सत्यमेव जयते

Air Pollution and Public Health Emergencies

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National Institute of Disaster Management

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Resilient India - Disaster Free India

Air Pollution and Public Health Emergencies

National Institute of Disaster Management (NIDM)

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Resilient India - Disaster Free India

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FOREWORD

Globally, air pollution contributes substantially to various disease burdens, premature mortality, morbidity, reduced life expectancy, etc. with a greater impact in developing countries than in developed countries. During any disaster, air quality management is dependent on the local community preparedness and external aid. Air pollution can also lead to disasters and disasters can trigger air pollution as well. In both the cases human health and the environment would be affected.

Now, it is not possible to perceive air pollution as an isolated environmental problem. It is high time that sudden air pollution management should be implemented into state and city planning processes. Hence, there is an urgent need to respond to the situation. There is also the requirement of effective representation and well-timely dissemination of air quality information, use of accurate and complex inferences to make significant implementation in air quality-related policy decisions.

I complement Prof. Anil K. Gupta and the HER-CAP project team for this important contribution. I also thank WHO India for supporting this endeavor. The efforts of the authors are praiseworthy, as they meticulously brought in the context of this thematic paper which covers all these existing and forthcoming air-quality problems and their mitigation measures and resilience policy.

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PREFACE

Over the past few years, air pollution has become a growing problem with an increasing number of acute incidents of air pollution in many cities across the world. As a direct consequence, air quality is contributing extreme risk to public health, accounting for about one in every nine deaths per year. Every year, as per the World Health Organization (WHO), about 7 million people die tragically from air pollution-induced diseases around the world. Approximately 4 million such deaths occur in the Asia-Pacific region only.

There is an immense need for an integrated framework for dealing with air pollution as a disaster during emergencies. There is an utmost requirement of an integrated framework on preparedness guidance and planning where all governing and regulatory bodies, stakeholders, businesses, households, and communities should work together to curb air pollution emergencies.

This thematic paper has been developed under the project "Health Adaptation and Resilience: Advancing Strategies Knowledge and Capacities" (HER-CAP)" with the support of WHO India, describing the sudden air pollution episodes and its implications on the public health and how we can reduce these adverse impacts by various mitigation and adaptation strategies and relevant policies.

(Prof. Anil K Gupta)

Air Pollution and Public Health Emergencies

ABSTRACT

Nowadays, ambient air pollution is a growing public health concern as its frequency and intensity are increasing with time. It is considered as the 5th highest-ranking risk factor for mortality, worldwide, accounting for about one out of every nine deaths per year. Globally, due to rapid industrialization, urbanization and population growth, the natural atmosphere is perturbed by increased air pollution. It creates smog and acid rain, causes cancer, respiratory diseases, depletion of the ozone layer and also contributes to global warming. In recent years, air pollution has become a growing concern, with a rising number of severe accidents in many cities around the world. Sudden and severe air pollution incidents are causing disaster-like conditions that are causing an urgent public health emergency. It is high time to think about our actions and move to new sustainable environmentally friendly technologies to solve the air pollution problems. There is an urgent need that sudden air pollution management should be implemented into state and city planning processes.

Keywords: Air Quality; Climate Change; Disasters; Air Pollution; Human Health; Public Health Emergency

I. Introduction

Air pollution is a complex mixture of harmful gases and aerosols and is the most serious environmental concern among the scientific community. The unprecedented growth in industrialization, urbanization, population, fossil fuel consumption and ever-increasing transportation network are deteriorating the air quality of the environment (Seinfeld and Pandis, 2016).

Air pollution has been described as one of the "great killers of our age" due to its tremendous and severe health effects on humans (Sweileh et al., 2018). The World Health Organization (WHO) estimated that 92% of the world population is living in places with less than optimum outdoor air quality. The 68th World Health Assembly (WHA), held in May'2015, also passed a resolution recognizing air pollution as one of the leading avoidable causes of diseases and global deaths (WHO, 2015, UNEP, 2015). Later, in the year 2017, United Nations Environment Programme (UNEP); also drafted the resolution on preventing and reducing air pollution to improve air quality globally (UNEP, 2017). Air pollution is linked to various medical conditions like cancer, respiratory diseases, negative pregnancy outcomes, infertility, cardiovascular diseases, stroke, heart disease, lung cancer, cognitive decline, and others. Nearly 90% of air pollution-related deaths occur in low and middle-income countries, with nearly 2 out of 3 occurring in South East Asia and Western Pacific regions. The top fifteen countries with the highest annual mean of fine particulate matter ($PM_{2.5}$) is shown in the **Figure 1.** Among the various air pollutants, particulate matter (PM), especially fine aerosols with less than 2.5 µm is the matter of concern as these particles are generally light-weight and hence, stay in the atmosphere for a long duration and can be transported to distant places with high-velocity winds (Singh and Panigrahy, 2011; Jain et al., 2014). Despite their extremely small size, fine-mode particulate matters have significant impacts on the global radiative budget, hydrological processes and climate change (Yan et al., 2014; Zheng et al., 2015; Dong et al., 2019).

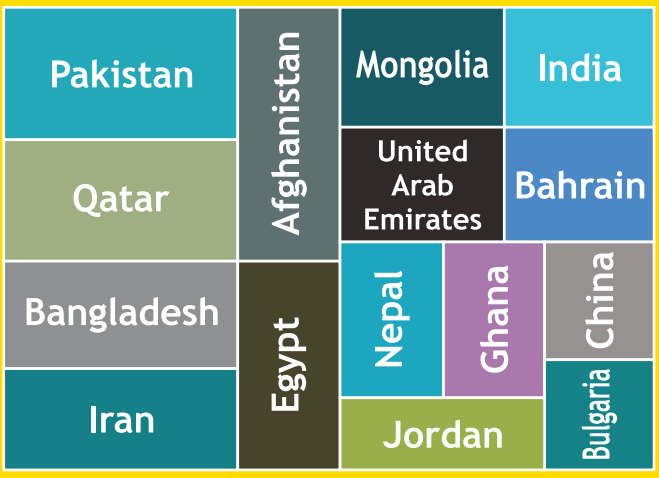

Figure 1 Top fifteen countries in the world having highest annual mean of fine particulate matter
(Source: The World Health Organization/infogr.am and Lough, 2015)

Increasing urban population and increased volume of motorized traffic in cities have resulted in severe air pollution affecting the surrounding environment and human health. It is reported that over 70-80% of air pollution in megacities in developing nations is attributed to vehicular emissions caused by a large number of older vehicles coupled with poor vehicle maintenance, inadequate road infrastructure and low fuel quality (Gulia et al., 2015). Re-suspension of road dust due to movement of traffic and tyre and brake wear are also some of the significant sources of air pollution (Amato et al., 2014). Ambient air pollutant concentrations are distributed non-uniformly in urban areas, creating hot spots mostly in the central business district, traffic intersections and signalized roadways.

Along with industrial and vehicular activities, biomass burning is also an important factor responsible for the worst air quality. In an agricultural country like India, a huge amount of agro-wastes is produced every year. The amount of these wastes has increased rapidly due to unprecedented population rise. A large amount of agro-wastes are produced annually, containing cereal straws and woody stalks, etc. After harvesting, farmers burn that crop residue in the open field resulting in air pollution. This activity contributes to 20% of Organic Carbon and Elemental Carbon out of the total budget of emission from agricultural residue burning in the north-western region of India (Bhuvaneshwari et al., 2019).

2. Air pollution as a disaster

As per United Nations International Strategy for Disaster Reduction (UNISDR) disaster is termed as a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its resources. Disasters are also known to be the result of insufficient risk management. Life exposure to high concentrations of pollutants over a short period can result in unexpected social, environmental and health impacts as seen in the events of chemical, petrochemicals, and other industrial accidents. Disasters involving extreme or sudden air pollution are causing an immediate public health crisis leading to an increased pressure on stakeholders and agencies to provide solutions to protect impacted communities during any such emergencies (Chandrappa and Kulshrestha, 2016). Disasters can be triggered by air pollution, and air pollution can be triggered by disasters. Human health and the environment would be harmed in both situations. There are three major disaster components of air pollution, which are interrelated with each other as mentioned in **Figure 2.**

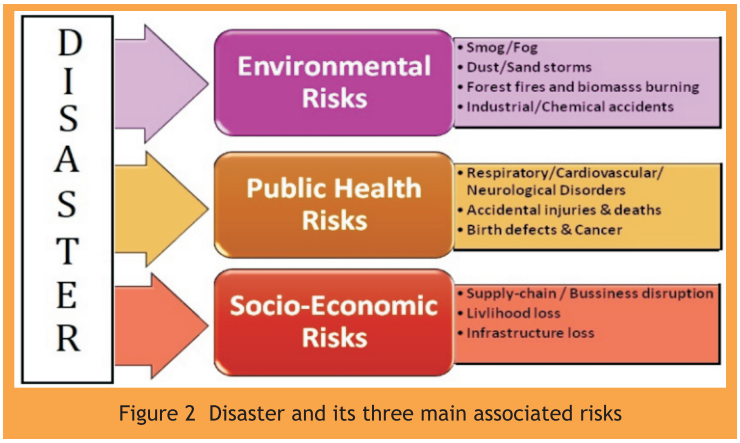

Figure 2 Disaster and its three main associated risks

The sudden surge in air pollution due to various sources such as forest fires, sand and dust storms, volcanic eruptions, biomass burning, chemical or industrial accidents, etc., cause widespread public health concern and is associated with measurable effects on human health. The most famous and devastating air pollution episodes that have happened across the world are mentioned below in **Figure 3.**

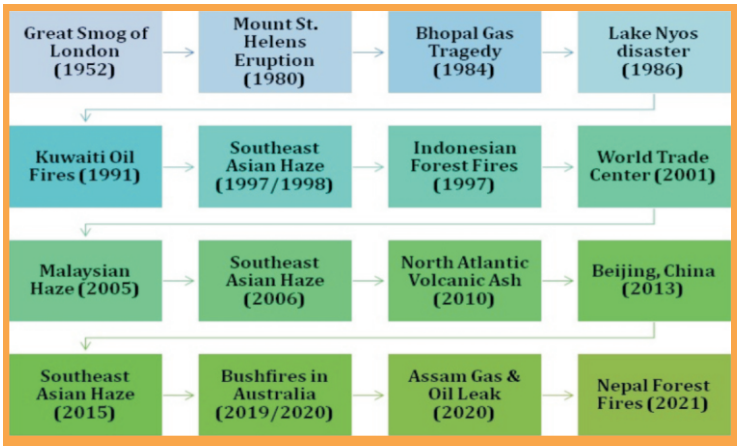

Figure 3 Major global air pollution episodes

3. Global scenario

Air pollution is responsible for premature mortality worldwide and has well-established exposure risk estimates (Di et al., 2017; Orach et al., 2021). The mortality rate caused by ambient air pollution has contributed to 7.6% of all deaths in 2016 worldwide (Isaifan, 2020). Similarly, the WHO has also estimated that worldwide around 7 million people die every year from various diseases such as stroke, heart

disease, lung cancer, pulmonary disorders, and respiratory infections, caused by polluted air quality (WHO, 2018), as illustrated in **Figure 4.**

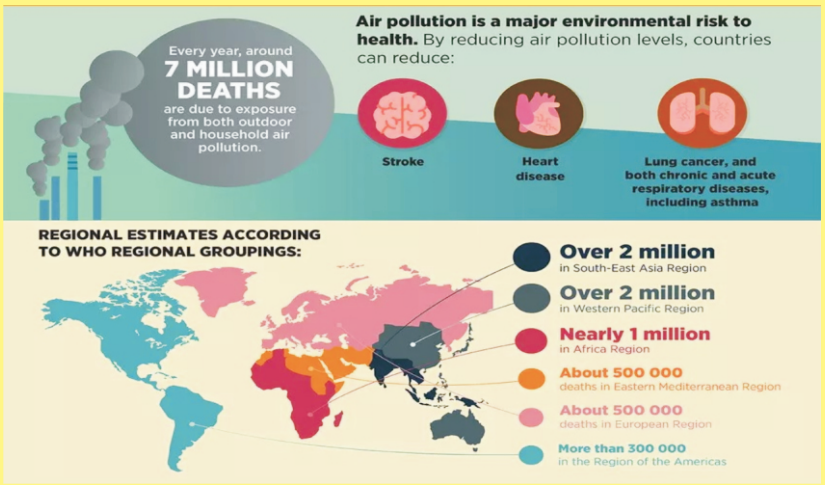

Figure 4 Regional estimate of air pollution and its health consequences
(Source: WHO PHE Infographics on air pollution, 2020)

More than 90% of the world's children breathe toxic air every day putting their health and development at serious risk. According to WHO, air pollution is responsible for more than 570,000 deaths in children under 5 years of age annually, as shown in **Figure 5.** Children who have been exposed to high levels of air pollution may have a higher risk of developing chronic diseases later in life, such as cardiovascular disease (WHO, 2018a).

Figure 5 Death among the children due to air pollution
(Source: WHO, 2018a)

Box Study 1: Beijing City Air Pollution

Beijing, a typical representative of rapidly developing cities of China, declared war on air pollution in 1998. The obstacle was to find sustainable ways to boost air quality in fastest-growing cities in the developing world. For twenty years Beijing has been maintaining it. Its air quality has enhanced dramatically, and the lesson learned provides a blueprint for other growing urban cities to combat air pollution (Schleicher et al., 2012). Beijing's case offers hope that the problems associated with improving air quality can be tackled during the time of explosive growth and motorization (Hao and Wang, 2005).

Beijing introduced more rigorous and strict steps to control air pollution in the year 2013 under Beijing's Clean Air Action Plan 2013-2017. The fine particulate emissions ($PM_{2.5}$) had reduced dramatically by 35% and 25% in the neighboring Beijing-Tianjin-Hebei area by the end of 2017. Over this period, Beijing's annual emissions were decreased by 83%, 43%, 55% and 42% for sulphur dioxide-SO_2, nitrogen oxides-NO_x, particulate matter-PM_{10} and volatile organic compounds (VOC), respectively. In the year 2018, China revised the new three-year Action Plan (2018-2020) for Winning the Blue Sky War.

In response to extremely serious $PM_{2.5}$ emissions, the Beijing Government has introduced a range of initiatives and a number of policies and steps on the prevention and regulation of air pollution and has taken some concrete action to enhance air quality and to meet the national air quality requirements as shown in the Figure 6.

Another significant factor impacting air quality is the weather conditions that restrict the density, dilution, diffusion, transport and transformation of ambient atmospheric contaminants. This further affects the distribution, composition and concentration of atmospheric pollutants.

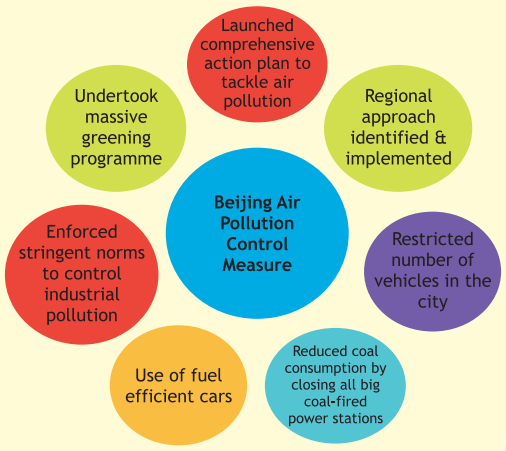

Figure 6 Air pollution control measures adopted by Beijing, China

Average annual PM levels in high-income countries are typically low (<35 μg/m^3), while the PM concentrations in medium to low-income countries frequently exceed WHO air quality standards (Anenberg et al., 2019). Even in less polluted regions, spikes in ambient PM concentration are associated with various disease burdens, premature mortality, morbidity, reduced life expectancy, etc. (Croft et al., 2017, Luben et al., 2017; Balakrishnan, 2019). Poor fuel quality, high traffic density, a large proportion of old vehicles, poor road infrastructure and inadequate inspection and maintenance programs, are some of the major causes of deteriorating urban air quality.

The WHO scientists also believe that global warming could lead to malaria, yellow fever, bone loss, respiratory diseases and other diseases. The proliferation of such infections is growing further in warm and humid environments as pathogens often live under such climatic conditions. Understanding of the geographical distribution of diseases for the health planning of each country is required to notify the regulators of the situation of each disease in the world and to include the necessary health initiatives for residents in their health policies as well (Javadinejad et al., 2020).

Asia is home to many extremely polluted cities in the world. South Asia is experiencing severely degraded air quality, with particulate matter less than 2.5 μm ($PM_{2.5}$) reaching unprecedented high levels.

Box Study 2: Nepal's Forest Fire

Air pollution is a chronic problem in the rapidly growing capital city of Kathmandu, Nepal. Forest fires are the main reason for the rising air pollution in Kathmandu and many other places in Nepal. Forest fires are common during the dry season, from January to May, when villagers burn dry leaves in the woodlands to prompt new grass growth for their cattle.

Recently (in March-April 2021), Nepal has been witnessing worst forest fires in years. The fire has generated a lot of smoke, which has spread across the mountain and is causing air quality problems as it settles around the Kathmandu city, raising the risk of cancer, stroke, asthma and high blood pressure. A forest fire has burnt at least 60 places across 22 of country's 77 administrative districts (Sharma, 2021).

Figure 7 Forest fire in Makwanpur, outskirts of Kathmandu on April 8, 2021 *(Picture Courtesy: Reuters, 2021)*

At the end of March 2021, the air pollution levels reached at hazardous levels and hit their highest in the capital since the government began keeping records in 2016. The central government ordered schools to close for four days, forcing millions of students to stay at home. During this time, visibility was confirmed to be as low as 800-1,000 metres at Nepal's only international airport in Kathmandu, causing widespread flight disruptions. Because of this sudden and high air pollution, people have also experienced itching and burning sensations in the eyes and nose.

For designing a practical anti-forest fire plan, awareness and appropriate planning must be taken into account. Community-based fire management plan must be practised by engaging local communities and other stakeholders from all aspects of fire planning and management sector. It will not only help to understand the range of causes, but also their role in managing fire risk.

4. Indian scenario

Air pollution and its impact on human health is a very serious problem in the Indian sub-continent too. India faces one of the highest disease burdens from air pollution in the world. There are various factors responsible for air pollution in India like integration of pollutants in a particular area and transboundary movement of air masses processes (Godwin and Kobziar, 2011; Guttikunda and Jawahar, 2012; Brauer et al., 2019), increase in vehicular activities, thermal power plant emissions (Gurjar et al., 2010; Moorthy et al., 2013), industrial units which lack proper emissions control measures, biomass burning, and domestic activities (Satheesh et al., 2017; Saxena and Sonwani, 2019).

Pollution alone has accounted for nearly 1.7 million premature deaths in India in the year 2019, i.e., 18% of total deaths that lays bare the human cost of the country's toxic urban air. India has led to an increase in diseases such as lung cancer, heart disease, stroke, diabetes, neonatal disorders and respiratory diseases, resulting in millions of more deaths. The majority of these deaths were from ambient particulate matter pollution (0·98 million) and household air pollution (0·61 million). The death rate due to household air pollution decreased by 64·2% from 1990 to 2019, while that due to ambient particulate matter pollution increased by 115·3% and that due to ambient ozone pollution increased by 139·2%. The death rate attributable to air pollution has accounted for the total loss of $36·8 billion which is approximately 1·36% of India's gross domestic product (GDP) (Pandey et al., 2021).

The IQ Air report found that Asian countries and territories dominated the list of most air-polluted regions in the year 2019 **(Figure 8)**. The map below shows pollution by country and territory using the US Air Quality Index (Regan, 2020).

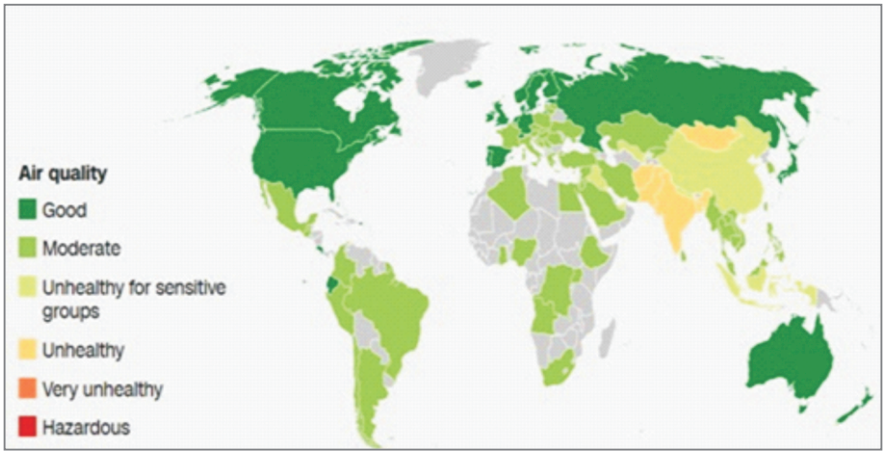

Figure 8 Air pollution levels by country and territory using the US Air Quality Index.
(Source: IQAir; Regan, 2020 -Graphic: Henrik Pettersson and Sergio Hernandez, CNN)

Twenty-one of the world's 30 cities with the worst air pollution is in India with six cities in the top ten (IQAir, World Air Quality Report, 2019). Ghaziabad city situated in northern Uttar Pradesh state is ranked as the world's most polluted city, with an average $PM_{2.5}$ concentration measurement of 110.2 in the year 2019, which is far more than double the US Environmental Protection Agency level that is considered as healthy. Whereas, in the year 2018, Ghaziabad recorded average $PM_{2.5}$ as 135.2 and 144.6 in 2017.

The national air pollution in India has decreased by 20% from 2018 to 2019, with 98% of cities experiencing varying levels of improvement. The report points to the economic slowdown, favorable weather conditions, and efforts towards cleaning the air as reasons behind this decrease.

5. Air pollution as a public health emergency

Air pollution is an important public health issue, causing cardiovascular and pulmonary diseases worldwide. In addition to these direct impacts on individual health outcomes, air pollution also causes indirect health harms on other key determinants of individual health. For example, with dangerously high levels of air pollution, people cannot go outside to exercise or cannot perform work during business hours. Every aspect of an individual's health is affected.

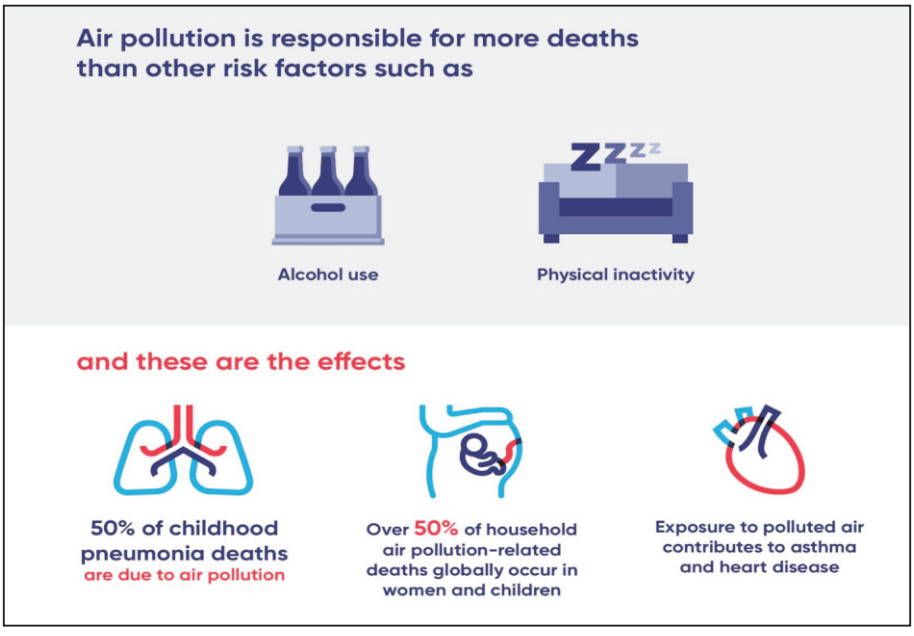

Figure 9 Air pollution is a global public health emergency
(Source: UN Twitter Handle)

The environmental impacts such as fog, smog, dust storms, industrial/ chemical accidents, and biomass burning ultimately lead to various health risks such as respiratory, cardiovascular, neurological disorders, accidental injuries, or even deaths (Tigala et al., 2019). Further, the health burden related to air pollution is associated with socio-economic impacts such as supply chain disruptions, livelihood losses, etc. Therefore, there is an immediate need to globally minimize air pollution emissions, as WHO has also cautioned air pollution as a "public health emergency".

Air pollution is responsible for 29% of all lung cancer deaths and illness, 17% of all acute lower respiratory infections, 25% of ischemic heart disease, 43% of chronic obstructive pulmonary disease deaths, and 24% of all stroke deaths worldwide (McHardy et al., 2020). Many airborne infectious diseases can be transmitted by dust. Researchers assume that inhaling dust particles in humid, dry weather destroys the mucosa of the nose and throat, providing optimal conditions for bacterial infection. Furthermore, dust particles containing iron oxides can increase the risk of infection (WMO, 2020).

Air pollution in India is quite a serious issue with the major sources being fuelwood and biomass burning, fuel adulteration, vehicle emission, and traffic congestion. Besides, rapidly increasing industrialization, urbanization, population growth and demand for transportation along with meteorological conditions influence air pollution in many Indian cities.

Box Study 3:
Air Pollution in Delhi

Delhi NCR is increasingly struggling with air pollution problems especially during the late fall and early winter. A public health emergency was declared in Delhi, capital city of India, in November 2017 and November 2019 when the air quality in the national capital rose to levels around 20 times (hazardous "severe plus" category) what the World Health Organization considers safe (Terry et al., 2018). Weather conditions seem to play a very important role in controlling air pollutants. Northern states of India experience a wintertime inversion layer of cool air that leads to the accumulation of pollutants near the ground level. Delhi experiences a decrease in temperatures and wind speeds from mid-September onwards, favoring the accumulation of air pollutants and rising outdoor pollutant levels. In the northern states like Punjab, Haryana, Uttar Pradesh, Uttarakhand, and neighboring areas, an estimated 20 million tonnes of paddy stubble is burned soon after the monsoon crop is harvested (Jaiswal et al., 2019). During festivals and events such as Diwali (despite some restrictions), the widespread use of crackers has helped to ooze poisonous air

into residential areas, workplaces, and playgrounds. The major factors contributing to Delhi's particulate matter levels include unpaved roads, ill-regulated industries, and an ever-increasing number of road vehicles. All of these variables have contributed significantly to the growing cases of non-communicable diseases (NCDs)-chronic respiratory diseases and cardiovascular problems which indicated that it would lead to over 61 percent of deaths in India (Tigala et al., 2019).

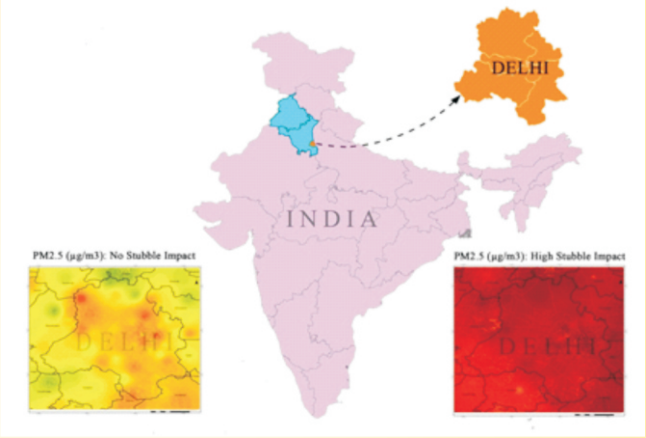

Figure 10 Air quality of Delhi before and after stubble burning
(Source: Beig et. al., 2020)

Air pollution has led to 24,000 deaths in Delhi in the first half of 2020 including three months of the COVID-19 pandemic lockdown (Bhowmick, 2020). The Environment Pollution Prevention and Control (EPCA) Authority for Delhi and NCR, is a committee appointed by Supreme Court and is in charge of all air pollution regulations in the city since 1998. The EPCA, in partnership with the federal and state governments, began implementing the Graded Response Action Plan (GRAP) in 2016. The GRAP has allowed expanded air pollution control so far in 2019. The Delhi government released a health alert/advisory for the first time to protect its residents from health-harming levels of air pollution. In addition to the actions under GRAP, the Delhi government had also declared the odd-even rule in the state. Under this scheme, private cars with odd-numbered registration plates were allowed to drive on odd days, and those with even-numbered plates were allowed to drive on even days from 8 am to 8 pm, except on Sundays. The state government had increased the number of buses, metro coaches and placed a temporary moratorium on surge pricing on app-based taxis like Ola and Uber. (Jaiswal et al., 2019).

The hospitals in Delhi also observed a sudden spike in the number of patients reporting with respiratory and breathing difficulty, asthma problems, allergy and chronic obstructive pulmonary diseases. The severe air quality also led to eye burning, teary eyes and troubling coughs in many people. Besides affecting lungs, high levels of pollutants in the atmosphere also caused inflammation in blood vessels which usually act as a trigger for stroke or heart attack in persons, already at risk of the disease.

5. Air quality management

The Air quality management (AQM) practices are country-specific and based on the priorities as agreed for a specific air quality control region to maintain acceptable ambient air quality. They are implemented and enforced through legislative laws. The key components of AQM are air quality objectives, monitoring, emission inventory, prediction and forecasting tools, control strategies and public participation. Further, each component plays a significant role in improving the efficiency of the AQM, thus reducing pollutant concentrations. Moreover, the effective and efficient implementation of AQM in developing countries remains a challenging task for air quality managers due to the lack of government commitment and stakeholder participation, weaknesses in policies, standards and regulations, lack of real-time air quality data and emission inventories (Naiker et al., 2012).

Urban air pollution is perhaps the most severe environmental problem due to rapid growth in the industrial and transportation sectors. The management practices to improve urban air quality are very limited and the portion of the budget allocated for urban air quality management is also insufficient (Santosa et al., 2008). Urban air pollution problems were analyzed in China, India and Brazil at a macro urban scale and proposed a system based methodology to develop the AQM that takes into account the (i) identification of critical pollutants and their sources, (ii) setting up of the air quality monitoring network, (iii) emission inventory, (iv) source prioritization, (v) control strategies, and (vi) development of decision support system (Kura et al., 2013).

The Indian government has also started moving to address this public health emergency. In January 2019, it launched the National Clean Air Programme, a five-year action plan targeting to achieve 20% to 30% reduction in Particulate Matter concentrations by 2024 keeping 2017 as the base year for the comparison of concentration by building an air-quality monitoring network and improving citizen awareness. The government has also provided cooking gas cylinders to more than 50 million poor households to try to reduce the use of biomass cooking fuels. Increased investment has made renewable India's second-largest generator of electricity.

To curb air pollution globally, new technologies and innovative approaches are needed. Ericsson, a telecommunication company, has suggested that Information and Communications Technologies (ICT) such as the Internet of Things (IoT), could enable to reduce greenhouse gas emissions by up to 15% by 2030. Ericsson, in partnership with the Indian Institutes of Technology-Kanpur, has deployed NarrowBand-IoT sensor networks at strategic locations in Delhi that help monitor air pollution levels. The real-time data collected by these sensors is then collected for analysis to increase awareness, supporting policy intervention, and allowing corrective actions to reduce air pollution in the city.

Delhi-based 'Chakr Innovation' curbs air pollution with the world's first retro-fit emission control device for diesel generators. The device captures around 90% of particulate matter emissions from the exhaust smoke from the generators without compromising on energy efficiency. Moreover, the diesel soot captured from the exhaust is afterward converted into ink and paint. Similarly, 'Cellzyme Biotech' from Coimbatore, Tamil Nadu, is another enterprise dedicated to combating air pollution by using an engineered enzyme to make antibiotics at room temperature, without using solvents - which are a major contributor to air pollution.

All the necessary mitigation measures need to be implemented through effective and efficient implementation of air quality management to maintain acceptable urban air quality. **Figure 11** shows the five key points that every city or state needs to learn to combat air pollution.

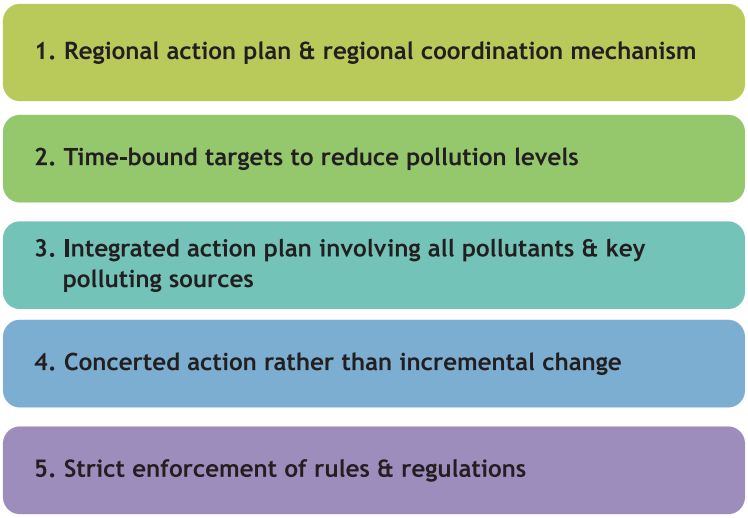

Figure 11 Five key lessons cities/states need to learn to combat air pollution

6. Existing policies

There are numerous policies and programs to address the air pollution problem that has been introduced across the world. However, like any other policy indicator, the performance and effectiveness of these programs have been dependent on cooperation and coordination among different stakeholders.

Emergency measures that have been taken under the Graded Response Action Plan (GRAP) of the Indian government suggested that if the air quality falls in moderate to poor category then banning garbage burning in landfills and enforcing all pollution control regulations in brick kilns and industries would be implemented. Further, if the

air quality falls in the very poor category, additional measures of stopping the use of diesel generator sets and use of public transport would be implemented. Severe category of air quality would be tackled with additional actions such as stopping the entry of trucks into Delhi, stopping construction activities and appointing the task force to decide on any additional steps. With increasing interactions among pollution, climate change, and human health, there is a growing need for the involvement of the government to prevent immediate and long-term harm.

The creation of the Environment Pollution (Prevention and Control) Authority (EPCA) and its subsequent declaration after air pollution episodes show the willingness to characterize the pollution problem as an emergency that is responsible for deteriorating environment and human health. EPCA is Indian Government constituted committee in the year 1998 for the National Capital Region (NCR) in compliance with the Supreme Court order.

The public health emergency declaration, which is necessary to address immediate issues and provide an impetus for further action, is not sufficient on its own to address this environmental and health catastrophe. First, the full potential of the law is released with considered legislative and executive action, taken based on detailed scientific advice and extensive public consultation. EPCA actions are, by contrast, reactive and aimed at sources most susceptible to prevention for the immediate protection of public health. For example, the EPCA's recommendation that people stay indoors and the subsequent closure of schools benefit those middle-class people who live in homes with well-maintained air purifiers. Similarly, an India Supreme Court order, issued in response to the declaration, aimed at causing stubble burning's immediate cessation was admirable but did not address the economic burden such a ban would impose on farmers or provide for their compensation. Later, in year 2020, the Commission for Air Quality Management in National Capital Region and Adjoining Areas Ordinance was constituted by dissolving the Environment Pollution (Prevention and Control) Authority (EPCA) for the NCR.

Figure 12 shows the cooperation from the various sectors are required to sustainably reduce the air pollution and its adverse impacts on the public health.

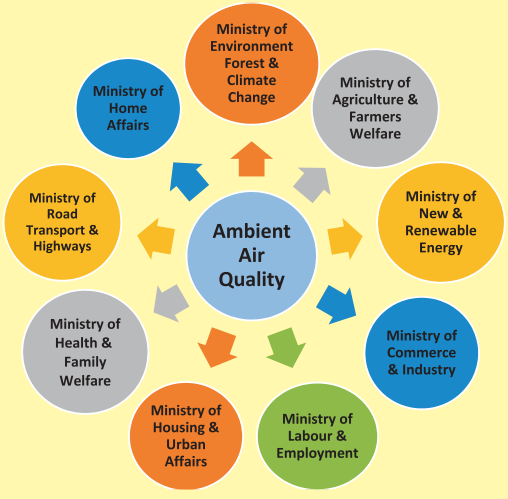

Figure 12 Cooperation from the various sectors are required to improve ambient air quality

7. Conclusion & Recommendation

Air pollution cannot be considered an isolated environmental concern, as it is now becoming a major public health emergency. It is high time that air pollution control and management should become a part of state and city planning processes. The high burden of death and disease due to air pollution and its associated substantial adverse economic impact from the loss of output could impede India's goal of becoming a $5 trillion economy by 2024. Successful reduction of air pollution in India through state-specific strategies could lead to substantial benefits for both the health of the population and the economy. Collaboration and coordination at all levels of government are very much important for the effective implementation of various air pollution-related judicial orders, policies, guidelines and crisis management plans. There is an immense need for an integrated framework for dealing with air pollution as a disaster during emergencies. In India and other developing countries, there is an utmost requirement of an integrated framework where all governing and regulatory bodies should work together to curb air pollution emergencies.

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About CECR and HER-CAP Project

Centre of Excellence on Climate Resilience (CECR)

National Institute of Disaster Management (NIDM) has a dedicated division for Environment, Climate and Disaster Risk Management (ECDRM) which has been designated as a Centre of Excellence on Climate Resilience (CECR) under the National Action Plan for Climate Change and Human Health (NAPCCHH). CECR is implementing six research projects namely Climate Adaptive Planning for Resilience and Sustainable Development in Multi-hazard Environment (CAP-RES) with support of DST-Govt of India, National Agriculture Disaster Management Plan (NADMP) funded by the Ministry of Agriculture & Farmers Welfare, Health Resilience and Capacity Building (HER-CAP) with World Health Organization India, Crisis Management Plan for Dealing with Contamination of Water Bodies (CMP-WB) funded by CPCB, Disaster Management Plan for Ministry of Environment, Forest and Climate Change (NEFC-DMP) with the support from MoEFCC and the Disaster Management Plan for Dept. of Chemicals and Petrochemicals (NCP-DMP) supported by DCPC-MoC&F. It also collaborates with a number of international and national organizations working in the areas of climate change adaptation, resilience and disaster risk reduction.

HER-CAP Project

NIDM in collaboration with WHO India has implemented the project “Health Adaptation and Resilience: Advancing Strategic Knowledge and Capacities” (HER-CAP). Under this project, the following documents have been drafted.'

- National Health Adaptation Plan for disasters related illnesses' for Ministry of Health and Family Welfare.
- Training Manual on 'Health Adaptation and Resilience to Climate Risks'.
- A compendium of case studies on 'Climate Change related Disasters and Health Resilience'.
- Four Policy briefs on Regional Issues and Opportunities for Health System Resilience to Climatic Disasters. (For North, East & North-East, West and South Region of India).

- Along with this, four thematic papers on key areas are as follows:
  - Temperature related disasters: Heat and Cold Wave - Implications for Health Adaptation and Resilience.
  - Water related disasters: Floods and Drought - Implications for Health Adaptation and Resilience.
  - Air Pollution and Health: Special Focus on Air Quality Emergencies.
  - Disaster Waste Management and Health Risk Reduction.

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