Chapter

Poor Air Quality: A Dark Cloud of Filth Poisons

Syed Abdul Rehman Khan, Adeel Shah and Zhang Yu

Abstract

Our home, the Earth, is the rarest planet in-universe the to sustain life. The thing which makes it unique amongst heavenly bodies is balance in the environment. This balance is the key to sustain life for millions of years. Air is one of the most critical components of mother nature; it provides oxygen for all species, both plant and animal, to live. Air not only provides oxygen but is also essential for keeping the human body cool. The advantages of air are countless, from the cloud, weather, humidity, dust, and pollen migration to burning fire; without it, life will not continue. Air is made up of chemical components, and if pollutants added, it would become harmful for all living beings. The chapter put forward is to highlight the importance of the quality of ambient air, standards to measure, and sources of pollution. Further in the chapter, the impacts of polluted air on human health and the countries' financial obstacles are discussed. The chapter concludes with a summary and recommendations for policymakers, NGOs, and affected people to better their lives and repair the damage caused to nature's precious gift, the air.

Keywords: Air quality, pollutants, and AQI

1. Introduction

Human beings need combustion energy to survive and live their daily lives. The energy needs are constant in the everyday affair, from cooking to use electricity. Out of the most abundant of all fuels in an urban and rural setting in developing countries are coal, wood, methane gas, and cow dengue. The heat produced from the fuel is used for cooking, keeping warm, and boiling water for sanitation. The combustion fuels mainly categorize as gas, liquid, and solids [1]. Solid fuels need an air mixture to fully combust and provide energy [2]. Such fuels produce heat for our well-being and produce gases that affect the air around us. A good quality air constitutes seventy-eight percent nitrogen, twenty-one percent oxygen, one percent other gases (National Geographic) for human beings to survive. In the one percent of other gases, 0.1% of gases are CO2, methane, water, and neon gas [3]. The combustion of solid fuel results in carbon monoxide emissions, particulate matter (PM), and organic compounds [4]. The emitted gases badly affect air quality and thus are termed as pollution [5].

There are many other activities in the daily walk of human life which are adversely affecting air quality. The leading causes are the construction of megacities, manufacturing of goods, usage of pesticides, automobiles, and airplanes [6]. The polluted emission from solid fuels and biomass in domestic use has declined since 1990 [7] due to the availability of liquefied petroleum gas (LPG) and methane gas. However, in developing countries, households in cities are still using solid fuel and biomass for heating and cooking [8]. The rural areas in developing countries are mainly using biomass and solid fuel for daily chores [9]. The pollution caused by domestic emission results in death, and it has increased since 1990 significantly in emerging economies [7, 10].

The natural sources are also affecting air quality in the atmosphere, and most significantly, they are volcanoes and wildfires. However, anthropogenic behaviors remain the most prominent [11]. The rapid deterioration of air quality started since oil discovery and byproducts due to rapid industrialization globally [12]. The consumption of fossil fuel has increased mammoth in the 21st century due to the human population explosion. It is a significant pollution source to negatively impact the ecosystem [13]. The air quality and pollution are not localized. However, a transboundary problem [14], the pollutant emitted in a country can transport through the wind in the atmosphere and thus need global attention and regional collaboration [15].

The air quality is measured through a numerical index is used know as the "Air Quality Index (AQI)," which gauges pollution concentration [5]. The AQI serves to identify air pollution levels impacting the health of the public. The assessment of air pollution by the measure helps policymakers strategize reduction by curbing activities serving as the source [16]. The data for the indexes gathers from worldwide city stations responsible for monitoring air quality. The AQI data is available online for the general public to use in studies and reports [17]. The "US Environmental Protection Agency (USEPA) " is first to use AQI in the year 1999, and then the index modified to use six chemicals measurement in the air: "carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), coarse particulate matter (PM10), fine particulate matter (PM2.5), and sulfur dioxide (SO2)" [18]. The AQI unit ranges from "0 to 500," and the values are directly proportional to the air's chemical concentration; thus higher the value greater the effect on health [19, 20]. As the AQI value exceeds 100, the air quality becomes unhealthy for certain groups of people. The AQI's values are color-coded to reflect the severity of pollutant concentration (see **Figure 1**) [22].

Air Quality Index

AQI Category and Color	Index Value	Description of Air Quality
Good Green	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Moderate Yellow	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups Orange	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Unhealthy Red	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy Purple	201 to 300	Health alert: The risk of health effects is increased for everyone.
Hazardous Maroon	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Figure 1.
The EPA AQI [21].

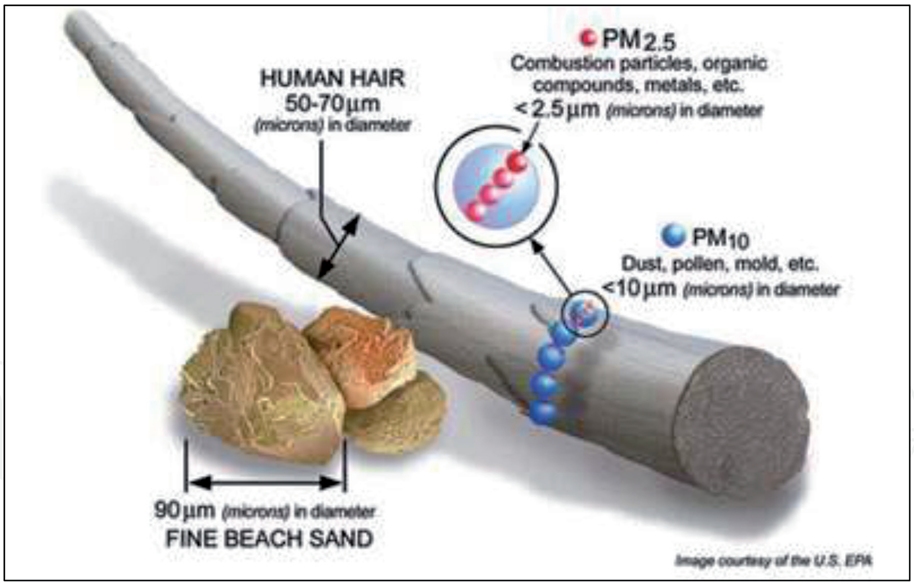


Figure 2.
Size comparison [21, 23].

The pollutant matter's size defines the PM; there are two types of sizes used in AQI: 2.5 and 10 microns (see **Figure 2** for size comparison) [23]. Many government agencies and NGOs like "IQAIR" collaborate with like-minded partners to report AQI to the public. The website also publishes reports yearly basis, and the result reflected are in PM2.5. There are many other websites which reflects air quality to view by tourists, policymakers, and certain groups with health conditions (see appendix 1 for websites).

2. Low air quality and society

The low air quality impacts plants, crops, aquatic water life, humans, and animals [24]. Globally, AQI standards protect the habitat; an example is the European Union's standards to protect vegetation. The transportation sector is also a significant source causing degradation, adding "acidification, eutrophication, and ozone." Acidification occurs due to the pH balance change of perception by the chemical reaction between "nitrogen dioxide, sulfur dioxide, nitric acid (HNO3), and sulfuric acid" to affect lake water, plants, and crops [24]. Carbon dioxide in the air reacts with water in the oceans to produce carbonic acid. The acid lowers the ocean's pH to impact sea life and is the primary cause of coral reefs [25]. The ozone is also a significant cause that harms human health and damage plants and jungles. The smog caused by ozone causes respiratory problems in humans and animals. It also interrupts the photosynthesis process in plants weakening to fight diseases, insects, and weather impacts [26].

Air pollution is responsible for killing millions; according to [27], seven million people die worldwide each year. In 2015, 2.8 million and 4.2 million people died from household and environmental air pollution [7, 10]. According to Hanson et al. [28], the same year's deaths categorize as "19% of all cardiovascular deaths worldwide, 24% of ischemic heart disease deaths, 21% of stroke deaths, and 23% of lung cancer deaths." Kioumourtzoglou et al. [29] studied the impact of air pollution and found evidence of the risk factor for neurodevelopment conditions in kids and neurodegenerative conditions in grownups. The effects of air pollution on humans depend on exposure, age, immunity, and predisposing conditions [11], resulting in nausea, respiratory problems, skin inflammation, organ failures, and cancer [30]. The epidemiological research on air pollution suggests that adverse effects primarily on cardiovascular and respiratory organs; however, the other organs may also damage [30–33]. WHO [27] published in their report below death percentages:

- "29% of all deaths and disease from lung cancer
- 17% of all deaths and disease from an acute lower respiratory infection
- 24% of all deaths from stroke
- 25% of all deaths and disease from ischemic heart disease
- 43% of all deaths and disease from chronic obstructive pulmonary disease."

Many studies suggest that air pollution long-term exposure to high and low pollutant concentrations affects the respiratory system [34]. The usual symptoms are irritation of nose and throat followed by bronchoconstriction and acute dyspnoea in asthmatic patients by exposure of sulfur dioxide [35] and nitrogen oxides [36]. The PM in air pollution enters the lung (see **Figure 3**) to affect alveolar epithelium [38], ozone starts lung inflammation [39], and nitrogen oxides increase the chances of lung infections [40]. The more prolonged exposure to ozone reduces lung function [41, 42]. Exposure to heavy metals increases the risk of asthma, emphysema, and lung cancer [43, 44].

Air pollution also affects the cardiovascular system as carbon monoxide joins with hemoglobin to reduce its ability to transmit oxygen [45]. It reduces oxygen availability in body organs, impacting their functions (see **Figure 4** for AQI chart and health recommendation). Blood coagulation is another problem that occurs due to PM presence in the body [47]. Similarly, air pollution may cause blood clotting, resulting in obstruction in cardiac blood vessels [48]. The nervous system in the human body exaggerates by inhalation of "heavy metals (lead, mercury, and arsenic) and dioxins" [11]. Researchers have found linkages of neurotoxicity and memory loss, sleep disorders, mood swings, emotional imbalance, impaired vision,

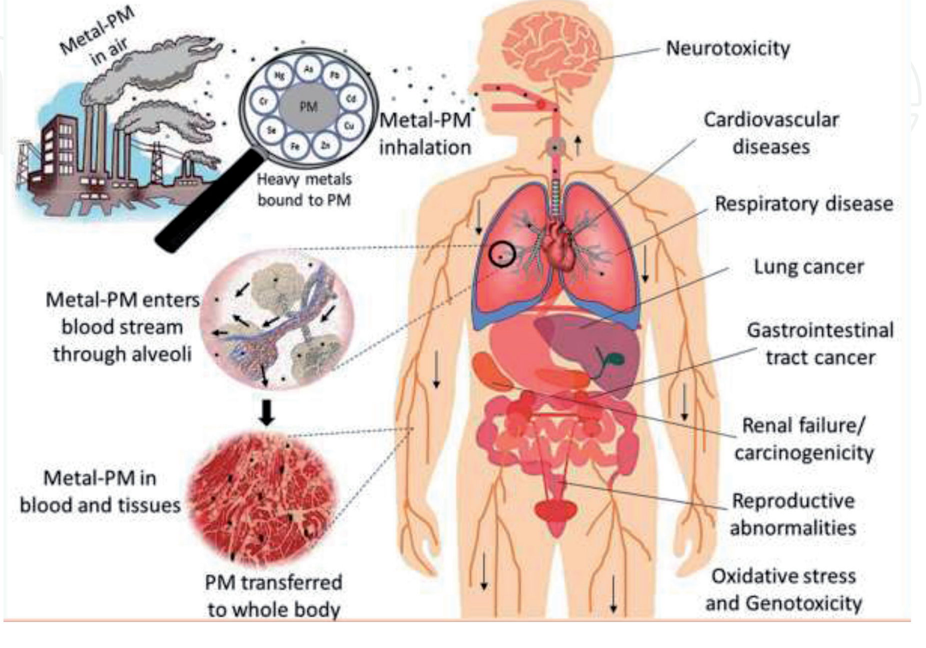
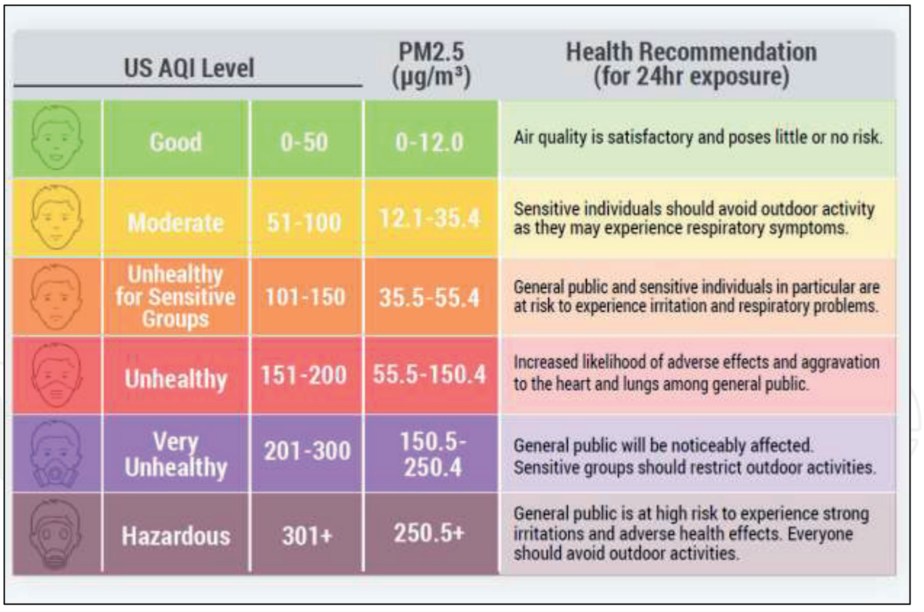


Figure 3.
Human diseases due to heavy metals in the air [37].

DOI: http://dx.doi.org/10.5772/intechopen.95456



US AQI Level		PM2.5 (μg/m³)	Health Recommendation (for 24hr exposure)
Good	0-50	0-12.0	Air quality is satisfactory and poses little or no risk.
Moderate	51-100	12.1-35.4	Sensitive individuals should avoid outdoor activity as they may experience respiratory symptoms.
Unhealthy for Sensitive Groups	101-150	35.5-55.4	General public and sensitive individuals in particular are at risk to experience irritation and respiratory problems.
Unhealthy	151-200	55.5-150.4	Increased likelihood of adverse effects and aggravation to the heart and lungs among general public.
Very Unhealthy	201-300	150.5-250.4	General public will be noticeably affected. Sensitive groups should restrict outdoor activities.
Hazardous	301+	250.5+	General public is at high risk to experience strong irritations and adverse health effects. Everyone should avoid outdoor activities.

Figure 4.
AQI chart and risk to health [46].

and slur speech [45, 49]. Air pollution can increase the risk of pregnancy complications by impacting fetus development [50]. In the case of exposure to lead and heavy metal, it risks abortion [11].

3. Low air quality and financial obstacles

Air pollution also influences economic conditions in a country. According to McCarthy [51], air pollution in China is USD 900 billion, and in the USA, it estimates to cost USD 600 billion. The deaths by the burning of fossil fuel and coal are three times higher than road accidents. The estimated economic cost of air pollution is USD 2.9 trillion that equates to 3.3 percent GDP of the world [52]. According to the report, the disease and treatment due to air treatment cost disability from chronic diseases costing USD 200 billion in 2018. Sick leave of absence and premature birth cost around USD 100 and USD 90 billion, respectively [51].

Similarly, India's air pollution cost a staggering yearly USD 150 billion (see **Figure 5** for GDP comparisons). The labor hour lost due to illness and absentees due to health-related issues caused by air pollution directly impacts the labor market. It results in less productivity and reduced labor contribution to GDP [54].

The above are direct economic cost implications of air pollution; however, indirect costs also impact the country's economy (see **Figure 6** for direct and indirect cost) [55]. According to OECD [56], air pollution is " The indirect economic effects come from reallocation of the factors of production across the economy, changes in international trade and changes in savings, as changes in relative prices induce them." The report further explains that unlike direct cost, which affects GDP, indirect cost increases gradually. Consumers and environment watchdogs globally aware of air pollution on the environment and remain concerned for ethical and sustainable manufacturing practices. According to Qiu et al. [57], air pollution and consumers' negative sentiment correlate and impact buying behavior. The textile and apparel exporting sector in developing countries exports goods, which significantly impacts GDP. The industry is also responsible for air pollution in manufacturing countries.

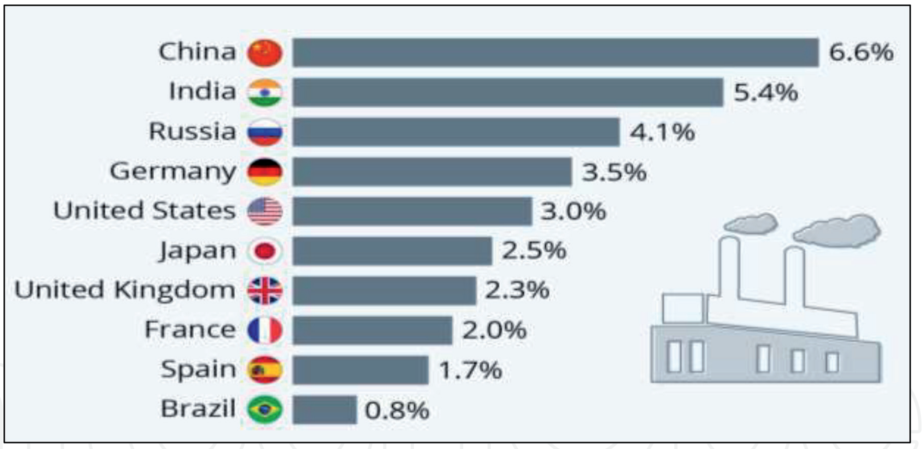


Figure 5.
Air pollution cost as GDP share (MacCarthy [53]).

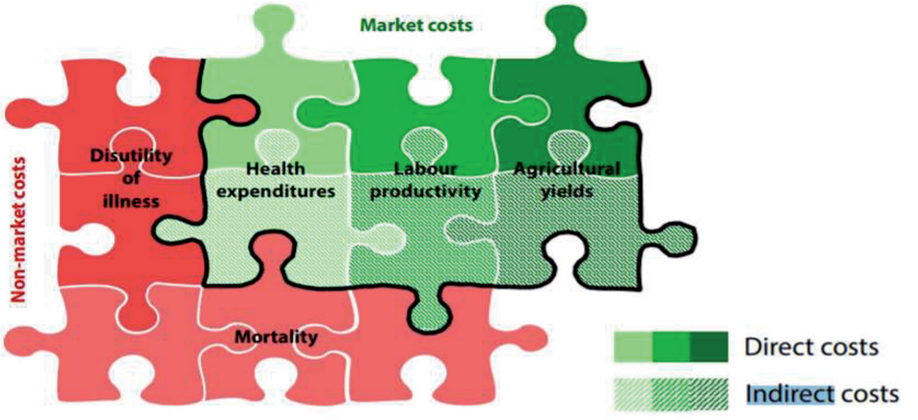


Figure 6.
Direct and indirect cost of air pollution.

In the textile and apparel sector, in which many processes use chemicals for treatment. Other than chemicals, the loss of short fiber called lint is air pollution hazardous to labor and people living near the factories [58]. According to Karthik and Gopalakrishnan [58], the following are the source of air pollution in the textile and garment industry (see **Table 1**): Similar studies by Haseeb et al. [59] and Heydebreck et al. [60] confirm the positive contribution of carbon dioxide CO2 and poly-fluoroalkyl substances (PFAS) in the textile and clothing industry.

An example of cotton fiber is relevant to the indirect cost of air pollution socioeconomically. An estimate of 25% of the pesticides used globally is the direct cause of cotton production. Further organic cotton is another demanded product in the west, used in fabric and garments label as "ECO" [61]. The water uses for irrigation is natural and rainwater. In air pollution, the rains will become a source of acid rain and damage the crop, resulting in economic loss to the country's farmers and exports [62].

The other primary air pollutant of the textile and garment industry is "toxic heavy metals, biochemical oxygen demand (BOD), chemical oxygen demand (COD), residual chlorine, dissolved solids, color, sludge, used oil, dyes, and non-biodegradable organics" [63]. Air pollution is a CSR activity in which organizations and governments are very conscious. Siri Lankas government in 2015 voluntarily designed and produce products that come under "ethical manufacturing" and to certify its industry to a complaint of "Garments without Guilt Certification" and

Due to manufacturing	Due to diffusion
"Boilers"	"Solvent-based"
"Ovens"	"Wastewater treatment."
"Storage tanks."	"Warehouses"
	"Spills"

Table 1.
Sources of air pollution in the textile and garment industry [58].

"Sustainable Environmental Friendly Manufacturing" to target EU markets and consumers [64].

4. Conclusion and recommendations

Low air quality is now a global phenomenon in which all countries are giving due consideration to improvement. Developing countries are the worst affected; according to [65] 21 out of 30 worst air polluted cities belong to India. New Dehli ranks at number 1 most air polluted city in the world (see **Figure 7**). Incontinent, Asia ranks no. 1 as most countries are developing economies and rely heavily on fossil fuel and coal to fulfill energy demands. Air pollution impacting on labor productivity and health care systems. China has turned around and is investing heavily to reduce air pollution [66]. The air transportation emission standards in China are at par with European standards [67]. Mainly china is investing in solar energy, and by 2024 it will be generating twice in comparison to the USA [68]. The world has to unite in the effort as air pollution is a transborder phenomenon and needs to combine effort from regional countries. By acting together, the world can safeguard the habitats that are getting toxic and affect billions of human lives, plants and trees, and aquatic life, essential for the ecosystem's substance.

The air pollution can reduce to a level if collective efforts are in the right direction. The awareness programs should start in developing countries, educating the masses about the effects of air pollution on human health and the environment. The primary cause of air pollution is due to transportation. The developing countries should invest in upgrade the transportation system in the cities. Local bodies and city policymakers should provide facilities to reduce traffics on the road. Mobile Applications should introduce in for pooling resources and transportation for passengers going to the same destination. Air pollution is because of the high usage of pesticides.

and stubble burning to vacate lands for the next harvest in rural areas. The government should make laws to restrict and educate the masses in this regard. The farmers should use the right amount of pesticides to avoid excess chemicals in the air.

People should avoid trash burning, and the government should implement a trash disposal system. Countries should invest in alternate energy, and countries with prolonged exposure to sunlight and coastal areas with wind should identify to generate energy from solar and wind. These are clean energy and can generate energy with long term wait, unlike hydraulic power. Hydral power generation is not possible everywhere. Tree plantation is also essential to reduce the greenhouse effect and decrease CO2 in the atmosphere. The government should invest and enact laws for the purpose. All fuels containing lead and heavy metal must put to a legal stop. Euro 5 standard fuels are the best examples; the compliant fuel has


PM2.5 Legend: WHO target | Good | Moderate | Unhealthy for sensitive groups | Unhealthy | Very unhealthy | Hazardous

Rank	City	2019 AVG	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	Ghaziabad, India	110.2	205.7	[illegible]	89.3	86.5	96.8	82.9	45.3	33	37.7	158.6	235.8	235.8
2	Hotan, China	110.1	80.1	70.1	188.1	151.8	128.6	57.9	119.7	126	87.8	103.9	114.5	106.1
3	Gujranwala, Pakistan	105.3	220.4	127.4	86.4	70.9	65.8	53.3	59.2	48.8	87.4	107.6	144.9	217.3
4	Faisalabad, Pakistan	104.6	223	128.3	82	59.1	56.8	46.3	54.2	58.4	66.5	92	148.5	226.2
5	Delhi, India	98.6	191.7	84.8	75.3	71.4	76.6	56.7	43.2	[illegible]	37.2	116.7	200.7	194.8
6	Noida, India	97.7	151.8	38.1	76.3	81.8	86.6	65.3	47.4	33.1	36.5	134.3	212.4	222.6
7	Gurugram, India	93.1	234.5	62.3	76.3	83	92.2	64.9	47.3	39.1	41.8	108.2	146.8	102.9
8	Raiwind, Pakistan	92.2	-	201.3	137.1	119	101.9	66.6	41.3	27.2	34.6	70.1	113.4	93.3
9	Greater Noida, India	91.3	194.5	66.8	76	70.3	61.2	51.8	39.4	32.1	30.2	130	195.5	191.1
10	Bandhwari, India	90.5	88.5	82.5	80.5	78.7	90.2	74.1	54.8	25.4	42.6	112.6	187.9	178.6

Figure 7.
Ten air polluted city in the world [46].

shallow content polycyclic aromatic hydrocarbons and sulfur to reduce unsafe environmental discharges. Education is the best weapon to use in the fight against air pollution, and it needs government and joint public effort, but once achieved, the whole community will enjoy the fruits and generations to come. Earth is unique and the only home which could sustain living beings. It is human beings' moral obligation to protect them from degradation, only possible by stopping all types of activities that cause air pollution.

A. Appendix 1

Website	Web address
Air Now	https://www.airnow.gov/
World's Air Pollution	https://waqi.info/
World Air Quality	https://www.iqair.com/us/world-air-quality
Purple Air	www.purpleair.com
EPA United States Environmental Protection Agency	www.epa.gov/outdoor-air-quality-data
Air Pollution in the world	www.aqicn.org/map/world/
Green Facts	www.greenfacts.org/en/ozone-o3/links/index.htm

Author details

Syed Abdul Rehman Khan[1,2]*, Adeel Shah[3] and Zhang Yu[2]

1 School of Management, Xuzhou University of Technology, Xuzhou, China

2 School of Economics and Management, Chang'an University, Xi'an, China

3 Institute of Business Management (IOBM), Karachi, Pakistan

*Address all correspondence to: sarehman_cscp@yahoo.com

References

[1] Morawska, L., & He, C. (2014). Indoor particles, combustion products and fibres. In *Indoor Air Pollution* (pp. 37-68). Springer.

[2] Paraschiv, L. S., Serban, A., & Paraschiv, S. (2020). Calculation of combustion air required for burning solid fuels (coal/biomass/solid waste) and analysis of flue gas composition. Energy Reports, 6, 36-45. https://doi.org/https://doi.org/10.1016/j.egyr.2019.10.016

[3] Nathanson, J. (2020, October 19). *air pollution | Effects, Causes, Definition, & Facts | Britannica*. Britannica. https://www.britannica.com/science/air-pollution

[4] Smith, K. R. (1993). Fuel combustion, air pollution exposure, and health: the situation in developing countries. Annual Review of Energy and the Environment, *18*(1), 529-566.

[5] Jassim, M. S., & Coskuner, G. (2017). Assessment of spatial variations of particulate matter (PM 10 and PM 2.5) in Bahrain identified by air quality index (AQI). *Arabian Journal of Geosciences*, *10*(1), 19.

[6] Landrigan, P. J. (2017). Air pollution and health. In *The Lancet Public Health* (Vol. 2, Issue 1, pp. e4–e5). Elsevier Ltd. https://doi.org/10.1016/S2468-2667(16)30023-8

[7] Forouzanfar, M. H., Afshin, A., Alexander, L. T., Anderson, H. R., Bhutta, Z. A., Biryukov, S., Brauer, M., Burnett, R., Cercy, K., & Charlson, F. J. (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. The Lancet, *388*(10053), 1659-1724.

[8] Molla, M. F. (2020). Assessment of the Carbon Footprint Across Urban Households in Kolkata. In *Habitat, Ecology and Ekistics* (pp. 115-131). Springer.

[9] Gupta, E. A., & Jain, A. (2020). *Role of Bio Gas Plant for Empowering the Women Communities in Rural Area of India*.

[10] Prüss-Üstün, A., Wolf, J., Corvalán, C., Bos, R., & Neira, M. (2016). *Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks*. World Health Organization.

[11] Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. Environmental Pollution, *151*(2), 362-367.

[12] Al-Salem, S. M., & Khan, A. R. (2010). Monitoring and modelling the trends of primary and secondary air pollution precursors: The case of the state of Kuwait. *International Journal of Chemical Engineering*, *2010*.

[13] Tang, H., & Dhari, A. (2008). Introduction to Air Pollution and Air Quality Management. *Environment and Urban Development Division Kuwait Institute for Scientific Research*.

[14] Haryanto, B. (2012). *Air Pollution: A Comprehensive Perspective*. BoD–Books on Demand.

[15] Abdullah, M., Hamzah, N., Ali, M. H., Tseng, M.-L., & Brander, M. (2020). The Southeast Asian haze: The quality of environmental disclosures and firm performance—*Journal of Cleaner Production*, *246*, 118958.

[16] Ruggieri, M., & Plaia, A. (2012). An aggregate AQI: comparing different standardizations and introducing a variability index. Science of the Total Environment, *420*, 263-272.

[17] Van den Elshout, S., Léger, K., & Heich, H. (2014). CAQI common air quality index—update with PM2. 5 and sensitivity analysis. Science of the Total Environment, *488*, 461-468.

[18] EPA. (2009). *Atmosphere | National Geographic Society*. National Geographic. https://www.nationalgeographic.org/encyclopedia/atmosphere-RL/

[19] Gore, R. W., & Deshpande, D. S. (2017). An approach for classification of health risks based on air quality levels. *2017 1st International Conference on Intelligent Systems and Information Management (ICISIM)*, 58-61. https://doi.org/10.1109/ICISIM.2017.8122148

[20] Kumari, S., & Jain, M. K. (2018). A critical review on air quality index. In *Environmental Pollution* (pp. 87-102). Springer.

[21] EPA. (2020). *Wildfire Smoke and Your Patients' Health: The Air Quality Index*. https://www.epa.gov/wildfire-smoke-course/wildfire-smoke-and-your-patients-health-air-quality-index

[22] Deep, B., Mathur, I., & Joshi, N. (2020). Coalescing IoT and Wi-Fi technologies for an optimized approach in urban route planning. Environmental Science and Pollution Research, *27*(27), 34434-34441.

[23] Cardinal, D. (2018, November 21). *How Air Quality and the AQI Are Measured - ExtremeTech*. Extreme Tech. https://www.extremetech.com/electronics/280956-how-air-quality-and-the-aqi-are-measured

[24] Meyer, M. D., & Elrahman, O. A. B. T.-T. and P. H. (Eds.). (2019). *Chapter 4 - Air and water pollution: An important nexus of transportation and health* (pp. 65-106). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-816774-8.00004-9

[25] Lindsey, R. (2018). Climate change: atmospheric carbon dioxide. *National Oceanographic and Atmospheric Administration, News & Features. August*.

[26] Carinci, F., Benedetti, M. M., Klazinga, N. S., & Uccioli, L. (2016). Lower extremity amputation rates in people with diabetes as an indicator of health systems performance. A critical appraisal of the data collection 2000-2011 by the Organization for Economic Cooperation and Development (OECD). Acta Diabetologica, *53*(5), 825-832.

[27] WHO. (2020). *Air pollution*. https://www.who.int/health-topics/air-pollution#tab=tab_1

[28] Hanson, M., Gluckman, P., & Bustreo, F. (2016). Obesity and the health of future generations. The Lancet Diabetes & Endocrinology, *4*(12), 966-967.

[29] Kioumourtzoglou, M.-A., Schwartz, J. D., Weisskopf, M. G., Melly, S. J., Wang, Y., Dominici, F., & Zanobetti, A. (2016). Long-term PM2.5 Exposure and Neurological Hospital Admissions in the Northeastern United States. Environmental Health Perspectives, *124*(1), 23-29. https://doi.org/10.1289/ehp.1408973

[30] Mandell, J. T., Idarraga, M., Kumar, N., & Galor, A. (2020). Impact of Air Pollution and Weather on Dry Eye. Journal of Clinical Medicine, *9*(11), 3740.

[31] Huang, Y.-C. T., & Ghio, A. J. (2006). Vascular effects of ambient pollutant particles and metals. Current Vascular Pharmacology, *4*(3), 199-203. https://doi.org/10.2174/157016106777698351

[32] Künzli, N., & Tager, I. B. (2005). Air pollution: from lung to heart. Swiss Medical Weekly, *135*(47-48), 697-702.

[33] Suzuki, T., Hidaka, T., Kumagai, Y., & Yamamoto, M. (2020). Environmental pollutants and

the immune response. Nature Immunology, 1-10.

[34] Beelen, R., Raaschou-Nielsen, O., Stafoggia, M., Andersen, Z. J., Weinmayr, G., Hoffmann, B., Wolf, K., Samoli, E., Fischer, P., & Nieuwenhuijsen, M. (2014). Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. The Lancet, *383*(9919), 785-795.

[35] Balmes, J. R., Fine, J. M., & Sheppard, D. (1987). Symptomatic Bronchoconstriction after Short-Term Inhalation of Sulfur Dioxide1, 2. Am Rev Respir Dis, *136*, 1117-1121.

[36] Kagawa, J. (1985). Evaluation of biological significance of nitrogen oxides exposure. The Tokai Journal of Experimental and Clinical Medicine, *10*(4), 348-353.

[37] Shahid, M., Natasha, Dumat, C., Niazi, N. K., Xiong, T. T., Farooq, A. B. U., & Khalid, S. (2020). *Ecotoxicology of Heavy Metal(loid)-Enriched Particulate Matter: Foliar Accumulation by Plants and Health Impacts* (pp. 1-49). Springer New York. https://doi.org/10.1007/398_2019_38

[38] Ghio, A. J., & Huang, Y.-C. T. (2004). exposure to concentrated ambient particles (CAPs): a review. Inhalation Toxicology, *16*(1), 53-59. https://doi.org/10.1080/08958370490258390

[39] Uysal, N., & Schapira, R. M. (2003). Effects of ozone on lung function and lung diseases. Current Opinion in Pulmonary Medicine, *9*(2), 144-150. https://doi.org/10.1097/00063198-200303000-00009

[40] Chauhan, A. J., Krishna, M. T., Frew, A. J., & Holgate, S. T. (1998). Exposure to nitrogen dioxide (NO2) and respiratory disease risk. Reviews on Environmental Health, *13*(1-2), 73-90.

[41] Rastogi, S. K., Gupta, B. N., Husain, T., Chandra, H., Mathur, N., Pangtey, B. S., Chandra, S. V, & Garg, N. (1991). A cross-sectional study of pulmonary function among workers exposed to multimetals in the glass bangle industry. American Journal of Industrial Medicine, *20*(3), 391-399. https://doi.org/10.1002/ajim.4700200311

[42] Tager, I. B., Balmes, J., Lurmann, F., Ngo, L., Alcorn, S., & Künzli, N. (2005). Chronic exposure to ambient ozone and lung function in young adults. *Epidemiology (Cambridge, Mass.)*, *16*(6), 751-759. https://doi.org/10.1097/01.ede.0000183166.68809.b0

[43] Kuo, C.-Y., Wong, R.-H., Lin, J.-Y., Lai, J.-C., & Lee, H. (2006). Accumulation of chromium and nickel metals in lung tumors from lung cancer patients in Taiwan. *Journal of Toxicology and Environmental Health*. Part A, *69*(14), 1337-1344. https://doi.org/10.1080/15287390500360398

[44] Nawrot, T., Plusquin, M., Hogervorst, J., Roels, H. A., Celis, H., Thijs, L., Vangronsveld, J., Van Hecke, E., & Staessen, J. A. (2006). Environmental exposure to cadmium and risk of cancer: a prospective population-based study. The Lancet. Oncology, *7*(2), 119-126. https://doi.org/10.1016/S1470-2045(06)70545-9

[45] Halkos, G., & Argyropoulou, G. (2020). Pollution and Health Effects: A Nonparametric Approach. Computational Economics, 1-24.

[46] IQAIR. (2019). *Empowering the World to Breathe Cleaner Air | IQAir*. https://www.iqair.com/us/

[47] Altemose, B., Robson, M. G., Kipen, H. M., Strickland, P. O., Meng, Q., Gong, J., Huang, W., Wang, G., Rich,

D. Q., & Zhu, T. (2017). Association of air pollution sources and aldehydes with biomarkers of blood coagulation, pulmonary inflammation, and systemic oxidative stress. Journal of Exposure Science & Environmental Epidemiology, *27*(3), 244-250.

[48] Bhandari, B. S., & Bijlwan, K. (2019). Effects of Atmospheric Pollutants on Biodiversity. In *Global Perspectives on Air Pollution Prevention and Control System Design* (pp. 142-173). IGI Global.

[49] Ewan, K. B., & Pamphlett, R. (1996). Increased inorganic mercury in spinal motor neurons following chelating agents. Neurotoxicology, *17*(2), 343-349.

[50] Forde, M. S., Dewailly, E., Robertson, L., Sidi, E. A. L., Côté, S., Dumas, P., & Ayotte, P. (2014). Prenatal exposure to persistent organic pollutants and polybrominated diphenyl ethers in 10 Caribbean countries. Environmental Research, *133*, 211-219.

[51] McCarthy, N. (2020). *How does air pollution affect the economy? | World Economic Forum*. World Economic Forum. https://www.weforum.org/agenda/2020/02/the-economic-burden-of-air-pollution

[52] Myllyvirta, L. (2020). Quantifying the economic costs of air pollution from fossil fuels. *Centre for Research on Energy and Clean Air*.

[53] MacCarthy Niall. (2020). *Chart: The Economic Burden Of Air Pollution | Statista*. Statista. https://www.statista.com/chart/20804/costs-of-air-pollution-from-fossil-fuels/

[54] Lave, L. B., & Seskin, E. P. (2013). *Air pollution and human health*. Routledge.

[55] Ali, S. H., & Puppim de Oliveira, J. A. (2018). Pollution and economic development: an empirical research review. Environmental Research Letters, *13*(12), 123003. https://doi.org/10.1088/1748-9326/aaeea7

[56] OECD. (2016). *Economic Consequences of Outdoor Air Pollution*. Organisation for Economic Co-operation and Development.

[57] Qiu, Q., Wang, Y., Qiao, S., Liu, R., Bian, Z., Yao, T., & Nguyen, T. S. (2020). Does air pollution affect consumer online purchasing behavior? The effect of environmental psychology and evidence from China. *Journal of Cleaner Production*, 120795.

[58] Karthik, T., & Gopalakrishnan, D. (2014). Environmental analysis of textile value chain: an overview. In *Roadmap to Sustainable Textiles and Clothing* (pp. 153-188). Springer.

[59] Haseeb, M., Haouas, I., Nasih, M., Mihardjo, L. W. W., & Jermsittiparsert, K. (2020). Asymmetric impact of textile and clothing manufacturing on carbon-dioxide emissions: Evidence from top Asian economies. Energy, *196*, 117094. https://doi.org/https://doi.org/10.1016/j.energy.2020.117094

[60] Heydebreck, F., Tang, J., Xie, Z., & Ebinghaus, R. (2016). Emissions of Per- and Polyfluoroalkyl Substances in a Textile Manufacturing Plant in China and Their Relevance for Workers' Exposure. Environmental Science & Technology, *50*(19), 10386-10396. https://doi.org/10.1021/acs.est.6b03213

[61] Bucklow, J., Perry, P., & Ritch, E. (2017). The influence of eco-labelling on ethical consumption of organic cotton. In *Sustainability in fashion* (pp. 55-80). Springer.

[62] Parvin, F., Islam, S., Akm, S. I., Urmy, Z., & Ahmed, S. (2020). A Study on the Solutions of Environment Pollutions and Worker's Health Problems Caused by Textile

Manufacturing Operations. Biomedical Journal of Scientific & Technical Research, *28*(4), 21831-21844.

[63] *Environmental Standards & Rules for Leather & Textile Industry - Fibre2Fashion*. (2014). Fibre2Fashion. https://www.fibre2fashion.com/industry-article/7287/environmental-standards-for-reducing-pollution-from-textile-and-leather-industry

[64] Hemachandra, D. W. K. (2015). *Adoption of voluntary environmental practices: evidence from the textile and apparel industry in Sri Lanka*.

[65] Helan, R. (2020). *India has 21 of the world's 30 cities with the worst air pollution - CNN*. CNN. https://edition.cnn.com/2020/02/25/health/most-polluted-cities-india-pakistan-intl-hnk/index.html

[66] Broom, D. (2020). *India dominates the list of the world's most polluted cities | World Economic Forum*. World Economic Forum. https://www.weforum.org/agenda/2020/03/6-of-the-world-s-10-most-polluted-cities-are-in-india/

[67] ICCT. 2020 (n.d.). *China: Light-duty: Emissions | Transport Policy*. Tnansportpolicy.Net. Retrieved November 26, 2020, from https://www.transportpolicy.net/standard/china-light-duty-emissions/

[68] *Global Trends in Renewable Energy Investment 2018 | Capacity4dev*. (n.d.). Retrieved November 26, 2020, from https://europa.eu/capacity4dev/unep/documents/global-trends-renewable-energy-investment-2018