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Part 1: Description of Critical Climate Change Issue

Since the rise of the industrial revolution, when populations began to heavily burn fossil fuels, such as coal and gas, Earth's atmosphere has observed a stark increase in carbon dioxide levels. The increase in carbon dioxide levels contributes to the greenhouse effect because carbon dioxide traps heat – further perpetuating warmer temperatures on the Earth's surface. This process is otherwise known as climate change, and countless environmental, health, and socio-economic consequences are expected to increase worldwide. Globally, we can expect to observe more frequent extreme weather patterns, melting glaciers, warming oceans, increased vector-borne diseases, disrupted water and food supplies, and energy shortages (U.S. Department of Commerce, 2021).

Climate change and the warming of the planet are also associated with an increase in ground-level ozone - a harmful air pollutant often found in smog - and particulate matter air pollution. Factors such as heat, the influx of chemicals, methane emissions, and wildfire emanations all contribute to worsened ozone, increased particle pollution, decreased air quality, and overall air pollution in regions around the world (Centers for Disease Control and Prevention (CDC), 2021). Air pollution is responsible for about seven million deaths worldwide with an estimated daily economic cost of about 8 billion dollars, or about 3-4% of the gross world product (World Quality Report, 2021).

Though air pollution continues to be a threat in locations around the world, India will serve as the primary region explored in this paper because air pollution in this country is the largest environmental health threat; the air quality index (AQI) is consistently unhealthy -

borderline hazardous (Ravindra et al., 2019). According to the 2021 World Air Quality Report, New Delhi, India had the worst air quality in the world with an average annual PM_{2.5} concentration (mg/m³) of 85.0. India as a country had the fifth-worst air quality in the world with an average annual PM_{2.5} concentration (mg/m³) of 58.1. Compare this with the PM_{2.5} concentration of China [32.6 mg/m³], the United States [10.3 mg/m³], and with Puerto Rico [4.8 mg/m³]. It is important to note, that the World Health Organization (WHO) states that annual PM_{2.5} exposure greater than 10 mg/m³ poses significant health risks to not only residents but also to the environment.

To illustrate the serious health consequences, death due to outdoor air pollution has become the fifth most common cause of death in India after high blood pressure, indoor air pollution, poor nutrition, and tobacco smoking (Kaur & Pandey, 2021). Nearly 25% of the 2.5 million premature deaths globally occur in India because of indoor air pollution. And in 2019 alone, there were an estimated 1.2 million premature deaths due to outdoor air pollution (International Energy Agency (IEA), 2021). Health effects such as asthma and cardiorespiratory illness also spike with the increasing air pollution throughout the country (Kaur & Pandey, 2021). It is also estimated that if the air pollution level in India was less than 10 mg/m³, then the average life expectancy in 2017 could have been longer anywhere between one and seven years depending on the region in India. Life expectancy in the northern Indian states of Rajasthan, Uttar Pradesh, and Haryana where air pollution is especially poor could have even seen life expectancy increase by an additional nine years (India State-Level Disease Burden Initiative Air Pollution Collaborators, 2018).

Air pollution is quickly emerging as one of the most severe health, social, and environmental problems in India, and unfortunately, the country also faces devastating indications of a warming climate. Due to the developing nature of India's economy, carbon dioxide emissions increased by 55% in the last decade and are expected to increase by another 50% by the year 2040 (World Quality Report, 2021). It is energy-related fuel combustion that lies at the heart of both India's air pollution issues and climate change issues. Thus, to address the health and social impacts of air pollution with public health interventions and to address the warming climate with environmental commitments is to address both simultaneously.

Part 2: Health & Socio-Economic Impacts from Climate Change Issue

The health and socio-economic consequences of air pollution are extensive. As stated earlier, more than 8 million premature deaths worldwide take place each year because of air pollution. That is more than the deaths from AIDS, tuberculosis, and malaria combined. Air pollutants are known to cause heart attacks, strokes, diabetes, cancer, pre-term births, and respiratory disease, and all deaths could have been prevented if populations had access to clean air (World Quality Report, 2021). Unfortunately, it is vulnerable populations such as children, the elderly, people with comorbidities, and marginalized communities that are especially susceptible to negative health and economic outcomes (Landrigan et al., 2015), such as in the form of missed days from work (Mudway et al., 2019), mental illness (Newbury et al., 2019), and decreased brain development in children (Rees, 2017). In India, it is well-researched that those that come from lower castes and those with lower levels of education have maximum

exposure to air pollution – further illustrating there is inequity in exposure (Kathuria & Khan, 2007).

Respiratory diseases, specifically asthma, appear to be a poignant health consequence of air pollution and climate change (Tiotiu et al., 2020) and will be the primary health consequence discussed in this aspect of the paper. Asthma is a chronic respiratory disease that impacts the airways in the lungs. Individuals with asthma will experience inflammation in their airways which can make it increasingly difficult to breathe. Others experience stiffness in their chest and coughing. Though under-diagnosis is expected, asthma impacts on average about 300 million people worldwide, and 40 million of these cases occur in India (Singh et al., 2020). In 2016, 51% of adult Indians who visited a health care provider complained about respiratory problems and 65% of children complained of respiratory problems that same year. In fact, one out of five child deaths throughout the country is related to air pollution. It is no wonder India reports 2.4 times more respiratory deaths than any other country in the world (India State-Level Disease Burden Initiative Air Pollution Collaborators, 2018).

Asthma and other respiratory illnesses have increased by 30% in the past five years because of climate change and air pollution (Down to Earth, 2018), and asthma deaths are projected to rise by 20% if steps are not taken to curb driving factors (Confederation of Indian Industry, 2017). Of course, the driving factor includes climate change, however, other crucial causes include industrial, traffic-related, and household combustion, indoor pollutants from chemicals, phthalates, and tobacco (Singh et al., 2020). For example, vehicular emissions are the fastest-growing source of carbon emissions in the nation contributing more than 300 metric tons

of carbon dioxide each year (Gulia et al., 2022). In fact, two-thirds of the air pollution in the city of Delhi alone is due to vehicular pollution (Kathuria & Khan, 2007).

Unfortunately, these problems are compounded due to the profound levels of poverty and the economic boom in the 1990s. The wide wealth disparity in India leaves 70% of the population living in poverty and having to choose between cooking food and staying warm and dying from respiratory diseases. For example, 80% of households in India burn firewood, kerosene, and cow dung. Ultimately, the use of biomass to heat homes and cook meals leads to about 25 million deaths each year due to indoor pollution and related respiratory diseases. The economic boom in the 1990s exacerbated the steep wealth disparity and allowed the wealthy to fuel industrial emissions through the burning of fossil fuels for profit (Kaur & Pandey, 2021).

Though there are several health and socio-economic consequences of climate change and air pollution in India, asthma is a prominent issue for the population. The consequences intensify due to India's developing nature, leaving little room for sustainable development and climate action. Poverty and a widening wealth disparity, compounded by poor nutrition levels, underlying diseases, and extremely high levels of pollution illustrate how complicated the population health impact from climate change truly is (Kaur & Pandey, 2021).

Part 3: Recommendations

Before jumping into possible avenues for solutions and recommendations, it is critical to first look at what is already being done to manage air quality in India. Legislation and policy on a national level provide an opportunity to make the necessary systemic changes to address air quality from the top-down. Legislative efforts date back to 1905 with the Bengal Smoke

Nuisance Act – a piece of legislation that sought to eliminate smoke from furnaces and fireplaces in the Indian suburbs of Kolkata and Howrah. Legislative policies continued to enact opportunities to mitigate and reduce the adverse consequences of air pollution and climate change (Gulia et al., 2022). The most recent include a law passed in August of 2021 to establish the Commission of Air Quality Management (CAQM) – which prioritizes expanding renewable energy, supporting electric vehicles, and providing millions of families across India with liquified petroleum gas (LPG) to cook and heat their homes (World Bank Group, 2021). For a comprehensive legislative history of Indian for Air Quality Management, please refer to Figure 1.

Of course, the success of any policy attempting to address the issue of air pollution and the secondary health consequences relies on collaboration across stakeholders and sectors (Roy et al., 2020). The complex list of factors contributing to air pollution highlight how the air pollution challenge in India spans across sectors including, but certainly not limited to, transportation, utilities, production and distribution, and waste management. Therefore, to mitigate and reduce the adverse consequences of air pollution and climate change, communities across India must look beyond their immediate jurisdiction and recognize that even pollutants on the other side of the nation mix and create an unhealthy air quality for everyone (World Bank Group, 2021).

However, the inclusion of sector-related stakeholders is not sufficient to address the multi-dimensional impact of air pollution. As mentioned earlier, vulnerable populations including, but not limited to, groups of women, children, indigenous populations, and the elderly are particularly vulnerable to the effects of air pollution. Unfortunately, these populations are

inequitably monitored for their health outcomes, as well. India faces extreme data-related hurdles to understanding air pollution. In other words, India lacks the appropriate methodology to report real-time data for air quality trends; this is because India has substandard monitoring stations. Even more so, there is only one monitoring station for every 6.8 million people with most stations found only in urban areas. Consequently, little is known about the urban-rural disparity regarding air quality (Roy et al., 2020).

To combat these shortfalls and to ensure that efficient mitigation, reduction, and preparedness techniques are practiced as air pollution and climate change persist, India must employ innovative solutions. This includes the active participation of vulnerable communities in decision-making and an increased and appropriate financial investment from the government. First, representation of those most impacted on decision-making boards safeguards an equity-based framework and ensures specific problems are kept in mind when developing proposals and plans. The second recommendation is a strong financial investment. The economic burden of air pollution is profound, and it requires a substantial and committed fiscal response from the government. Rather than directly pouring money into these sectors and furthering the nation's debt – India is among the twenty poorest countries in the world, after all - the Indian government can foster a financial architecture in which private entities are encouraged and incentivized to develop and implement clean energy solutions to improve air quality (Roy et al., 2020).

Conclusion

As the consequences and perils of climate change continue to endure and compound, the complex issue of air pollution has emerged as one of India's most serious environmental issues.

The developing nature of the country compounded with the extreme energy demands put on by the large population safeguards the unfortunate truth that the country will likely become the world's largest carbon dioxide contributor in the coming years. Therefore, mitigating and reducing air pollution carries profound importance not only to the environment but also to the health and socio-economic development of India's human population. Given the multi-sectoral nature of the issue, air quality management will demand the ongoing collaboration of major stakeholders with a sustained focus on building capacity.

Figure 1. Legislative History of India for Air Quality Management



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