

ENVIRONMENTAL AND HEALTH IMPACTS OF AIR POLLUTION: AN EVALUATION IN INDIAN CONTEXT

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ABSTRACT

Air pollution is considered as one of the major drivers of climatic variation in the world. It is now the biggest environmental as well as health risk. At present, nine out of ten people breathe polluted air. It is the main cause of 11.6 percent of universal deaths. Each year/almost 5,43,000 children below five years die as a result of respiratory problems connected to air pollution. Therefore, air pollution has emerged as an important issue all over the world. India is no exception from this problem and also facing serious air pollution, especially in its big cities. The solution to this problem is very complex because of the existence of wide range of pollutants and sources. Understanding the seriousness of this problem, the Government of India has taken various steps for the control and prevention of air pollution in the country. The Ministry of Environment and Forests, Central Pollution Control Board and State Pollution Control Boards have been set up for protecting the environment and controlling the pollution in the country. The paper provides an insight into the extent of air pollution in India, emission sources of air pollutants and the environmental and health impacts of air pollution. The paper also deals with some of the air pollution control measures taken by the Government of India.

KEY WORDS : Air Pollution, Environment, Health, Pollutants, Particulate matter

INTRODUCTION

Air pollution is considered as one of the top ranking environmental and health hazard in the world, particularly in developing countries like India. Now India projected to have worst levels in the world as compared to other countries. Air pollution states that the existence of harmful toxins in the air, which contaminate the air quality that everyone breathes. Almost 90 percent of the population is breathing hazardous air globally. The two possible ways of air pollution are man-made causes and natural causes. So air pollution is a combination of some particles and numerous gases that can leads to harmful concentrations in the air both indoors and outdoors. Its adverse effects can range from large health risks to increasing atmospheric temperatures. It leads to an increase in respiratory problems in the people, especially in child population.

According to World Health Organization (WHO), air pollution constitutes 7 million premature deaths per year, though 92 percent of the global population is breathing toxic air. In developing countries, 98 percent of children under the age of five breathe toxic air. Therefore, air pollution is the leading cause of mortality of children under the age limit of 15, which killing 600000 children annually. The World Air Quality Report 2019 delivers PM2.5 data in order to draw attention to the present state of particulate pollution all over the world and nurture the awareness about accessibility of data related to air quality. The regions like South Asia, Southeast Asia and Western Asia bring the greatest burden of fine Particulate Matter (PM2.5) pollution in the world. Similarly, the cities within these regions also rank in the top of the worldwide city ranking in case of pollution. During 2019, of the top 30 most polluted cities in the world, 21 cities are situated in

India, 27 are in South Asia, and then the entire top 30 cities are located within Asia. The major air pollutants consist of particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO₂), ozone (O₃) and carbon monoxide (CO).

PM_{2.5}

PM_{2.5} is widely considered as most harmful pollutant to human health. It is defined as some airborne particles both solid and liquid measuring less than 2.5 microns (more than 100 times thinner than a human hair) in size. These pollutants are formed due to chemical reactions and burning fuels that occur in the air. The natural processes like forest fires also create PM_{2.5} in the atmosphere. These are also the main reason for happening of smog. Its microscopic size permits these particles to go into the blood stream through the respiratory system and spread throughout the body, producing far-reaching health issues with asthma, heart disease, lung cancer and so on. Similarly, air pollution leads to increased number of severe respiratory infections, low birth weight and stroke. The two important guidelines relating to PM_{2.5} pollutants are

World Health Organization (WHO) Guideline

It has sketched an annual mean vulnerability of 10 µg/m³ to reduce the risk of health effects from PM_{2.5}.

United States Air Quality Index (US AQI)

This is the most widely accepted index connecting for air quality. It converts pollutant absorptions into a color-coded scale of 0 to 500, where the higher value shows the bigger health hazard. This index 'Good' range (<12 µg/m³) is slightly greater than the World Health Organization (WHO) Air Quality Guideline (<10 µg/m³).

Today, air pollution has considered as a worldwide public health issue and is recognized as a most important environmental health risk by agencies like the WHO and the different Governments across the world. As per the latest data from World Health Organization (WHO), the indoor and outdoor air pollution were accountable for 3.7 million deaths of persons aged under sixty. Therefore, the prime air pollutants have been broadly classified as indoor and outdoor pollutants.

MATERIALS AND METHODS

The present study is descriptive in nature. It was

mainly based on secondary data, which is collected from the published and unpublished reports, records and the contributions of several institutions and organizations. Specifically, the secondary sources comprise data from World Health Organisation (WHO) and Central Pollution Control Board (CPCB), World Air Quality Report, *National Clean Air Programme (NCAP)* report, UN Environment Programme (UNEP) report, journals, books and websites.

RESULTS AND DISCUSSION

Even though India's air pollution better in 2019 by 20 percent as compared to previous year, the average yearly exposure to PM_{2.5} greater than the World Health Organization (WHO) suggested standards by a gigantic 500 percent. These making India's air quality is a large threat not only to human beings but also to the whole environment. The major sources of air pollution are depicted in Table 1.

Table 1. Main Sources of Air Pollution

Source	Percentage
Dust and Construction	45
Waste Burning	17
Transportation	14
Diesel Generator	9
Industries	8
Domestic Cooking	5
Others	2

Source: NCAP Report

Dust and Construction constitute about 43 percent to India's air pollution followed by Waste Burning. Dust and Construction activities are mainly related to urban areas at the same time as Waste Burning especially in the rural areas that is agriculture.

According to the World Air Quality Report 2019,

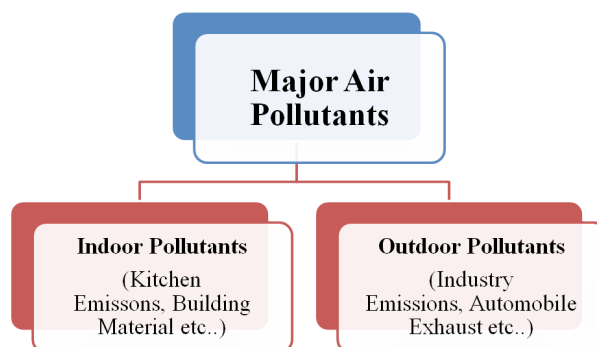


Fig. 1. Classification of Air Pollutants

Bangladesh (83.3 micrograms per cubic metre) takes top position among the most polluted countries for PM 2.5 followed by Pakistan (65.8), Mongolia (62.0) and Afghanistan (58.8). India (58.08) ranked fifth in the most polluted countries in the world and accounts for two-thirds of the world’s most polluted cities. 21 out of the world’s most polluted 30 cities are in India, 14 of the highest 20. Six cities from India are in the top ten. In the order of their ranking, the 21 Indian cities which are in world’s 30 most polluted cities are Ghaziabad, Delhi, Noida, Gurugram, Greater Noida, Bandhwari, Lucknow, Bulandshahr, Muzaffarnagar, Baghpat, Jind, Faridabad, Coraut, Bhiwadi, Patna, Palwal, Muzaffarpur, Hisar, Kutail, Jodhpur and Moradabad.

Ghaziabad in India is ranked as the world’s most polluted city. It recorded an annual PM2.5 average of 110.2 mg/m³, whereas the safe level is 60 mg/m³ in 2019. Hotan in China occupies second spot followed by Gujranwala and Faisalabad in Pakistan and then New Delhi in India in the fifth place. Noida and Greater Noida in India were in the sixth and ninth position in the list. The annual PM2.5 average of Noida and Greater Noida was 97.7 mg/m³ and 91.3 mg/m³, respectively, as per the World Air Quality Report 2019.

New Delhi faces worst air pollution as compared to any global capital. And Indian cities constitute 6

of the 10 world’s most polluted areas. New Delhi’s troubles are caused by vapors from its sclerotic traffic and by diesel generators and the burning of fossil fuels. Industry contributes its part as does the burning of its waste and farmers are also alight waste for setting fields after crops are harvested.

Table 3. Most Polluted Cities in the World

Rank	Cities	PM2.5(micrograms/cu.m)
1	Ghaziabad (India)	110.2
2	Hotan (China)	110.1
3	Gujranwala (Pakistan)	105.3
4	Faisalabad (Pakistan)	104.6
5	Delhi (India)	98.6
6	Noida (India)	97.7
7	Gurugram (India)	93.1
8	Raiwind (Pakistan)	92.2
9	Greater Noida (India)	91.3
10	Bandhwari (India)	90.5

Source: World Air Quality Report, 2019

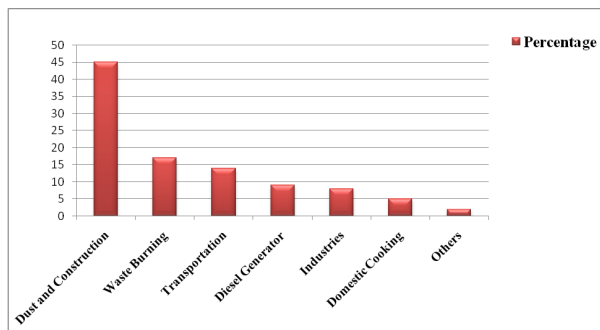


Fig. 2. Main Sources of Air Pollution

Table 2. Most Polluted Countries (Accounting for Population)

Rank	Country	PM2.5 (micrograms/cu.m)	Population
1	Bangladesh	83.30	166 mn
2	Pakistan	65.81	201mn
3	Mongolia	62.00	3 mn
4	Afghanistan	58.80	36 mn
5	India	58.08	1354 mn

Source: World Air Quality Report, 2019.

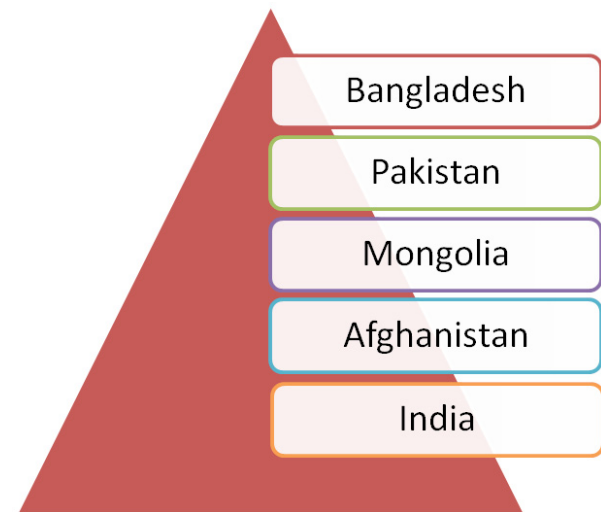


Fig. 3. Ranked the Countries on the Basis of Air Pollution

Environmental Impacts

Air pollution can cause a variety of environmental effects:

Global warming

Global warming is considered as one of the most disturbing factor for environmentalists and scientists. It is a direct result of the greenhouse effect produced by the large emission of carbon dioxide (CO₂) and methane into the atmosphere. The majority of these emissions are formed by the industry. According to the estimates, the average global temperature increased from 3°C to 8°C in the

Table 4. World's Worst Ten Most Polluted Capitals on the Planet

Rank	City	Country	PM2.5 Concentration
1	Delhi	India	98.6
2	Dhaka	Bangladesh	83.3
3	Ulaanbaatar	Magnolia	62.2
4	Kabul	Afghanistan	58.8
5	Jakarta	Indonesia	49.4
6	Kathmandu	Nepal	48.0
7	Hanoi	Vietnam	46.9
8	Manama	Bahrain	46.8
9	Beijing	China	42.1
10	Tashkent	Uzbekistan	41.2

Source: World Air Quality Report, 2019

next 100 years. This will adversely affect the climatic conditions, allocation of plants and animals in the nature and also creates the disorder in agriculture and food productivity, melting of snow caps and consequential increase in sea levels. This will submerge some parts of coastal areas of Calcutta, London, New York and some other major cities in the world.

Climate Change

Climate Change is an important effect of global warming. When the average global temperature increases, there is an interruption in the typical climatic cycles all over the world. Due to the climate change, the larger part of the poles is melting and ultimately leads to flooding and the increasing of sea levels.

Formation of Photochemical Smog

The smog is formed when the pollutants like hydrocarbons and nitrogen oxides are combining together in the presence of the sunlight. It is a mixture of various gases. It is produced by photochemical reactions in the atmosphere; so it is called the photochemical smog. The term 'smog' is derived from two words - smoke and fog. It produces a yellowish brown haze in the atmosphere especially during winter seasons and it hampers the visibility. At the same time it causes many respiratory problems and allergies because it comprises lot of polluting gases.

Formation of Acid Rain

Sulphur dioxide (SO₂) and nitrogen oxides (NO_x), released into the atmosphere when fossil fuels are burned, react with water in the atmosphere formed

sulphuric acid and nitric acid. These acids fall to the Earth along with the rain. This phenomenon is known as acid rain. The pH of the acid rain varies from 3 to 6. In the environment, the acid rain damages trees and soils and water bodies to acidify, this makes the water unsuitable for some fish and wildlife.

Aerosol Formation

Aerosol is created by the scattering of liquid or solid substance in the atmosphere. If the aerosols form a thick layer in the troposphere, they affect the weather conditions and also affect the photosynthesis.

Depletion of Ozone

The Earth's upper atmosphere called stratosphere has ozone (O₃). Ozone is recognized to absorb the Ultraviolet (UV) rays, which is present in the sun's radiation. Ozone forms a layer that protects life on the earth from the harmful effects of the UV rays. But this 'good' ozone is gradually being damaged by man-made activities and chemicals known as ozone-depleting substances like chlorofluoro carbons (CFCs) and hydro chlorofluorocarbons. Thinning of this protective layer can leads to increased amounts of UV rays into the Earth, which can caused large cases of skin cancer and impaired immune systems. UV rays can also harm to sensitive crops like soybeans and reduce the total crop yields in the world.

Crop and Forest Damage

Air pollution can harm crops and trees in different ways. It leads to reduction in agricultural crops and commercial forest yields. It reduced the growth of trees and survivability of the tree seedlings, and also amplified plant susceptibility to diseases, and other environmental stresses like harsh weather conditions. The crop and forest damage can result from acid rain and from increased amount of UV radiation caused by the depletion of ozone.

Extinction of Animal Species

As the masses of the poles melt and consequential increase in sea levels, various animal species, whose continued existence depends on rivers and oceans, are threatened all over the world. Deforestation and the poor soil quality also denote the vanishing of ecosystems and various habitats. And definitively creates an imbalance in the nature of many wild species.

Health Impact

As per World Health Organization (WHO), air pollution leads to seven million premature deaths in every year worldwide. Nine out of ten people breathe polluted air globally. Air pollution is one of the biggest planetary health risks. India has some of the worst levels in case of air pollution globally. Every year, 1.24 million deaths are reported in India due to air pollution.

Particulate Matter (PM₁₀, PM_{2.5})

Particulate Matter (PM) is a complex mixture of very small airborne particles such as dust, drops of liquids and soot. The major part of PM is formed in urban areas directly from burning of fossil fuels. Some other sources of PM are dust, soot, diesel emissions and the secondary particle creation from vapors and gases. Coarse Particulate Matter (PM₁₀ - particles which is less than 10 microns in diameter) is well-known to cause major nasal and respiratory health issues. Fine Particulate Matter (PM_{2.5} - particles which is less than 2.5 microns in diameter) enters directly into the lungs and results strokes, heart attacks, asthma, bronchitis and premature death. Studies reveal that high level of PM_{2.5} exposure can weaken brain growth among children.

Ozone (O₃)

Ozone layer in the atmosphere can protect the earth from severe ultraviolet radiation from sun. But ozone at ground level, an important ingredient of smog, is a deep-rooted respiratory irritant. It can cause lung inflammation, chest pain, wheezing, shortness of breath, coughing and respiratory diseases like asthma and pneumonia. The long-term exposure of it has been connected with chronic respiratory problems. Almost 142,000 people died in 2010 as a result of exposure to ozone, an increase of 6 percent since 1990.

Nitrogen oxides (NO and NO₂)

Nitrogen oxide (NO) and Nitrogen dioxide (NO₂) are formed primarily from the transportation sector. It can cause several chronic diseases like asthma and bronchitis, and also leads to a greater risk of heart diseases.

Sulfur dioxide (SO₂)

SO₂ is a colourless gas that contains sulfur. It was produced by the burning of fossil fuels. It causes eye irritation, increases susceptibility to respiratory infections, cardiac diseases, worsens asthma and

bronchitis and adversely affects the cardiovascular system which leads to increased mortality rate. When SO₂ combines with water and forms sulfuric acid; this is the major constituent of acid rain, a well-known supplier to deforestation.

Carbon monoxide (CO)

Carbon monoxide (CO) is a colourless and odourless gas, which is produced generally by vehicles and fuel combustion boilers. It can cause visual impairment, headaches, reduced cognitive ability and functioning, and reduced the ability to carry out complex tasks in everyday life. A very high level of Carbon monoxide (CO) can also result in unconsciousness and finally death.

Major Government Legislations and Initiatives

The Air (Prevention and Control of Pollution) Act, 1981

The Act designed for abatement, prevention and control of air pollution, maintaining air quality and the establishment of Boards at the Central and State levels for prevention and prevention of air pollution.

The Environment (Protection) Act, 1986

It is considered as an umbrella legislation, which is designed to ensure a strong framework for the efficient co-ordination and functioning of central and state authorities established under the Water Act, 1974 and Air Act, 1981.

National Air Quality Monitoring Programme

The Central Pollution Control Board (CPCB) in India has been executing the programme of ambient air quality monitoring all over the country, which is known as National Air Quality Monitoring Programme (NAMP). The National Air Quality Monitoring Programme (NAMP) is undertaken for determining the status and trends of ambient air quality, ascertain the compliance of NAAQS, recognize non-attainment cities in India, understand the natural process of cleaning in the atmosphere and undertake preventive and corrective measures for air pollution in the country.

National Ambient Air Quality Standards (NAAQS)

National Ambient Air Quality Standards (NAAQS) were notified in 1982 and duly revised in 1994 on the basis of the land uses and health criteria. It have been again revised in 2009 for 12 pollutants, that is, Sulphur dioxide (SO₂), Ozone, Nitrogen dioxide

(NO₂), Particulate matter having size less than 2.5 micron (PM_{2.5}), Particulate matter having size less than 10 micron (PM₁₀), Lead, Nickel, Carbon monoxide (CO), Benzene, Ammonia, Arsenic and Benzopyrene.

National Air Quality Index (AQI)

The National Air Quality Index was launched in 2015 to disseminate the air quality information in the country. It classifies the air quality of a day taking into account the criteria pollutants through distinct colour codes. Further, it also relates the air quality with likely health impacts. It has six groups of air quality such as Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe with different colour schemes. The AQI considers eight major pollutants, namely, Particulate matter (PM₁₀ and PM_{2.5}), Nitrogen dioxide, Sulphur dioxide, Ozone, Carbon monoxide, Ammonia and Lead.

CONCLUSION

All types of pollution especially air pollution is a complicated problem in the country. It negatively affects the health of the people and the entire economy of the nation. It has emerged as one of the foremost causes of deaths in India. The Central and the State Governments of India have recognized the unfavorable effects of air pollution and there is improved seriousness on addressing the air quality issues among the stakeholders. The Government of India has taken various measures to control and prevent air pollution. Further, the government wants to enact adequate laws for the prevention of increasing air pollution in the country and the emission standard of major air pollutants in the atmosphere. It is very important that an integrated, comprehensive and well organized long-term plan of actions, involving the co-ordination between different departments and ministries of the government, is drawn to tackle this issue and ensure that the people in the country breathe clean air.

REFERENCES

- Aman, H. 2017. A Comprehensive Study of Air Pollution in India. From: <https://www.youthkiawaaz.com/2017/10/a-comprehensive-study-of-air-pollution-in-india/>
- Central Pollution Control Board, Monitoring Network, 2019. From: <http://cpcb.nic.in/monitoring-network-3>.
- Gargava, P., Sengupta, B. and Biswas, D. 2000. Strategies for Prevention and Control of Air Pollution in India. From: https://www.researchgate.net/publication/236179607_Strategies_for_Prevention_and_Control_of_Air_Pollution_in_India
- Ghosh, D. and Parida, P. 2015. Air Pollution and India: Current Scenario. *International Journal of Current Research*. 7 (11) : 22194-2219.
- Guttikunda, S. K., Goel, R. and Pant, P. 2014. Nature of Air Pollution, Emission Sources, and Management in the Indian Cities. *Atmospheric Environment*. 95: 501-510.
- Jalan, I. and Dholakia, H.H. 2019. What is Polluting Delhi's Air? From: <https://www.ceew.in/sites/default/files/CEEW>
- Kandlikar, M. and Ramachandran, G. 2000. The Causes and Consequences of Particular Air Pollution in Urban India: A Synthesis of the Science. *Annual Review of Energy and the Environment*. 25 : 629 - 684.
- Malla, C. 2019. Particulate Matter Air pollution in India: comparing with USA and China. From: <https://www.researchgate.net/publication/336318843>
- Ministry of Environment, Forests and Climate Change, The National Clean Air Programme, 2019. From: <http://envfor.nic.in/sites/default/files/press-releases/NCAP%20Report%20Full.pdf>
- NCAP Report, Ministry of Environment, Forest and Climate Change Government of India, 2019. From: http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf
- Rizwan, S. A., Nongkynrih, B. and Gupta, S. K. 2013. Air pollution in Delhi: Its Magnitude and Effects on Health. *Indian Journal of Community Medicine*. 38 (1): 4 - 8.
- Sharma, A. K., Baliyan, P. and Kumar, P. 2017. Air pollution and public health: the challenges for Delhi, India. *Reviews on Environmental Health*. 33 (1) : 77 - 86.
- UN Environment, Air Pollution in Asia and the Pacific: Science-based Solutions, 2018. From: <http://ccacoalition.org/en/file/5689/download?token=qAsWDG2Y>
- UNEP's 2019 Report, Air Pollution in Asia and the Pacific: Science-based Solutions. From: <https://www.unenvironment.org>
- World Air Quality Report 2019. From: [file:///C:/Users/User/Downloads/2019-World-Air-Report-V8-20200318%20\(6\).pdf](file:///C:/Users/User/Downloads/2019-World-Air-Report-V8-20200318%20(6).pdf)
- World Health Organization (WHO), WHO Global Ambient Air Quality Data-base (update 2018). From: <https://www.who.int/airpollution/data/cities/en/>