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India, Air Pollution

**Air Pollution: India's Plague**

Air pollution is one of the most urgent problems in the world today, and India is more deeply affected than any other nation. Rapid growth and weak regulation have created the world's worst air pollution there. And India's people, many of whom are already poor and bereft of government services, have less capacity to absorb the costs that pollution imposes. An intensive effort, embracing both new technology and urgent government action, is the only way to protect the people of India who are adversely affected by worsening air quality and greenhouse gas emissions.

Air pollution is quickly becoming one of the largest problems society faces on a daily basis, and the nation of India is currently dealing with its disastrous effects. India is the second most populous country in the world and is quickly becoming a global leader in industrial output. Its government is a federal parliamentary republic and although the head of state is President Ram Nath Kovind, all the power is vested in the head of the executive branch, Prime Minister Narendra Modi. India is "the fastest-growing trillion-dollar economy in the world and the sixth-largest with a nominal GDP of $2.61 trillion" and "ranks third when GDP is compared in terms of purchasing power parity at $9.45 trillion" (Silver). About 60.5 % of its land is cultivated and dominated by crops such as rice, wheat, tea, oilseed, and sugarcane. Other major exports include petroleum, machinery, clothing, and precious stones. In general, the land is very fertile with about 52.8% of the total land area being arable (*The World Factbook*). India's climate is tropical in the South and more temperate in the North, with the monsoon season in late summer bringing heavy rains to the whole country. India's terrain varies greatly, from the rainforests of the South to the Himalayan mountains in the North to the Thar Desert in the Northwest. India's weather patterns, such as the dominant monsoon season, contribute to pollution, making the problem even worse.

A distressingly high number of families in India deal with a lack of basic resources, which deprives them of healthy lifestyles. The average household size in India is 4.9 members, much larger than other countries with a similarly-sized economy ("Average Household Size in India"). Most houses are very small and consist of brick walls and mud floors, while 78% of rural households lack a latrine within the house. Less than half of urban households have a flush toilet or water closet, and only 24 million out of 192 million households have a proper sewage connection (Haub and Sharma). Additionally, around 200 million households lack electricity access (BBC). These statistics show how countless individuals are unable to practice basic hygiene and don't have access to essential resources such as electricity, resulting in additional health problems and uncomfortable living situations. The staple Indian diet consists of *roti*, a type of flatbread, rice, and *dal*, a lentil soup. These are served with a variety of vegetable, meat, or

seafood dishes. Families get their food from local marketplaces or from their own land if they own any. Most households use firewood and cow dung for cooking in rural areas, but liquid petroleum is more commonly used in urban households, reflecting the transition from a developing agricultural nation to one that is industrialized. In India, the major barrier preventing people from having a healthy and nutritious lifestyle is poverty. 21.9% of the population is below the poverty line (*The World Factbook*). Furthermore, the average annual per capita income is $1,790, ranking 70th of the 77 countries surveyed ("World Data"). However, 1% of the population makes up 73% of the entire nation's wealth showing how massive the wage gap is ("Income Inequality Gets Worse"). As of July 2018, of the 1.3 billion people living in India, only 34% live in urban areas as compared to 83% in the USA. Clearly, much of India's economy is based on farming. In fact, 47% of India's labor force, which, at 521.9 million is the second largest in the world, is invested in agriculture (*The World Factbook*). The average farm size in India is about 1.08 hectares (Mukherjee). This is tiny compared to the average farm size in the US which is about 178.9 hectares (Freese). Aside from the 47% in agriculture, 22% of workers are engaged in other industries such as software, textiles, and chemical products, and 31% provide miscellaneous services for a living such as auto rickshaw drivers and doctors. Although recent efforts have been made to improve access to education, work remains. Only about 70% of the population above 15 years old is literate and only 3.8% of the GDP is spent on education, ranking 118th in the world. Additionally, access to healthcare is a major problem for most Indians, as only 4.7% of the GDP is spent on health, ranking 149th in the world (*The World Factbook*). The National Sample Survey Office (NSSO) revealed that 8 out of 10 Indians do not have health insurance, with a staggering 86 percent of rural households and 82 percent of urban households uninsured (Agarwal).

India's already poor living conditions are severely worsened by the dangerous effects of air pollution. Alarmingly, of the top 15 most polluted cities in the world, 14 are in India. In Delhi, "every day for nearly two weeks, the air quality index has been between 400 and 478 – more than eight times the permissible maximum" (Jaiswal, Knowlton, and Lamaye). There are numerous factors which contribute to India's pollution problem. These include vehicle emissions, industrial processes, agricultural byproducts, power plants, wildfires, deforestation, construction, biofuels, and e-waste. People in both rural and urban areas are affected by pollution, although, "an international team of scientists, including experts from the Indian Institute of Technology Bombay and the Health Effects Institute, estimates that 75% of air pollution-related deaths in India during 2015 came in its rural areas" (Wu). The pollution in India is widespread and therefore affects all walks of life, however, very poor, very old, and very young people suffer the most. The poor do not have proper health care or nutrition, and the elderly and young are physically weaker making them more susceptible to the effects of pollution. Common deadly pollutants, such as nitrogen dioxide and sulfur dioxide, can seep into bloodstreams and airways, causing major cardiovascular and respiratory problems. In fact, worldwide ambient air pollution is responsible for 43% of all deaths and disease from chronic obstructive pulmonary disease and "29% of all deaths and disease from lung cancer." In 2012 alone, pollution accounted for 7 million deaths worldwide, making it the world's largest single environmental risk. Disturbingly, 1.5 million of those deaths occurred in India (Chatterjee).

Furthermore, pollution contributes to lower crop yields making access to nutritious food harder to find for low-income families. A 2014 study found that "wheat yields were over 36% lower in 2010 than they would have been absent climate and SLCP (short-lived climate pollutants) emissions trends" and rice yield was 20% lower than expected (Burney and Ramanathan). The crop yields are perpetually declining as pollution increases, resulting in higher prices for consumers, many of whom are already below the poverty line and barely getting by. The pollution is not only extremely dangerous to the people and agricultural output of India, but it also affects wild animal and plant life. Furthermore, it largely contributes to global warming around the world, resulting in extreme weather patterns and rising sea levels.

Fortunately, there are possible solutions which can effectively limit the release of additional pollutants into the atmosphere. One of the major causes of pollution in India is the burning of biomass fuels such as firewood and cow dung for fuel. Burning is also used to clear fields for upcoming harvests. In 2016, 34 million tonnes of rice straw and husk, leftover products, were burned in the state of Punjab, despite the fact that only 18 million tonnes of rice were produced. This annual burning is one of the largest causes of pollution in the nation. Rather than burning the leftover product, it can be gasified via simple chemical processes. Incomplete combustion, Fischer-Tropsch Synthesis, and the water-gas shift reaction can convert rice straw and other agricultural byproducts into aviation fuel, a cooking gas similar to liquefied petroleum, and biochar, which is a carbon-residue that can be used as fertilizer. This chain of processes has been used by British Airways since 2011 to convert 575,000 tonnes of London's municipal solid waste into usable aviation fuel (Jha). Similarly, the rice straw can be sold to the gasification industry for a profit by the farmers, helping them financially and creating a new source of livelihood. The cooking gas created can be used by rural families as an alternative to firewood or cow dung which release harmful gases into the atmosphere. As the Indian economy continues to expand and industrialize, the government itself could fund these programs, which in turn would allow the government to collect a tax on the straw sold by farmers, therefore allowing the whole process to be self-sufficient. Furthermore, new industry and jobs would be created at the gasification plants. Unfortunately, it may be difficult to encourage farmers to collect and sell all their byproducts. However, once they "have a captive customer for the straw, the price of that straw will invariably increase…regardless of the terms of any fuel supply agreement" (Lane).

Improved technology can be employed to control India's air pollution as well. The Carbon Capture and Storage (CCS) process "can capture up to 90% of the carbon dioxide emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere" ("What is CCS?"). There are three steps to the process: carbon dioxide capture, transportation, and storage. The capture used to be done through a variety of methods including pre-combustion and post-combustion capture, oxyfuel combustion. These methods, however, were not very cost-effective and required a lot of energy. Recently, a new powder has been developed by Zhongwei Chen, a chemical engineer at the University of Waterloo, which is vastly more efficient and cost-effective. It works by trapping carbon dioxide molecules in microscopic pores within the powder particles

(Cimons). Furthermore, the powder can be created through a variety of raw materials, including rice straw, which, as mentioned earlier, is a huge agricultural byproduct in Indian farms, meaning the powder could easily be produced locally. Once the carbon dioxide is collected, it is transported via ship or pipeline and is then safely stored in a number of carefully selected rock formations deep below the earth's surface. Another significant advantage of this solution, is the fact that there is an entire organization dedicated to the Carbon Capture technology, the Carbon Capture and Storage Association (CCSA), which has stated that its deployment "will involve the widespread adoption of these CCS techniques, combined with robust monitoring techniques and government regulation" ("What is CCS?"). In other words, the CCSA can work with the Indian government to utilize this eco-friendly technology in industrial processes throughout the nation. The fact that CCS isn't a renewable energy source is a double-edged sword. On the one hand, industrial processes and power plants don't have to be completely redesigned or taken down to be made more environmentally safe, which is good for the economy and for political reasons. On the other hand, it will not be the best long-term solution as it is not 100% efficient. Eventually, alternative environmentally-friendly methods for energy generation and various industrial processes must be developed.

Along with these solutions, it is crucial that the Indian government continues to tighten regulations on emissions and other hazardous activities to match the rapidly expanding economy. Examples of such regulations can be seen in Delhi, where auto rickshaws are starting to run on natural gas, and the government has created a "congestion scheme to reduce the volume of traffic, in which vehicles with odd and even number plates could enter the city on alternate days" (Chatterjee). While environmental conditions are slowly improving in Delhi, the same can't be said about many of the other dangerously polluted cities in India. With increasing national revenue from its industrial sector, the Indian government must do more to protect the lives of all citizens who are being endangered by air pollution. This means spending more money on public health care in order to reduce and eventually eliminate the 1.5 million yearly deaths caused by pollution and helping the countless other citizens who have developed health conditions as a result of severe contamination of the atmosphere. It is important to note that pollution not only causes health problems but also contributes to hunger and poverty by lowering crop yields and driving up the prices of basic necessities. Finally, air pollution and greenhouse gas emissions contribute to climate change around the world, meaning this problem affects not only all 1.3 billion inhabitants of India, but all living creatures on our massive planet. Thus, prompt action must be taken to combat air pollution, in order to protect the citizens of India and future generations.

No one pretends that eliminating air pollution will be a quick or easy process. Even if the technologies work as we hope, it seems unlikely that pollution can be brought down to safe levels within the next few decades. But even a relatively moderate reduction in air pollution would mitigate the worst effects, improving crop yield and reducing pollution-related illness. And that would mean a better, longer life for hundreds of millions of people.

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