Role of Disaster Risk Management in Addressing Air Pollution Hazards

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***Abstract*—Air pollution has become one of the biggest problems for both the environment and people's health. It can also be seen as a slow-moving, human-made disaster because its effects build up over time and affect large numbers of people. Growing industries,**
fast-expanding cities, more vehicles on the road, and heavy use of fossil fuels have all made the air worse—especially in cities like Delhi. Long-term exposure to dirty air can cause breathing problems, heart disease, and lower quality of life.
This study looks at air pollution as a kind of disaster risk and tries to understand how Disaster Risk Management (DRM) can help reduce its impacts. The work is based on information from published papers, reports, and earlier studies. It explains the main causes and effects of air pollution and talks about DRM steps like prevention, mitigation, preparedness, and response. The study suggests that stronger rules, better monitoring, and more awareness among the public are needed to deal with air pollution. So, bringing air pollution control into the DRM framework is important for long-term safety and a healthier environment.

***Index Terms*—Air Pollution, Disaster Risk Management (DRM), Slow-Onset Disaster, Human-Induced Hazard, Urban Health, Public Awareness, Particulate Matter.**

AIM

To study how Disaster Risk Management helps in reducing the risks and impacts of air pollution on human health and the environment.

I. INTRODUCTION

Nowadays, air pollution has become one of the biggest problems we face—not just in India, but in most countries of the world. In simple terms, air pollution means that the air around us is no longer clean and safe to breathe. Harmful things like smoke, dust, gases, and chemicals mix into the atmosphere and make the air dirty. These pollutants mostly come from human activities such as vehicles on the road, factories, power plants, construction work, burning of waste, and the use of fossil fuels like coal, diesel, and petrol.

In cities, the problem is even worse. As more people move into urban areas, the number of vehicles, buildings, and industries keeps increasing. This fast growth is good for jobs and development, but it also puts extra pressure on the environment. The air quality slowly gets worse, and people start to feel its effects in their daily lives—through cough, breathing problems, eye irritation, and even long-term diseases. In many ways, air pollution is like a silent disaster. It does not announce itself with loud sounds or sudden destruction, but it slowly harms health, the environment, and the economy over time.

Disaster Risk Management (DRM) is a framework that governments and organizations use to plan for and reduce the impact of disasters. It includes steps like trying to prevent the disaster from happening, reducing its effects, being ready to respond, and taking action when it strikes. These ideas are usually used for events like cyclones, floods, and fires, but they can also be applied to long-term problems like air pollution. Instead of waiting for a crisis, DRM helps people act early, plan properly, and protect lives and property.

The present study focuses on understanding air pollution in this way—as a disaster-related hazard. It looks at how continued exposure to polluted air can harm health, damage the environment, and create economic problems. It also studies how the tools and strategies of Disaster Risk Management can be used to reduce these impacts. The main aim is to show that managing air pollution should not be left only to environmental departments; it should be part of broader risk-management planning by governments, city planners, and the public. By using a more organized and long-term approach, it is possible to make cities cleaner, healthier, and safer for everyone.

II. LITERATURE REVIEW

Many earlier studies have looked at air pollution and its effects. Most of them agree that the main sources are vehicles, industries, construction work, and burning of crop stubble or waste. These activities release tiny particles (PM2.5 and PM10) and gases like nitrogen dioxide, sulfur dioxide, carbon monoxide, and ozone into the air. Over time, these pollutants lower air quality and make breathing harder.

Health-related studies show that people living in polluted areas suffer more from respiratory problems, such as coughing, wheezing, and shortness of breath. Children, the elderly, and people with existing health problems are more at risk. Long-term exposure can lead to chronic lung diseases, heart attacks, and even early death in some cases

Research on policy and regulation points out that many countries have introduced pollution control laws and standards. However, enforcement is often weak, and coordination between different government departments is poor. Some recent studies suggest that air pollution should be treated as a risk that needs good governance, clear responsibilities, and citizen participation to be managed effectively.

III. METHODOLOGY

This study is based on secondary data, meaning it uses information already published in research papers, government reports, and environmental studies. It does not collect new data from surveys or fieldwork but instead reviews and analyzes what is already available.

The approach is mostly descriptive and somewhat analytical. First, it explains what air pollution is and how it works as a hazard. Then, it looks at the main causes and effects. After that, it checks how Disaster Risk Management tools can be used to reduce these impacts.

The focus is mainly on cities, with a special look at Delhi, which is a clear example of high-level air pollution. By comparing findings from different studies, the research tries to show the main issues and possible ways to manage them better.

IV. AIR POLLUTION AS A DISASTER HAZARD

Air pollution can be understood as a disaster-type hazard, even though it does not behave like a sudden earthquake or flood. Unlike those events, air pollution develops slowly and its effects build up quietly over time. People may not notice it clearly every day, but the damage to health, environment, and daily life keeps increasing. In many ways, it has the same basic features of a disaster: it harms large numbers of people, it is linked to human choices and weaknesses in planning, and it can be predicted and managed if proper attention is given. When air pollution is seen as a hazard, it becomes easier to plan and take clear steps to reduce its impact instead of only reacting when the situation becomes very bad.

In disaster-risk language, every hazard has three parts: the hazard itself, the exposure of people to that hazard, and the vulnerability of those people. For air pollution, the hazard is the release of harmful substances such as fine dust particles, nitrogen dioxide, sulfur dioxide, carbon monoxide, and other toxic gases into the atmosphere. These pollutants mainly come from vehicles, industries, construction dust, burning of waste, and crop stubble burning in nearby regions. The exposure is the fact that millions of people live, work, and study in polluted areas every day, especially in crowded cities. The vulnerability comes from weak health systems, poor housing, high traffic, and the presence of children, elderly people, and those with existing diseases, who are more easily affected by dirty air. When these three things come together, air pollution acts like a slow-moving disaster that can harm society over many years.

Treating air pollution as a disaster hazard also helps in shifting the focus from blaming weather or nature to looking at human responsibilities and planning. A lot of pollution is not accidental; it is the result of how cities are designed, how industries are allowed to operate, how people use transport, and how waste is managed. When this is seen as a hazard, there is more pressure to follow better rules, invest in cleaner energy and transport, and control major pollution sources. It also makes it easier to introduce early-warning systems, clear action plans, and public information so that people

know
what to do when air quality becomes very poor. In crowded cities like Delhi, this idea is very clear: every winter, people know that the air will get worse, but if air pollution is treated as a disaster hazard, there would be stronger pressure to plan ahead, reduce the main sources, and protect people before the situation becomes an emergency. In this way, air pollution is not just a health or environmental problem; it is a full-blown disaster-type risk that needs serious planning, rules, and public cooperation to manage.

V. IMPACTS OF AIR POLLUTION

Air pollution creates deep and long-lasting impacts that touch almost every part of life, not just the environment. When people breathe polluted air over a long time, their health slowly gets worse, even if they do not feel it clearly every day. The tiny particles and harmful gases in the air can enter the lungs and even reach the bloodstream, which can lead to breathing problems, frequent coughing, and chest tightness. In highly polluted cities, hospitals often see more cases of asthma, bronchitis, and other lung diseases, especially during winter when pollution levels rise. Children, older people, and those with heart or lung problems are more vulnerable, and continuous exposure can increase the risk of chronic diseases and even early death. This means that air pollution is not a small or temporary issue; it quietly harms people's health over many years, shortening lives and lowering the quality of everyday living.

The environmental impacts of air pollution are also very serious. Polluted air contributes to climate change by adding greenhouse gases and other harmful substances to the atmosphere. This leads to rising global temperatures, which can affect weather patterns, crops, and water availability. In cities, air pollution often forms a thick layer called smog, which makes the sky look hazy and reduces visibility. This makes driving more dangerous, increases the chances of road accidents, and makes outdoor activities uncomfortable. Polluted air can also cause acid rain, which falls on crops, soil, lakes, and rivers. Acid rain slowly damages plants, reduces the productivity of farms, and harms aquatic life. It can also weaken buildings and metal structures over time, which means that even the physical infrastructure of cities and villages suffers due to poor air quality. Forests, rivers, and farmland—all parts of the natural environment—pay the price when the air remains dirty for long periods.

The social and economic effects of air pollution are often hidden but very heavy. When people fall sick more often, families spend more money on medicines, hospital visits, and treatment, which can create financial stress, especially for poorer households. Workers who are unwell may miss work or work less efficiently, which lowers output in factories, offices, and farms. This reduces overall productivity and slows down economic growth. In cities, bad air can discourage tourists and investors, because people may avoid visiting places known for very poor air quality. Businesses may think twice before setting up offices or factories in such areas, which can limit job opportunities. In this way, air pollution does not only harm health and nature; it also affects jobs, income, and the future development of regions. Overall, the impacts of air pollution are wide-ranging, long-term, and deeply

connected to people's health, environment, and daily lives, making it one of the most serious risks that modern cities face today.

VI. ROLE OF DISASTER RISK MANAGEMENT (DRM)

Disaster Risk Management (DRM) is usually applied to sudden events like floods, earthquakes, or industrial accidents. But its basic ideas can also be used for slow-moving risks like air pollution. Disaster Risk Management has four main parts:

Prevention in Disaster Risk Management means stopping air pollution from becoming very serious in the first place. It focuses on reducing the sources of pollution through long-term planning and smart decisions. For example, cities can encourage cleaner forms of energy such as solar and wind power, improve public transport so people depend less on private vehicles, and plan industrial areas away from residential neighbourhoods. Prevention also includes setting strict rules for new industries and vehicles, so that they are not allowed to operate unless they follow pollution-control standards. In simple terms, prevention is about changing the system so that less pollution enters the air from the beginning. When done well, prevention can save money, protect health, and avoid the need for constant emergency actions later on.

Mitigation is about reducing the intensity or seriousness of air pollution when it is already happening. It does not stop pollution completely, but it makes the problem less harmful and easier to manage. In cities, mitigation can include using cleaner fuels, introducing stricter emission standards for vehicles, and installing pollution-control devices such as filters and scrubbers in factories. Dust from construction sites can be controlled by watering roads, covering materials, and limiting excavation during high-pollution days. Mitigation also means reducing open burning of waste and working with farmers to find better alternatives to crop-stubble burning. The main idea is to lower the concentration of harmful particles and gases in the air so that people are less exposed and face fewer health risks.

Preparedness means getting ready in advance for when air pollution becomes very bad. It involves setting up systems so that people and institutions know what to do even before the situation becomes a crisis. In the case of air pollution, preparedness includes installing air-quality monitoring stations, sharing pollution levels with the public in simple language, and sending early warnings when pollution is expected to rise. Governments can prepare clear action plans, like graded response plans, that list which steps should be taken at different pollution levels—such as limiting traffic, stopping construction, or advising schools to keep children indoors. Public awareness is also part of preparedness; people should know how to protect themselves, for example by using masks, avoiding outdoor exercise on bad-air days, and closing windows when pollution is high. Being prepared helps reduce panic and makes the response to high-pollution episodes more organized and effective.

Response is the short-term action taken when air pollution has already reached very high levels and the situation has become an emergency. In this stage, the focus is on protecting people and limiting harm as quickly as possible. Typical response measures include temporary traffic restrictions such as odd-even schemes, banning certain construction or industrial activities, and asking people to stay

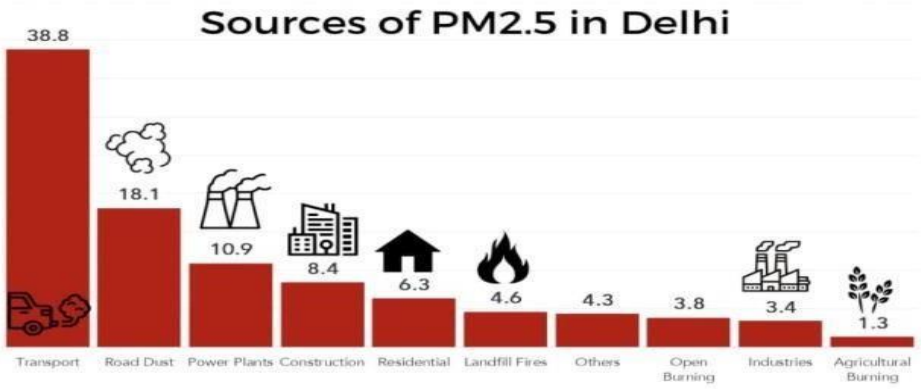
indoors, especially children, the elderly, and those with breathing problems. In some cases, "clean-air shelters" may be opened in schools or community centers for vulnerable groups. Health services may also scale up their support by increasing staff and medicines for respiratory illnesses. While response is important, it should not be the only strategy. A strong Disaster Risk Management system relies on *prevention, mitigation, and preparedness* so that the need for heavy response actions is reduced and the overall risk to lives and livelihoods is lowered over time.

VII. CASE STUDY: DELHI

Delhi is one of the most polluted cities in India and often ranks among the most polluted cities in the world. It is a good case study to show how *multiple factors*—traffic, industries, construction, seasonal burning, and weather—come together to create a severe
air-pollution problem.

1. Main sources of pollution in Delhi

Delhi's air pollution is mainly caused by a mix of human activities within and around the city. The biggest sources include vehicles, road dust, industries, power plants, construction, and the burning of waste and crop stubble in nearby areas. Studies show that road dust and transport together contribute a large share to fine-particle pollution (PM2.5 and PM10), while industries and coal-based power plants also add significant amounts of smoke and harmful gases. In many neighbourhoods, burning of garbage, plastic, and biomass for cooking or disposal adds to the problem, especially in poorer and informal settlements. Because of its dense population and heavy traffic, even small pollution sources become serious when they are spread across the whole city.



2. Seasonal pattern and weather

Air pollution in Delhi follows a clear seasonal pattern that is strongly linked to weather. During winter months, especially November to January, pollution levels rise sharply because of lower temperatures and weak winds. Cold air near the ground gets trapped under a layer of warmer air, a situation called temperature inversion, which stops pollutants from rising and spreading. This creates thick smog that reduces visibility and makes breathing difficult. In contrast, the monsoon season washes away some pollutants through rain, and stronger winds help disperse smoke and dust.

However, after the monsoon, open burning of crop residue in nearby states like Punjab and Haryana sends large clouds of smoke towards Delhi, making the air very bad again each year.

Month	2024 AQI	2025 AQI	2026 AQI
January	320	310	300
February	250	240	230
March	210	200	190
April	180	170	—
May	190	180	—
June	160	150	—
July	110	100	—
August	90	85	—
September	140	130	—
October	280	270	—
November	420	410	—
December	350	340	—

DELHI WINTER AIR POLLUTION

3. Measures taken so far

Several measures have been taken so far to reduce Delhi's pollution, but the problem remains severe. The government has introduced cleaner fuels such as CNG in public transport, tightened vehicle emission standards, and expanded the metro network to reduce dependence on private cars. There are also rules like the Graded Response Action Plan (GRAP), which bans certain activities such as construction, brick kilns, and burning-when pollution reaches very high levels. Despite these steps, enforcement is still weak; coordination between different agencies is limited, and the number of vehicles and construction projects keeps growing. The experience of Delhi shows that without strong, long-term policies and real public support, air pollution will continue to behave like a slow, repeated disaster for the city.

VIII. MITIGATION AND PREVENTIVE STRATEGIES

To reduce air pollution in cities like Delhi, Mitigation and preventive strategies need to focus on different sectors so that air pollution is reduced from the start and does not become a crisis.

Energy and industry sector, the main step is to shift from coal and dirty fossil fuels to cleaner sources like solar, wind, and other renewable energy. Industries should be required to use modern pollution-control devices such as filters, scrubbers, and emission-treatment systems, and they must follow strict rules on how much they are allowed to release. Fuel quality should also be improved, and regular checks should be done to make sure factories and power plants are not harming the air around them. When energy and industry are cleaner by design, a big part of the pollution problem is solved at the source.

Transport and mobility sector is to reduce the number of polluting vehicles and improve how people move around cities. Public transport like buses, metro, and shared services should be made more comfortable, reliable, and affordable so that people choose them instead of private cars. Encouraging electric vehicles, two-wheelers, and e-autos through subsidies, charging stations, and simple rules can also cut down emissions. At the same time, traffic management should be improved—better road design, fewer traffic jams, and smoother flow of vehicles help reduce the stop-start driving that creates a lot of pollution. When cities plan mobility in a clean and efficient way, the air automatically becomes better.

Urban planning and green spaces, Cities should be planned so that people do not need to travel very long distances; homes, workplaces, markets, and schools should be closer together to reduce the need for long-distance travel. More parks, tree plantations, and open green areas can help absorb some pollutants and improve local air quality. Zoning rules should keep highly polluting industries away from crowded residential areas and schools, and construction sites should be controlled so that dust does not spread into surrounding neighbourhoods. Good planning from the beginning makes it easier to avoid heavy pollution instead of fighting it later.

Waste and burning sector, the main goal is to stop open burning and manage waste properly. Garbage should be collected, processed, and treated in a scientific way so that people do not feel forced to burn it in open spaces. Burning leaves, plastic, and other waste should be clearly banned and those who break the rules should face penalties. At the same time, farmers need support to deal with crop stubble without burning it—through machinery, subsidies, bio-decomposers, or other alternatives. If waste is managed well and burning is controlled, a major source of smoke and harmful particles disappears from the air.

Public awareness and behaviour change are essential because people's daily choices affect air quality. Simple awareness campaigns in schools, colleges, offices, and colonies can explain how pollution harms health and what each person can do. People can be encouraged to use public transport, car-pool, avoid unnecessary vehicle use, and stop burning waste at home or in the street. When citizens understand the problem and feel responsible, they start making small changes-like choosing cleaner options, reporting polluting activities, and supporting greener policies. This kind of public involvement, combined with strong government action, creates a stronger and more lasting impact on air pollution.

IX. CONCLUSION

This study has looked at air pollution as a *slow-moving human-induced disaster* and examined how *Disaster Risk Management (DRM)* can help reduce its impacts. The main sources of air pollution-vehicles, industries, construction, and burning of waste and crop stubble—are linked to the way cities and industries have grown. The impacts are not limited to dirty air; they include serious *health problems, environmental damage, and economic costs*.

Disaster Risk Management offers a structured way to deal with these risks. By using *prevention, mitigation, preparedness, and response*, it is possible to plan ahead, reduce the sources of pollution, prepare for high-pollution episodes, and respond effectively when they occur.

The case of *Delhi* shows that many measures are already in place, but pollution levels remain high, especially in winter. This highlights the need for *stronger enforcement, better coordination, and long-term planning. It also shows that **public awareness and involvement* are essential, because people's choices about transport, waste, and energy use directly affect air quality.

In the long run, managing air pollution is not just a job for the government. It requires *a shared effort* between policymakers, scientists, industries, and ordinary citizens. If air pollution is treated as a disaster-type risk, with clear plans and responsibilities, it becomes possible to protect people's health, the environment, and the economy for future generations.

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