_x may cause DNA mutations and leads to cancer. Smog can also jeopardize the resistance power of body. It also raises the illnesses like cold and pneumonia and is very dangerous for patients of pneumonia. Other toxins present in polluted air cause birth defects and deformities.

The children who are the most vulnerable and worst victims when exposed to pollutants present in air have slow lung development, poor cognitive system, underdeveloped immune system and high mortality rate due to cardiovascular or respiratory infections. WHO report of 2018 mentions that more than one in every four deaths of children under 5 years of age is related to environmental risk. Ambient air pollution and household air pollution together contributed to respiratory tract infections that resulted in 5,43,000 deaths of children under the age of 5 years in 2016, of which almost 3,00,000 died of ambient air pollution alone.

AQI	Levels of Health Concern	Associated Health Impacts
Good (0–50)	Good	Minimal impact. Air quality is considered satisfactory, and air pollution poses little or no risk.
Satisfactory (51–100)	Moderate	May cause minor breathing discomfort to sensitive people. Air quality is acceptable; however, for some pollutants there may be a moderate breathing discomfort for a very small number of people who are unusually sensitive to air pollution.
Moderately polluted (101–150)	Unhealthy for Sensitive Groups	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults. Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Moderately polluted (150–200)	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Poor (201–300)	Very Unhealthy	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease. Health alert: everyone may experience more serious health effects.
Very poor (301–400)	Hazardous	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases. Health warnings of emergency conditions. The entire population is more likely to be affected.
Severe (401–500)	Hazardous	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity. Health warnings of emergency conditions. The entire population is more likely to be affected.

Source: <https://airnow.gov/index.cfm?action=aqibasics.aqi>

According to the study published in *The Lancet*, it was estimated that pollution related health ailments killed almost 1.24 million Indians in 2017 alone. As per report, 0.67 million deaths were due to ambient air pollution while remaining were due to household air pollution. The pollution is also reducing the life expectancy of citizens. According to “*The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: The Global Burden of Disease study 2017*” released in December 2018 by Ministry of Health and Family Welfare, the total number of deaths in India in 2017 caused by air pollution out of which 51.4 percent were younger than 70 years. It is also mentioned in the report that 76.8 percent Indians breathe air that is worse than the levels recommended by National Ambient Air Quality Standards. The figures of diseases triggered by air pollution are alarming and needs immediate attention. It includes 29.2 percent of chronic obstructive pulmonary disease,

29.3 percent lower respiratory infections, 23.8 percent Ischaemic heart disease, 7.5 percent stroke, 6.9 percent diabetes, 1.8 percent lung cancer and 1.5 percent cataract.

The dust pollution contains many components like aluminium, asbestos, cadmium, silica, lead, etc. which can damage kidney, liver, heart, brain and nervous system causing osteoporosis, hypertension, male reproductive problems, hearing impairment and delayed development among infants. The ground level ozone does not affect only humans but also damages vegetation and degrades man-made material. It also contributes to climate change being a powerful greenhouse gas. The fine particulate matter could be generated by human activities or naturally by dust, windblown soil, sea salt spray, etc.

Besides mankind, the vegetation is also directly affected by smog. Smog inhibits the growth of plants and also cause damage to crops and forests/vegetation. Many crops like wheat, cotton, tomato, etc. gets infected when get in contact of smog. It mortifies the over-all environment by affecting and killing many animal and plant species through toxic gases.

Issues & Challenges

According to WHO report, between 3 to 4 lakh people die annually in India due to indoor air pollution and carbon monoxide poisoning caused due to biomass burning for cooking and heating. Besides, the burning of biomass cakes and fuel wood is also a cause of Asian brown cloud causing air pollution. In rural India, the biomass cakes are more used for cooking purpose which produces smoke and other pollutants at concentration 5 times higher than coal. Though Govt. of India has taken initiatives to provide cooking gas at every region of country, still it is estimated that over 100 million households use such fuel every day that too 2-3 times in a day.

It has been noticed that as a general practice, whenever fuel prices increases, the daily wages drivers try to make some money by using adulterated fuel blends upto 20-30 percent. Adulterated fuel increases tailpipe emissions of hydrocarbons, carbon monoxide, oxides of nitrogen and particulate matter. The increased quantity of sulphur in diesel also increases the emission of irrespirable particulate matter. The consequences not only affect the quality of life and health of human beings but also reduce the life of vehicle engine and its maintenance cost.

The study of 2017 reflects that India was the third largest producer of carbon dioxide (6.82%) after China (27.21%) and United States (14.58%) and contributor of Greenhouse Gas Emission. It is seen that India's thermal power plants emit 50 to 120 percent more carbon dioxide per KWh in comparison to the average emissions from coal-fired, oil-fired and natural gas-fired thermal power plants in European Union countries. A study by CSE reflects that thermal power plants are responsible for over 60 percent of particulate matter emissions, 50 percent of SO₂ and NO_x emissions and more than 80 percent of mercury emissions by the industrial sector.

It has been mentioned by Kirk Smith, a professor of global environmental health at the University of California Berkley, that India has anti-pollution laws but they are not enforced well. For eg. most of the cities can ban the pollution caused by brick kilns which has become largest emitter of greenhouse pollutants from within their boundaries but they do not stop exhaust from blowing over the perimeter. And the number of such brick kilns is increasing day by day to meet the demands of growing construction sites.

Poor enforcement of traffic laws and lack of infrastructure also forces the vehicles to spend more time on roads with the speed of 5 to 20 kilometres and cover less distance. Traffic congestion results in reducing the average trip speeds and emission of pollutants 4 to 8 times higher in air. Emission of particles and heavy metals increase over time because the growth of fleet and mileage outpaces the efforts to curb emissions.

The pollution concentration in India differs regionally. It has been observed that the northern Indian cities are more affected with pollution while coastal regions of southern and western India subside the pollution level with the support of sea breeze. The pollution may vary drastically over small areas, and many places in India are monitored with one air quality monitor and that too with its inappropriate placing. For eg. in Panipat, it has been seen that the pollutant particulate matter (PM) 2.5 and PM 10 were recorded at the highest level of 487 and 500 respectively in last week of October 2019 just because the AQIMS was established near the toll plaza where traffic jam is a regular problem.

Limited air quality monitoring system and absence of fixed standards for instrument calibration and testing also limits our knowledge. While considering the data of October 2019, there are 793 manual stations under the National Air Quality Monitoring Programme

(NAMP) that provide bi-weekly data and 202 Continuous Ambient Air Quality Monitoring Stations (CAAQMS) that provide real time data on concentration of pollutants like CO, NO₂, SO₂, O₃, particulate matter (PM₁₀ & PM_{2.5}), and volatile organic compounds in air. Hence, one more reason of rise in India's ranking in air pollution is that many cities got air quality monitoring system for the first time while they might have the problem for the long. Another problem is that many centres do not have consistent and sufficient CAAQMS like Guwahati and Shillong have only one station, Andaman & Nicobar and Lakshdweep islands do not have any CAAQMS. Besides, due to power outages, untrained manpower, instrument calibration and maintenance, several NAMP manual stations do not meet the criteria of 104 observations per year. Thus, there are many possibilities of having ambiguous and erroneous data.

Initiatives Taken

To regulate the air pollution, the need of the hour is to prepare the detailed mechanism to prepare action plan and achieve stringent targets in time-bound manner. All such plans should be based on the nature and sources of pollution that particular city or region is contributing. To regulate the air pollution, years back the Air (Prevention and Control of Pollution) Act was passed in 1981 by Indian Government. Delhi has also notified Graded Response Action Plan (GRAP) and Comprehensive Action Plan (CAP) under the Environment Protection Act 1986.

In 1996, a report was published by Centre for Science & Environment "Slow Murder" on air pollution of Delhi which was taken seriously by Supreme Court and *suo moto* notice was issued to Delhi government to submit an action plan to control air pollution against which in December 1996, the first action plan was submitted by Delhi govt. to combat air pollution. In January 1998, Ministry of Environment and Forest constituted the Environment Pollution (Prevention & Control) Authority (EPCA) for NCR. The government also launched the National Air Quality Monitoring Programme (NAMP), a network of monitoring stations across the country to constantly monitor key pollutants round the year. In June 1998, government submitted "*Report on monitoring and priority measures proposed by the authority for Air pollution Control*" to Supreme Court for which court ordered all authorities

to comply with the framework. This plan also included the conversion of vehicles to run on compressed natural gas (CNG). But, despite of tightening the emission norms, the number of vehicles in Delhi itself has increased more than double fold from 2004 to March 2018. In 2009, MoEF&CC notified National Ambient Air Quality Standards for 12 pollutants and introduced monitoring of PM_{2.5}, along with establishment of monitoring stations. In 2010, government implemented BS-IV standards in Delhi and other metropolitan cities for vehicular technology and fuel, and in 2017, BS-IV implemented to entire country.

Other initiatives taken from 1990 to 2010 includes setting up of two independent fuel adulteration labs, CNG safety regulations, complete ban on open 2T oil, reforms in PUC, creation of dedicated fund for air pollution control measures, shut down of outdated power plants, focus on use of clean fuels in Delhi. In 2014, the National Air Quality Index was launched by Government of India.

In November 2016, when the PM_{2.5} level of Delhi reached over 750 µg/m³, i.e. over 12.5 times the permissible limit, Delhi government took the initiative of “ODD-EVEN” to reduce the vehicular emissions and traffic congestion. On intervention of Supreme Court to prepare a plan to deal with such pollution, the MoEF&CC notified Graded Response Action Plan on 12 January 2017 to categorize the pollution level. To assess the pollution level, the Central Pollution Control Board set up a centralised open access portal that provides data from 52 monitoring stations in NCR. With the access to regional pollution data, the need of local action plan to control the sources of pollution was focused. The winters of 2018-19 again faced the pollution at alarming level and the immediate initiatives included ban on use of diesel generator sets in Delhi, closure of brick kilns, shut down of Badarpur power plant, closing of hot mix plants and stone crushers across NCR.

In January 2019, the National Clean Air Programme was launched as a five year plan in 102 cities to reduce the PM_{2.5} & PM₁₀ to 20% - 30% by 2024 considering 2017 as the base year for comparison. The main aim of the NCAP is to initiate mitigation actions for prevention, control and abatement of air pollution besides augmenting the air quality monitoring network across the country and strengthening the awareness and capacity building activities. It includes the stringent norms for fuels, policies for electric vehicles, industrial standards, clean fuels and technologies for industries, continuous emissions monitoring

systems, increasing the penetration of liquefied petroleum gas for cooking and heating, and other such initiatives.

The decision of introducing Bharat Stage (BS) VI from April 2020 will help in narrowing the gap between emission limits for petrol and diesel cars and will also count the particle number in exhaust emissions to ensure the use of effective diesel particulate filter over 95 percent. It is also proposed that between 2020 and 2023, the real-world driving emissions (RDE) will be monitored with the help of portable emissions measurement system (PEMS) to bring down on-road emissions by passenger cars. To further reduce emissions from light and heavy duty vehicles, India has decided to implement Euro-VI, which will reduce tailpipe PM_{2.5} emissions by 74 percent by 2030 from 2015 levels. The planning of Central government to develop Great Green Wall of Aravalli from Gujarat to Delhi with planting of 1.35 billion new trees at the stretch of 1400 kilometer long and 5 km wide green belt over 10 years could combat the climate change, desertification and certainly help in cleaning the pollutants of air.

Conclusion and Suggestions

Smog is mostly caused by traffic, high temperatures, sunshine & calm winds. Since smog is not limited to any particular area, the short term solution is to remain indoors or move to some better place with clean air. The other options to sustain in the smog condition includes using air purifiers, pollutant filter mask, avoid congested air and physical exercise especially in outdoors. But most of the times, it is an impossible option. The need of the hour is to take prepare aggressive action plan and implement them at war level.

Despite of intervention of several key authorities, the results in reducing the air pollution are not very satisfactory. Since air pollution is not limited to any boundary and blows with the wind, its reduction at national, state and regional level is highly required. A cohesive agency is needed who is accountable to implement and monitor the various notifications and orders issued by government and courts.

The Air Quality Early Warning System is an in-built web-based system that could inform in advance to the public at large and other line agencies about the high pollution level. This system has incorporated all the major sources of pollution like crop residue burning and

also the feature to analyse wind speed and direction to determine the pollution levels and origin. Use of GIS based satellite data is another emerging source of high quality and standardised pollutant data though it needs trained and experienced manpower. The need of government's New Car Assessment Programme seems to be urgently required and expected to be a long-term commitment for sustained air quality and health gains.

According to study of European Union, Indian households spend an average of 15 percent of its income on transport. Promoting the availability of safe public transport and increase in parking charges of private vehicles can reduce the number of vehicles on road. The success of public transport system depends upon affordability and financial sustainability. Delhi Metro Rail Corporation is one of them which had shifted the focus of daily commuters but with the increase in fares from 25 percent to 117 percent, again the commuters prefer to use their two-wheeler, private cab or buses which aggravate pollution and congestion. The shifting of focus more on electric public and private transport facilities is essential to control the air pollution through vehicular emission. Promoting use of car pool, walk, cycling could decrease the use of non-renewable fuel and can reduce toxic emission from vehicles. Fuel up during the cooler hours of day-night or early morning also helps to prevent gas fumes from heating up and producing ozone.

There is a need of National Brick Mission which can ensure that proper cleaner technology is used for brick making and internal fuel used with embracing innovations in the process to reduce the CO₂ emissions, black carbon and particulate matter. Ban on diesel generator set which is also a major source of pollution could also be done for which government can provide unrestricted power supply. Use of electric appliances instead of gas-powered equipments is also a way to reduce the smog. Promoting use of solar energy through Solar Roof Top on subsidized rates is cheaper than coal based power generation & diesel generator set and is also a non-polluting alternative to grid-electricity. Fortunately the major part of country has sun-shine for almost 300 days in a year and the ambitious plan of India prepared in 2015, to complete 100,000 megawatt (MW) of solar installations by 2022 has covered only 2,141 MW of SRT by July 2019. There is a long way ahead to cover the country with solar energy.

Clean burning fuels and electricity need to be made available to rural India. Increasing use of LPG as domestic fuel instead of coal, biofuel or fuelwood and use of CNG instead of

diesel can certainly help in reducing the level of sulphur dioxide and nitrogen content. Finding and communicating better options for disposal of crop residues to farmers can control the stubble burning like using biomass as fuel in power stations can serve the dual objective of reducing emissions from thermal plants and also to control stubble burning. If the revised emission norms of 2015 notified under the Environment (Protection) Amendment Rules 2015 would be implemented properly across the country than it can reduce the emission of PM, SO₂ and NO_x by 40 to 50 percent by 2022 in thermal power plants. There is also need to take a policy decision to shut down the old thermal power generation units.

To make states more actionable, in October 2018, the National Green Tribunal issued final warning and orders to prepare action plans within 2 months and bring ambient air quality within 6 months of its implementation but the responses are too slow. The need to shift the focus to larger airsheds which is a mix of multiple state jurisdictions and governance for harmonised action, monitoring and compliance across the country is badly felt at this moment. The various initiatives taken in Delhi like phasing out of old vehicles, stopping use of dirty fuels, proper electricity supply to reduce use of diesel generator set, closing of coal-based power plants, parking area management, use of LPG, etc. should cross the regional boundaries and must be adopted by other states and NCR to ensure their participation against the fight to pollution.

Close monitoring and inspection by pollution control boards can also ensure the effective implementation of all the notifications issued by agencies from time to time and to also take appropriate measures on violation of combined action plans. The joint working efforts by provinces of countries like China, Europe, United States are few examples we can learn from to reduce the air pollution in India. There is urgent need to work in harmony with all the states contributing in making the air dirty to inhale.