World's Most Polluted Cities: A Brief Review

Prannoy Deep Sharma, Shruti Patil, . Jidnyasa Pawar

M.tech (energy and environment)
Vellore Institute of Technology, Vellore, India

Abstract: *Air pollution is increasing and getting worse in the urban areas all around the world, hitting the poorest city inhabitants hardest. According to the World Health Organization almost 98% of the urban areas affected by pollution are from the low and middle income countries. As per the researches particulate matter is the main cause of pollution in these countries. Out of this particulate matter, particles of size less than 2.5 micrometers ($PM_{2.5}$) are the deadliest as they can enter the human lungs easily. As per the scientists in the high income countries air pollution levels are lower and are improving continuously, whereas in the developing world especially Asia pollution level is high and is getting degraded day by day. The best example of these Asian countries is India and China, where the air pollution level has surpassed all the countries around the world. This paper reviews about the status of air quality in India and why it is more serious than other countries.*

Keywords: *Pollution, particulate matter, Asia*

I. Introduction

Air pollution refers to the release of pollutants into the air which are harmful to human health and the planet as an entire. Air pollutants are released in a massive quantity which damage the health of humans or animals, kill plants or prevent them developing well, harm or disrupt a few other aspect of the environment , or create some other form of nuisance (decreased visibility, perhaps, or bad odour) (1).

Air pollutants consists of gaseous, liquid, or stable substances that, when found in excessive limits, for a enough time and above optimum level, tend to interfere with human comfort, health or welfare, and cause environmental harm. Air pollutants cause acid rain, ozone depletion, photochemical smog, and many other harmful effects. (2)

Release of various gaseous emissions and particulate be counted (PM) has been at the upward thrust because of rampant industrialized increase. Anthropogenic emissions of various types are being pumped into the environment (known as primary pollution) and lead to the formation of recent pollution due to chemical reactions within the ecosystem (referred to as secondary pollutants). Those are building up the priority of ambient air pollutants (AAP) as an outstanding global threat to human fitness in different of approaches.

Urban air pollutants are generally the end products of combustion of fossil fuels which are utilized in transportation, electricity production, industrial region, and other financial areas. Indoor air pollutants (IAP), is an extreme area of concern in rural areas, as majority of this populace keeps to rely on traditional biomass for cooking and space heating and depend upon kerosene or different liquid fuels for lighting, all of that are distinctly possibly to cause excessive ranges of HAP. More than 70% of the populace in India relies upon on conventional fuels (firewood, crop residue, cow dung, coal and lignite) for cooking and nearly 32% rely upon kerosene for lighting fixtures About 3 billion people around the world depend upon the conventional biomass for the purpose of cooking and an predicted 500 million households depend on kerosene and similar for the cause of lighting (WHO, 2015). In rural India, for instance, best 11.4% of the households use LPG for cooking (Census 2011).

Air pollutants include a range of various harmful substances in different physical and chemical forms. Many of them are believed to be gravely dangerous to human fitness. WHO specializes in four health-associated air pollutants, specifically, particulate be counted (PM), measured as entity with an aerodynamic diameter lesser than 10 μm (PM_{10}) and lesser than 2.5 μm ($PM_{2.5}$), nitrogen dioxide, sulphur dioxide and ozone. The focus on just these four are for the sake of tracking the general country of air best and it does not mean that the other air pollutants do not impact health of human beings and that of the surroundings (WHO, 2006).

In 2012 alone, 7 million deaths in the world have been because of the mixed outcomes of ambient (3.7 million) and indoor (4.3 million) air pollutants (WHO, 2015). Ischemic heart sickness is at the forefront on this rating of reasons, and COPD, lower respiratory infections, lung cancer also are amongst the pinnacle five causes of deaths globally. Air pollutants lead to a considerable quantity of mortality and morbidity. Air pollution has always been a subject of public concern. Particularly from the mid-twentieth century onwards, there has been a

growing societal impetus to curtail and counteract the hazardous effects of air pollution. In recent decades, as anthropogenic air pollution has reached historically high levels, international public and scientific interest has intensified towards this topic. Air pollutants influence both directly and indirectly. Direct influences encompass fitness, harm of substances and ecosystems, and poor visibility. Less direct influences include 'acid rain' which results from chemical substances being launched into the environment. Adjustments in human behaviour also end result from air pollutants, together with population of closely polluted city regions relocating or tourists staying away from polluted towns. The main impact is climate change. The biomass and fossil fuels that purpose air pollutants also have brought on the warming of the earth's ecosystem resulting from the release of greenhouse gases (GHGs). Therefore, air pollution has many and various affects.

Road transport is the main supply of nitrogen dioxide and carbon monoxide. Power stations and different industrial sources also produce nitrogen dioxide. Industry is the primary source of sulphur dioxide. Particulates come from many assets, along with street shipping, electricity stations and other industry. The burning of timber or coal for domestic heating can also be an important source of sulphur dioxide and particles. Ground level ozone isn't always emitted at once from any source. As a substitute it's far formed while sunlight acts on nitrogen dioxide and different atmospheric substances near Pollutant fitness effects at very excessive degrees. Nitrogen dioxide irritates the airways of the lungs, increasing the sulphur dioxide symptoms of these suffering from lung illnesses. Ozone particles can be carried deep into the lungs wherein they are able to cause irritation and a worsening of heart and lung illnesses. Carbon monoxide prevents the everyday exchange of oxygen by way of the blood. This will cause a full-size reduction inside the supply of oxygen to the coronary heart, in particular in human beings stricken by heart ailment. Ground level ozone is unique to the ozone layer, that is suffering from ozone depleting substances, including CFCs, which have been launched into the surroundings.(3)

II. Air pollution in India

For the past many years China used to be the most polluted country around the world but as per the recent reports of two years India has replaced China. Delhi the capital was the main reason due to which India topped the charts of the most polluted countries of the world. Often both the capitals Delhi and Beijing are compared when it comes to air pollution level. As per the 2013 reports, earlier China which used to be the most polluted country of the world now includes only four of its cities among the top 20 most polluted cities of the world. According to one of the reports of 2016 the fine particulate matter levels in the capital crossed **128 micrograms per cubic meter**, when compared to Beijing with 81 and Washington D.C's with 12 micrograms per cubic meter. These studies also show that there are about 0.5 million deaths each year in India due to air pollution.

It is very difficult to analyse the exact number of deaths due to air pollution but by the use of modelling and statistical algorithms an approximate amount can be guessed. Thus as per the previous year's data there have been few million premature deaths due to particulate matter in India. The most severely affected region of the country is the Indo-Gangetic region, which includes the northern strip. According to the 2014 and 2015 reports world's most polluted cities were:

Rank	City	$PM_{2.5}$
1.	**Varanasi**	180
2.	Al Jubail	152
3.	Xingtai	131
4.	Baoding	129
5.	Shijiazhuang	126
6.	Pasakha	117
7.	**Delhi**	116
8.	Handan	116
9.	Greater Cairo	116
10.	Hengshui	108

Table 1. 2014 Data

Rank	City	$PM_{2.5}$
1.	**Muzaffarpur**	197
2.	Pasakha	150
3.	Novi Sad	142
4.	**Delhi**	123
5.	Greater Cairo	117
6.	**Agra**	115
7.	**Varanasi**	114
8.	**Kanpur**	108
9.	**Lucknow**	108
10.	Baoding	107

Table 2. 2015 Data

As per the data given above, in 2014 only two cities of India were among the top 10 most polluted cities of the world (indicated by red colour) but this data was drastically changed within one year. In 2015 India included six of the world's most polluted cities, which is an alarming state for the country.

III. Major causes of pollution in India

There are a number of air pollutants like CO, NO_x, SO_x, PM_{10}, ozone, which are exceeding the standard level in the environment but out of these $PM_{2.5}$ is the most harmful one. The main causes of air pollution in India are the small scale industries like brick kilns, vehicle exhausts; open burning of fuels for coking and heating, burning of different type of wastes in an open environment and even the large scale industries like power generation. Pollutants which are specifically contributing in the increase of the concentration of $PM_{2.5}$ in the ambient air are:

- Soil and road dust – 20%
- Industries – 15%
- Open waste burning – 15%
- Diesel generators – 10%
- Power plants – 5%
- Vehicle exhaust – 30%

The main composition of particulate matterincludes:

1. Primary Aerosols- Metals and Elements
    - Sodium
    - Aluminium, silicon calcium (soil and road dust)
    - Calcium (cement industries)
    - Aluminium, selenium, cobalt, arsenic (burning of coal)
    - Vanadium, nickel, manganese, iron (oil burning)
    - Zinc, lead, potassium (incineration)

2. Secondary Aerosols- Gas
    - Sulphates (diesel and coal combustion)
    - Ammonium (fertilizers)
    - Nitrates (vehicle exhausts)

$PM_{2.5}$ is considered to be the deadliest pollutant and is very challenging to control it. This due to its very small size and the other harmful components which are released along with it (mentioned above). The particles are of size of 2.5µm, which can easily enter the human lungs and lead to life causing diseases.

IV. Top most polluted cities of the world

Previously it was shown that India included six cities among the top 10 most polluted cities of the world. As per the latest reports this data got more devastating because India now has **14 most polluted cities out of 15,** all around the world.

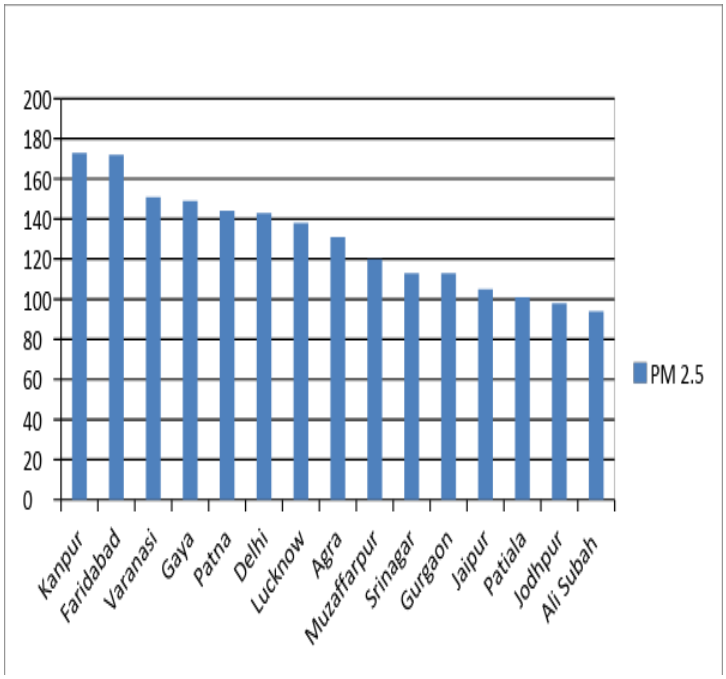

Fig.115 most polluted cities of the world

Thus as per the data given it can be deducted that year after year the country's ambient air quality got degraded. It not only has adverse impacts on environment but is affecting the social and economic scenario of the country as well. There were reports that the airplanes from US refused to land in Delhi, as there was smog and the vision was not suitable. This level of pollution has also reduced the tourists visiting the heritage places of the country. The winter season is considered to be the best time for the pollutants to spread easily in the environment but in the above mentioned cities smog and unclear sky can be observed throughout the year.

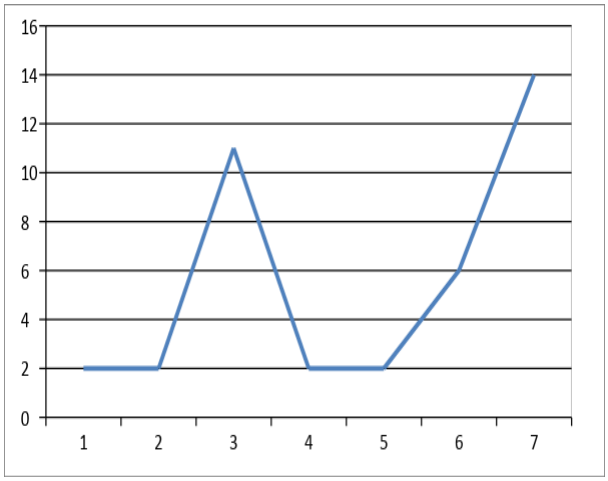

Fig 2. Number of Indian cities among the world's most polluted

The figure shows the varying number of polluted cities of the country in the world's top polluted, through previous years. Now as per the latest reports it is an alarming situation for the nation. According to the reports discussed earlier about half a million people are killed each year due to pollution in India.

With improved air quality monitoring, people are now beginning to understand the effects and spread of air pollution in India. While the capital city Delhi is at crossroads and is expected to bend the curve posts of the previous years, the other pollution hotspots are proliferating across the country. Though from the past two years government has reduced and in places banned the sale of crackers, which was considered the major cause of pollution in the country but that is not the case. With increasing population, the large scale industries, vehicle production, household cooking emissions and construction sites are also increasing at an enormous rate. If the ambient air quality is not controlled now, the day is not far that people dying due to pollution will be more than the deaths due to natural cause.

V. Conclusion

India is a second highest populated country in the world. To serve this much population there are no enough resources available and this is the root cause for the pollution. Day by day economy of country is improving and population is diverting towards new vehicles, air conditioning equipment and other advanced machines. To maintain any equipment, instrument or machinery at desired emission standards there should be some planned check-ups, maintenance and repairs. India is lagging behind in these aspects but in European and other countries, they have properly managed systems for maintenance of all the machinery and instruments. There should be development in sustainable ways to reduce air pollution. Adoption of energy conservation practices also has great impacts on air pollution. There should be serious control on air pollution as it impacts severely on human health and environment. The rules and regulations should be strictly followed by government to control all types of air pollution. The stakes are truly high and world needs to wake up and begin acting right presently on the grounds that environmental issues are continually developing in number and size.

References

[1.] vox.com, (2017). *How Delhi became the most polluted city on Earth.* www.vox.com/energy-and-environment. Accessed on [6 May 2018]

[2.] timesofindia.indiatimes.com, 2018. *India tops world in bad air quality.* www.timesofindia.indiatimes.com/india. Accessed on [6 May 2018]

[3.] Hanna Zell, David Quarcoo, Cristian Scutaru, Karin Vitzthum, Stefanie Uibel, Norman Schöffel, Stefanie Mache, David A Groneberg and Michael F Spallek, *Airpollution research: visualization of research activity using density-equalizing mapping and scientometric benchmarking procedures,*Volume 10.1186/1745-6673-5-5

[4.] Dr. S. Waseem A. Ashraf, Safia Khanam and Ayaz Ahmad, *Effects of indoor air pollution on human health: A micro-level study of Aligarh City-India, 2013.*

[5.] Naveen Kishore and Surinder Deswal, *Analysis of Air Pollution In Indian Cities - A Literature Review,* (2017)

[6.] washingtonpost.com, (2016). *Air pollution in India is so bad that it kills half a million people every year.*www.washingtonpost.com/news/energy-environment. Accessed on [9 May 2018]

[7.] Dr. S. Waseem A. Ashraf, Safia Khanam and Ayaz Ahmad, *Effects of indoor air pollution on human health: A micro-level study of Aligarh City-India, 2013.*

[8.] Keiko Hirota , Shogo Sakamoto , Satoshi Shibuya and Shigeru Kashima, *A Methodology of Health Effects Estimation from Air Pollution in Large Asian Cities,* 2017.

[9.] accuweather.com, (2017). *Why air pollution in the US will likely never reach India's extreme levels.*www.accuweather.com. Accessed on [10 May 2018]

[10.] P.Thilagaraj1, R.Ravinder2, R.Kesavan3, *A study on air pollution and its impact on human health in chennai city*, 2015.