



Effect of Air Pollution on Environment: A Review

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ABSTRACT: in last few decades air pollution has emerged as a major pollution type causing various problems. Air pollution has many adverse impacts on economic and biological systems (human health, plants, and animals). The high criteria pollutants (CO, rspm, SO₂, NO₂, SPM, O₃, etc.) Can be life threatening, as diseases like respiratory infections such as rhinitis, bronchial asthma, headache, dizziness, depression were prevalent among the urban dwellers. According to a joint study conducted by the world bank and the institute for health metrics and evaluation (ihme) at the university of Washington ,air pollution costs the world economy \$5 trillion per year as a result of productivity losses and degraded quality of life. This paper focuses on effects of air pollution on human health, vegetation and economy.

I. INTRODUCTION

Cities in developing countries are growing at rapid pace. Increased emission of various pollutants from industries, vehicular traffic and refuse burning all poses for air pollution risk. The increase of air pollution is a major environmental problem. Pollution has become a great topic of debate at all levels in India and especially the air pollution because of the enhanced anthropogenic activities. According to World Health Organisation "Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulphur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases, which can be fatal".

According to a special report of The International Energy Agency (IEA), Air pollution is considered the fourth greatest overall risk factor for human health worldwide, after high blood pressure, dietary risks and smoking. A latest estimate shows 6.5 million premature deaths to air pollution. Among the major air pollutants,

PM₁₀, PM_{2.5} is the most damaging to human health, and SO_x, NO_x and O₃ are associated with a range of illnesses. Primarily air pollutants can be caused by primary sources or secondary sources.

Primary pollutants are direct result of the processes. A classic example of a primary pollutant would be the sulphur-dioxide emitted from factories

Secondary pollutants are the ones that are formed by the inter mingling and reactions of primary pollutants. Smog created by the interactions of several primary pollutants is known to be as secondary pollutant.

Ambient air pollution has been recognised as a severe problem since it is 5th biggest cause of mortality in India (Atkinson, Cohen, Mehta, et al. 2011). Central Pollution Control Board (CPCB) in India has implemented the National Air Quality Monitoring Programme through a network of 544 Ambient air quality stations covering 224 cities/towns in 26 states and 5 union territories of the country.

CPCB has mentioned 12 parameters for air quality after revising National Ambient Air Quality Standards in 2009 and. These parameters include PM₁₀, PM_{2.5}, NO₂, SO₂, CO, O₃, NH₃, Pb, Ni, As, Benzo(a) pyrene, and Benzene. The current standards are listed below.

Table 1: CPCB revised National Ambient Air Quality Standards, 2009.

S.N	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide(SO ₂),µg/m ³	Annual* 24 hours**	50 80	20 80	-Improved West and Gaeke -Ultraviolet fluorescence
2	Nitrogen Dioxide(NO ₂),µg/m ³	Annual* 24 hours**	40 80	30 80	-Modified Jacob & Hochheiser(Na-Arsenite) -Chemiluminescence
3	Particulate Matter(size less than10 µm) or PM ₁₀ µg/m ³	Annual* 24 hours**	60 100	60 100	-Gravimetric -TOEM -Beta attenuation
4	Particulate Matter (size less than 2.5 µm) or PM _{2.5} µg/m ³	Annual* 24 hours**	40 60	40 60	-Gravimetric -TOEM -Beta attenuation
5	Ozone(O ₃) µg/m ³	8 hours* 1 hour**	100 180	100 180	-UV photometric -Chemiluminescence -Chemical Method
6	Lead(Pb) µg/m ³	Annual* 24 hours**	0.50 1.0	0.50 1.0	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
7	Carbon Monoxide(CO) µg/m ³	8 hours* 1 hour**	02 04	02 04	-Non Dispersive Infra Red(NDIR) spectroscopy
8	Ammonia (NH ₃) µg/m ³	Annual* 24 hours**	100 400	100 400	Chemiluminescence -Indophenol blue method
9	Benzene (C ₆ H ₆) µg/m ³	Annual*	05	05	-Gas chromatography based continuous analyzer -Adsorption and Desorption followed by GC analysis
10	Benzo(a)Pyrene(BaP)-Particulate phase only, µg/m ³	Annual*	01	01	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic(As), µg/m ³	Annual*	06	06	-AAS/ICP method after sampling on EPM2000 or equivalent filter paper
12	Nickel(Ni), µg/m ³	Annual*	20	20	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

**24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

II. EFFECTS OF AIR POLLUTION ON ENVIRONMENT

A. Effects of Air Pollution on Human Health

In 2012 alone, 7 million deaths in the world were due to the combined effects of ambient (3.7 million) and household (4.3 million) air pollution (WHO, 2015). Out of 10 more than 8 people in the world's urban areas live where the level of air pollutants – whether gaseous or other damaging substances introduced into the atmosphere exceeds the World Health Organization's (WHO) Air Quality Guidelines (WHO, 2006). This

result in millions of premature deaths each year and huge costs to the global economy

Air pollutants have many acute as well as chronic effects on human health. Irritation of the respiratory tract, eye, nose and throat, cardiovascular diseases, kidney and liver damage(due to Cadmium particulates through cigarette smoking), convulsions, delirium, coma(due to Lead particulates from automobile exhausts) nerve, brain damage even death(due to Mercury from Combustion of fossil fuels, plants) are major health problems arising from air pollution.

Eleven out of 20 most polluted cities of world are in India and poor air quality is already a major public health issue. India has registered an increase of around 12% in the number of deaths and about 3% in years of life lost between 2005 and 2010. Outdoor air pollution has caused around 590 000 premature deaths in 2015 and around 1 million premature deaths to household air pollution.

Average life expectancy in India today has been reduced by 23 months due to air pollution. Figure 1 shows the alarming increase in the death toll in India over the period from 2005 to 2010 i.e 72000 more deaths. Figure 2 gives the disease-wise percentage distribution of deaths attributable to ambient PM pollution in India.

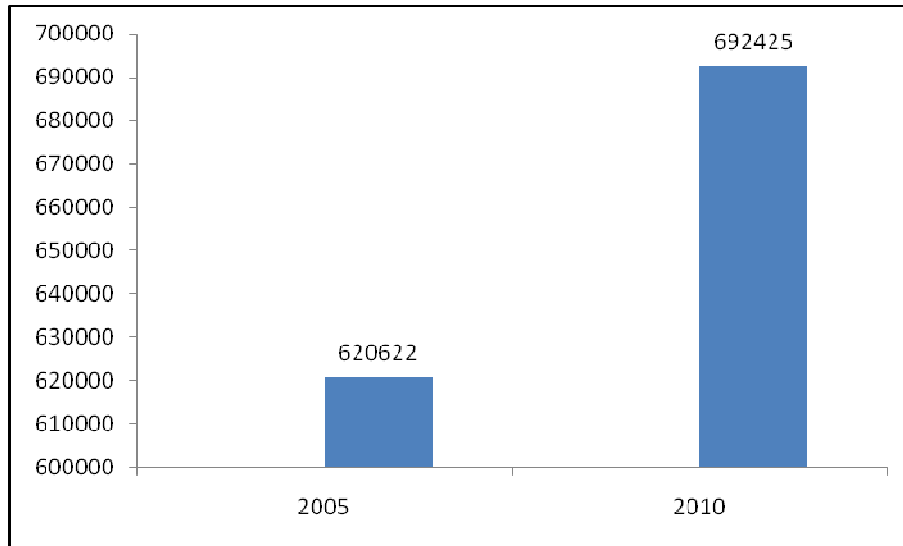


Fig. 1(a) Total deaths from ambient PM and ozone pollution in India. (Source: OECD 2014)

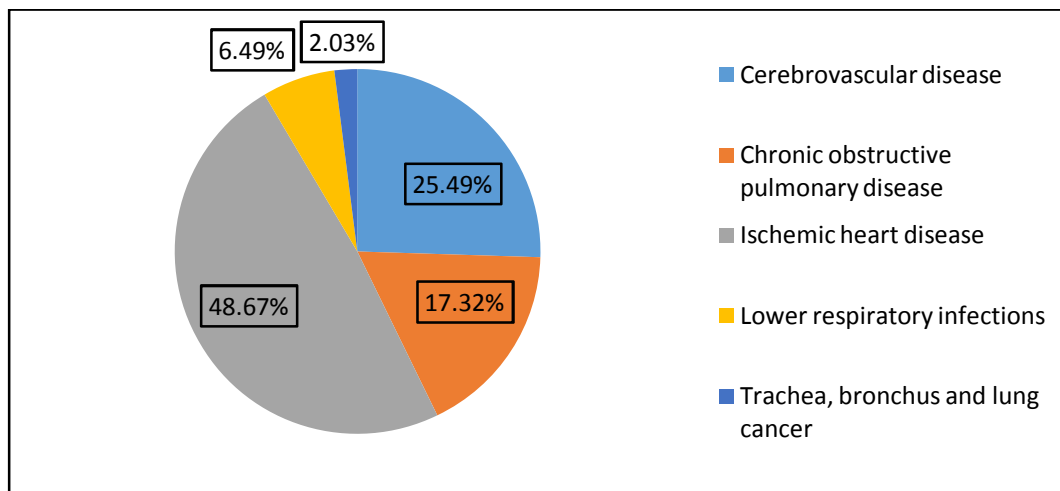


Fig. 1(B) Percentage distribution of deaths from ambient PM pollution in India (Source: Lim *et al*, 2012)

Many studies have been conducted across the world and also in India which prove that outdoor and indoor air pollution is a serious environmental risk factor that causes acute and chronic diseases. Household air pollution (HAP) due to burning of biomass cooking fuel is an important risk factor for many diseases, especially

among adult women who primarily cooks in India (Lin SS *et al* 2010). Biomass fuel is more widely used energy source in rural India (80% of households) than in urban India.

It has been estimated that around 2.4 of 5.6 million cases of chronic bronchitis, 0.3 of 0.76 million cases of Tuberculosis, 5 of 51.4 million cases of cataract among adult Indian women and 0.02 of 0.15 million stillbirths across India are because of household air pollution due to biomass cooking fuel (Sehgal M, Suresh R *et al.* 2014).

B. Effects of Pollutants on Animals

Air pollution harms animals in two ways either by direct exposure to contaminants or by destructing of

their habitats, food and water sources. For example, acid rain, which forms when pollutants in the atmosphere combine with precipitation, causes leaching out of aluminium from the soil which poisons and often kills fishes. When the animals consume the particulate coated plants (especially with Fluorine, Lead, Arsenic) they suffer with Arsenic poisoning and lead poisoning. Lead poisoning causes bronchitis and lack of appetite in pet animals.

Table 2. Diseases caused by the excess of pollutants in air.

S/N	Parameter	Air Quality Standards source: CPCB			Diseases in Animals
		Industrial Area	Residential Area	Ecological sensitive zone	
1	SO _x (µg/m ³)	120	80	30	Suffocation, Lung embolism, reproductive failure, damage veins of brains, skin disease and chronic bronchitis.
2	NO _x (µg/m ³)	120	80	80	Impaired lung function, damages Internal enzyme system, Asthma, Disturbances in blood circulation
3	NRSPM(µg/m ³)	500	200	100	Asthma, Suffocation, Lesions, Damages respiratory track, Tumour
4	RSPM (µg/m ³)	500	60	60	Cough, Whooping cough, cough, Lesions

C. Effects of Pollutants on Vegetation

Pollutants from car exhaust, factory emissions, fuel combustion and other sources can form brown cloud over some cities. Vegetation can be injured when exposed to these high concentrations of various air pollutants.

Air pollution can damage vegetation in a variety of ways- acidification, eutrophication and ground level ozone. Pollutants such as sulphur dioxide, ozone, fluorides and peroxyacyl nitrate damage the leaves of plants. Ground-level ozone can cause reductions in agricultural crop and commercial forest yields, deduction in growth and survivability of tree seedlings, and more chances of plant susceptibility to disease, pests and other environmental stresses (such as harsh weather). Damage of Crop and forest can also result from acid rain and from increased UV radiation caused by ozone depletion.

Spraying of various pesticides and other agricultural practices has exposed the plants to larger number of air pollutants which are ultimately adversely affecting their growth and metabolism by destroying chlorophyll content and disrupting photosynthesis. Studies have shown impact of air pollution on the following properties of plants, the Ascorbic acid content (Hoque *et al.*, 2007), Chlorophyll content (Flower *et al.*, 2007), leaf extract pH (Klumpp *et al.*, 2000), Relative water content (Rao 1979), Soluble Sugar content (Helle-bust and Graigie 1978; Assade *et al.*, 2011), Proline content

(Bates, *et al.*, 1975). following pollutants have these effects

- SO₂ causes bleached spots on the leaf surface, chlorosis (i.e. loss of chlorophyll and yellowing of the leaf), chronic injury to spinach and other leafy vegetables.
- NO₂ causes abscission (premature leaf fall) and also suppresses growth of plants which results in reduced yields of crop plants.
- Ozone causes bleaching and necrosis (dead areas on a leaf structure) and damages leaves.
- PAN (peroxyacetyl nitrate) damages leafy vegetables causing glazing or bronzing of underside of leaf, premature fall, discoloration and curling of sepals.

D. Economic Effects of Air Pollution

The projected increase in concentrations of various air pollutants will in turn lead to grave effects on the economy. Various economic losses due to air pollution are as-

- Direct or indirect losses due to air pollution: On human health, livestock, plants
- Losses to various materials due to corrosion.
- Maintenance cost on inside and outside of buildings for restoring of objects or merchandise exposed to pollution.
- Cost for the adoption of technical measures for the suppression of smoke or emissions from factories.

(5) Various indirectly losses due to pollution, such as increased transport costs during smog; wasted electricity due to premature twilight caused by smoke, etc.

According to The OECD report, global healthcare costs related air pollution are projected to increase from USD 21 billion in 2015 to USD 176 billion in 2060 as well as by 2060, the global annually lost working days, which affect labour productivity, are projected to reach 3.7 billion (currently around 1.2 billion). The impacts of outdoor air pollution on market include impacts on labour productivity, health expenditures and agricultural crop yields. These impacts are projected to lead to global economic costs that gradually increase to 1% of total global GDP by 2060.

E. Effect of Air Pollution on Climate

Air pollution and climate change are related closely. The main sources of CO₂ emissions (burning of fossil fuels etc.) are not only major sources of air pollutants but also they are foremost cause of climate change. Also, many air pollutants which are also harmful to

human health and various ecosystems contribute to climate change by affecting incoming sunlight either by reflection or by absorption, with some pollutants warming and others cooling the Earth.

Deforestation and fuel combustion in industries and automobiles are causing increase in the CO₂ content of the atmosphere which is expected to be double by the year 2020. This increase in amount of CO₂ will increase the atmospheric temperature of earth which will cause the melting of polar ice, glaciers etc. this will consequently cause the flooding of coastal towns (i.e. green house effect). Pattern of rainfall also changes due to air pollution which will affect agricultural output.

F. Effects of Air Pollution on Materials

Air pollutants along with various climatic parameters, are of major causes for the deterioration of materials. The important pollutants affecting materials are SO₂ and sulphates, NO_x and nitrates, chlorides, CO₂ and ozone. Various Materials are affected by pollutants in the following four ways: Corrosion, Abrasion, Deposition and removal of materials, Chemical attack.

Table 3: Air pollution damage to various materials.

Materials	Principal air pollutants	Effects
Metals	SO ₂ , acid gases	Corrosion, spoilage of surface, loss of metal, tarnishing
Building materials	SO ₂ , acid gases and particulates	Discolouration, leaching
Paint	SO ₂ , H ₂ S, particulates	Discolouration
Textile and textile dye	SO ₂ , acid gases and Ozone, NO ₂	Deterioration, reduced tensile strength and fading
Rubber	Oxidants, Ozone	Cracking, weakening
Leather	SO ₂ , acid gases	Disintegration, Powered surface

III. CONCLUSIONS

Over the year air pollution has increased and as various data suggest it still have upward trends. Gases like SO_x, NO_x etc and particulates are one of the main constituents of air pollution. These pollutants are causing various cardio-vascular and respiratory disease in human similarly they also have very adverse effect on plants and animals, even global economy is in reach of its bad effects. For the remediation of these effects many organization (WHO, CPCB etc.) are taking steps but there's no one-size-fits-all recipe for reducing these adverse impacts of air pollution. As both the sources of air pollution and the economic consequences that arise because of air pollution are very unequally distributed across different areas, policies are needed to be tailored that they act according to specific local circumstances. Nevertheless, the implementation of various policies, such as incentivising the adoption of end-of-pipe technologies and implementing air quality standards and emission pricing, shall certainly help human race to avoid the worst impacts of outdoor air pollution.

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