Air Quality Under Siege: Smog, Climate Change, and Public Health Challenges in Pakistan

Dr. Asma Iqbal [1] Mr Muhammad Masood [2]

[1] Associate Professor, of Political Science Govt. Graduate College for Women, Samanabad Lahore, Punjab, Pakistan.

[2] PhD Scholar, Visiting Lecturer, UOL, UMT, Punjab, Pakistan.

Corresponding Author: asma.iqbal79@hotmail.com

ABSTRACT

Air pollution is one of the most serious challenges facing Pakistan, which has some of the most polluted urban areas in the world. This issue has received more recent scrutiny due to smog—often in combination with socioeconomic, public health, and environmental crises— most notably in winter months. According to recent estimates, over 40% of the metropolitan population of Pakistan is directly affected by smog, with Lahore hitting risk-branded air quality indices during peak season. This essay examines some components of Pakistan's air quality crisis, traced back to colonial-era transportation infrastructure, rapid urbanization, and a lack of environmental governance. Making the situation worse is the connection between pollution and climate change, which makes the pollutants more concentrated as temperatures rise. The public health impacts are severe, resulting in long-term consequences for mental health, and respiratory and cardiovascular diseases, particularly for vulnerable populations like the elderly and children. The burden of medical care and lost output highlights how far afield the impact of untrammeled pollution extends.

1. Introduction

They contend that air pollution currently impacts millions of residents globally, undermines climate stability, and, therefore, is regarded as one of the key environmental challenges of the twenty-first century. This problem has reached a dangerous level in Pakistan, especially in winter when smog pervades big cities such as Lahore, Karachi, and Faisalabad. The WHO (2018) reported that air pollution is presently responsible for at least 40% of urban Pakistan's population experiencing direct health impacts from increased rates of hazardous air quality. Pakistan's current problem of air pollution can be attributed to its colonial past. The British-era development of transportation infrastructure to spur economic activity in effect erected the necessary preconditions for industrialization, which resulted in a great number of emissions. It has worsened since independence due to an increased rate of urbanization and unrestricted industrial development, which has led to high levels of industrial discharge, burning of agricultural residues, and vehicle emissions (Ali et al., 2020). These pollutants are due to unsustainable planning and design of urban areas, inadequate management of wastes, and limited availability of environmentally friendly transportation.

These problems are exacerbated by the prospects of climate change shortly confronting societies. Increased temperatures mean that air has stagnated more and smog episodes have become more frequent and severe in the urban setting as confirmed by the UNEP 2022. For this reason, there is always a cycle whereby pollution intensifies other effects such as making cities dirty and hot due to climate change. These are low-income areas, children, and the elderly which shows that this is a social economic injustice.

Which are compounded by the arrival of climate change. Further global warming poses an increased threat to the general enhancement of air stagnation leading to high smog episodes especially in urban regions (United Nations Environment Program [UNEP], 2022). As a result, there is a vicious circle, which is pollution makes the impact of climate change worse, making cities dirtier and hotter. The most affected groups that are at higher risk include the poor area, children, and the elderly hence the social vulnerability that ignites this subject.

Tracing the causal relationship between smog, climate change, and public health in this country from historical, economic, and scientific perspectives is the main thrust of this essay. This paper examines the best practice implementation and provides a comprehensive set of recommendations to provide directions for eliminating the air quality problem in Pakistan.

Regarding air quality ratings, the majority of respondents from urban areas rated the air quality as "Very Poor" (27.9%, or 62 respondents), followed by "Poor" (23.9%, or 53 respondents) and "Average" (20.3%, or 45 respondents). Only a small number rated the air quality as "Good" (6.8%, or 15 respondents) or "Excellent" (1.4%, or 3 respondents).

2. Research Objective

i.   Studying potential precursors of smog and pollution.
ii.   Knowledge of how public health issues are related to environmental degradation.
iii. Assessing the international interventions to implement in Pakistan tending to public health challenges linked to environmental degradation.
iv.   Evaluating global solutions for applicability in Pakistan.

3. Research questions

i. Primary Source and Dimension of Air Pollution in Pakistan and Its Connection with Climate Change.

ii. Emerging issues; What are the effects of decline in air quality on the health of the people with reference to Pakistan especially developed areas such as urban and industrial districts furnishing the answer.

iii. What has to be done to apply the principles of the leading experiences of managing air quality for application in the context of Pakistan?

4. Methodology

This research uses both quantitative and qualitative data collection methods based on the Structural Functionalism Theory. There are two approaches, namely; a critical review of academic literature laterals, police reports, newspapers, and World Bank documents, and a case-study analysis on historical, socio-economic, and environmental perspectives of air pollution in Pakistan. This type of data is collected by conducting face-to-face, and informal, yet guided interviews with policymakers, environmentalists, and healthcare workers.

The quantitative technique includes the measurement of pollutant concentration, disease incidence rate, and social demographic response surveys. The specified structural functionalism perspective reflects the interaction of the organizations and institutions, such as governance, economy, and health care on the air quality and health of the population. This approach brings out the existing disconnections and recommends the application of corrective measures to tackle the problem of air pollution in Pakistan.

5. Literature Review

i. The emissions from our vehicles are ranked high in contribution to the pollutants.

In the view of Khan et al. (2021), transportation emissions remain the biggest contributor to air pollution in Pakistan's urban areas. The problem becomes even more complicated because of the old transportation systems due to their flexible regulations and low-standard fuels**.**

ii. Industrial Development and Volatile Degradation of the Firm's IAPs

The literature review of Malik et al. (2020) also revealed that the level of air pollution in the country has substantially risen mainly due to fast industrialization without corresponding environmental protection.

iii. Smog's Effect on Health

Iqbal et al. (2022) revealed that long-time exposure to smog more people to suffer from cardiovascular and respiratory diseases more people are affected by health emergencies most of which occur during winter in Lahore.

iv. Pollution and agriculture or farming practices

According to Shah & Ahmed (2020), Punjab's hazy environment owes it to crop residue burning and urged the implementation of mechanical measures for effective farming.

v. International Comparisons: Chinese Lessons

To give an example, Zhang et al. (2021) have shown a way that Pakistan might follow by pointing to China's experience of having enshrined strict contentious air quality standards and employing renewable power to reduce particulate matter.

vi. Pollution's Economic Costs

Air pollution in Pakistan negatively affects economic growth by leading to productivity and health loss that annually can total $6 billion, which is 3-6% of the country's GDP (World Bank, 2021).

vii. Public awareness is defined as the condition where an interested public exists during the business operation process of organizations.

UNICEF (2022) was careful to acknowledge that a general populace that lacks an understanding of the causes and consequences of air pollution cannot collectively act, and hence, air pollution national education campaigns are needed.

viii. Air Quality and Urbanization

Ahmad et al. (2019) argue that due to unplanned urbanization, people's density and need for commodities that harm the air such as fossils have risen hence air quality is poor.

ix. Pollution that is related to deforestation

Ali and Khan, 2021 posited that due to the high level of deforestation in the country, the natural air conditioning feature has been compromised hence raising pollution levels in urban areas.

x. A Review of the Existing Air Quality Management Policy Divide

In its 2022 report, UNDP highlights that an antiquated legal environment and the lack of any institutional capacity hampers air quality initiatives, and thus poor compliance with environmental laws is a challenge.

6. Historical and Socio-Economic Context

This paper, therefore, seeks to investigate and analyze the factors that have contributed to the perceived deterioration of air quality in Pakistan to understand the country's socioeconomic development. To understand the dynamics of how environmental degradation and its consequences have been aggravated one has to look at this background. Short-term planning has emerged as a massive constraint on Pakistan's modernization process due to the constraints which derive from colonial transportation systems, and uncontrolled urban and Industrialization growth. Splendid, this section reviews the aforementioned socioeconomic and historical factors and, in doing so, exposes how the matters with air quality in the contemporary world are influenced by the mentioned aspects.

A. Legacy of Colonial Transportation Infrastructure

The Indian subcontinent witnessed extremely radical change infrastructural changes during the British colonialism period which includes the 1858–1947 period. However, this infrastructure not only created conditions for an industrial economy but also for an economy that generates a significant amount of carbon. Large cities, factories, and railroads constructed during the time were the chief polluters, and the effects on the environment were always secondary to economic goals. (Malik & Ali, 2019). Transportation currently contributes to over 40% of Pakistan's today's carbon emissions, primarily because of the colonial infrastructure that was put into place and never retrofitted for today's environmental standards (Government of Pakistan, 2021).

B. Urbanization and Industrial Growth

Pakistan has witnessed vibrant urbanization after its independence in 1947 starting from 17% in the 1950s to over 38% at the time of writing this research (World Bank, 2022). Population expansion has thus occurred in an uncoordinated manner, however; Karachi, Lahore, and Islamabad, among other cities, have become financial hubs. Due to the lack of strict regulation of the emission of hazardous substances through the factory chimneys, factories contribute largely to the significant growth of pollution hot plates around densely populated regions such as the urban areas dense with businesses.

The agriculture sector which is also significant in contributing to the economy of Pakistan also contributes indirectly to air pollution in cities. Much of the particulate greenhouse gases are released into the air, through the process of burning agricultural residue that farmers use to clear the fields for the next planting season. This practice and Industrial pollutants worsen air quality issues in the populous Punjab province (Rashid et al., 2020).

C. Economic Growth vs. Environmental Sustainability

Industrialization has often been put ahead of concerns for environmental conservation in Pakistan's medium and long-term economic planning since its independence. The demand for growth of the economy has led to an increased use of fossil energy such as coal and petroleum products in transport and industries. Such practices have given rise to much environmental degeneration even though they have called for GDP and employment gradients.

The recorded examples of the energy industry provide a typical example of this trade-off. As shown above, over 60% of energy in Pakistan comes from non-renewable sources such as coal, oil, and natural gases that are highly implicated in air pollution (IEA, 2021). In Pakistan Lahore still suffers from pollution-related hazards including poor air quality during the haze period. The increased building sector in the city and car emissions make the situation even worse showing that sustainable urban design and shifts in regulation must be implemented (Greenpeace, 2021).

7. Dimensions of Air Pollution in Pakistan

Pakistan's contamination issue is complex and affected by numerous interrelated factors. . These variables incorporate family vitality utilization, burning rural remains, vehicle contamination, industry outflows, and the more extensive impacts of climate alteration. Each of these components ought to be carefully considered in arrange to completely get the degree and reality of Pakistan's discussion of contamination.

A. Industrial Outflows

In Pakistan, businesses play a major part in discussing contamination, particularly those near urban zones. Expansive sums of toxins, including sulfur dioxide, nitrogen oxides, and particulate matter (PM2.5 and PM10), are discharged by cement producers, brick furnaces, material plants, and chemical offices. These contaminants display genuine well-being risks in expansion to bring down the discussed quality. The Pakistan Natural Assurance Act (1997) has laws input, but the requirement is remiss, empowering undertakings to proceed utilizing old-fashioned innovation without satisfactory contamination control frameworks (Khan & Ahmed, 2020).

B. Vehicular Pollution

The transportation industry is presently one of the most common causes of air pollution in Pakistan due to the sharp rise in the number of automobiles on the country's interstates. Activity is congested in urban regions like Karachi and Lahore, and the discussed quality issue is made more regrettable by emanations from severely kept-up cars. An expansive parcel of these poisons, which are a combination of particulate matter, hydrocarbons, and carbon monoxide (CO), start from diesel-powered cars that do not take after Euro emanation controls. According to Ponders, over 40% of the discussed contamination in metropolitan zones is caused by vehicles (Natural Security Organization [EPA] Pakistan, 2022). Tending to this issue requires upholding more grounded emanations directions and making the switch to cleaner fuel innovations.

C. Agricultural Developments

Despite being the establishment of Pakistan's economy, farming is additionally a major supporter of the country's discussion of the contamination issue. In Punjab and Sindh, burning edit buildup may be a common practice that results in critical outflows of nursery gasses and particulate matter. Since stagnant climate traps poisons near the ground, making thick exhaust clouds, this can be particularly tricky amid the winter. About 20 million tons of trim buildup are burned in Pakistan each year, which significantly declines the region's discussed quality, concurring with the Nourishment and Agribusiness Organization (FAO, 2020).

D. Domestic Energy Utilize

Households in Pakistan's rustic ranges, where getting to clean vitality is rare, cook and warm utilizing routine powers like coal, wood, and excrement. This contributes to both worldwide warming and the weakening of nearby discuss quality by discharging toxins like carbon monoxide and dark carbon. Ladies and children are excessively influenced by indoor contamination from these behaviors since they spend more time closely cooking stoves (WHO, 2021). On the other hand, urban homes as often as possible compound the issue of contamination by utilizing reinforcement generators amid standard control blackouts.

E. Climate Change as a Multiplier

Pakistan's contamination issue is made more regrettable by climate alteration, which escalates the concentration of poisons. Clean storms are made more regrettable by rising temperatures and expanded dry spells, particularly in bone-dry ranges. Besides, toxins are regularly transported over locales by climate-induced changes in wind designs, coming about in hotspots of destitute quality even in places that are distant from contamination sources.

A horrendous circle exists between climate alter and contamination: even though climate-induced changes in climate designs make it more troublesome for poisons to spread, nursery gasses worsen worldwide warming. For case, Punjab's murkiness occasions have gotten more awful as of late as a result of both expanded contamination emanations and stagnant climate (UNEP, 2022).

8. Stagnant Weather Conditions and Smog

Transformations in temperatures - specifically, imposed smothering caused by climate change shifts in wind streams and their sustainability into the atmosphere - instill the capacity to keep the quantity of impurities suspended close to the surface of the earth which manifested in thick stratum of smoke. It is even more so in cases when the air that is nearest to the land has a significantly cooler temperature, a phenomenon known as "temperature inversion" which prevents pollutants from escaping to higher altitudes. Research shows that the phenomenon of smog in Punjab became more severe mostly because of the climate adjustment in the local meteorology setting, with the

volume of suspended dust regularly reaching 500% and more than the acceptable concentration (Ali et al., 2020).

9. Public Health Challenges

Thus, in Pakistan, where millions of people are daily confronted with dangerous rates of air pollution, air pollution, and climate change lead to substantial health problems. The healthcare system of the nation is under pressure from interconnections between the deteriorating air quality, emerging health risks from climate change, and social and economic risk factors.

A. Chronic diseases involve either the respiratory system or the cardiovascular system.

Major respiratory diseases in Pakistan include diseases arising from exposure to ground-level ozone and particulate matter including PM2.5 and PM10 and other pollutants. Research also shows that individuals who are exposed to high concentrations of PM2.5 have a propensity to develop bronchitis, asthma, and COPD. Old-aged people and children are the most affected in society when such a virus is being spread.

Another regrettable consequence is cardiovascular disorders. Principal facts were acknowledged many times that some pollutants like black carbon and nitrogen oxides increase the chances of heart attacks, strokes, and high blood pressure. A work conducted by the Pakistan Institute of Medical Sciences (PIMS) discovered that twenty-two percent of the total hospitalization instances due to cardiovascular diseases in Lahore, Karachi, and other cities were due to air pollution (Ali et al., 2020).

B. Contribution to The Health of Women of Childbearing Age and Their Offspring

It concludes that air pollution in the country specifically affects the health of mothers and children. Pregnant women who breathe in polluted air are likely to have their babies born with a low weight, they are likely to give birth prematurely, and their unborn children also suffer developmental issues. Also, studies have associated a higher intake of PM2.5 with more stillborn babies (World Health Organization [WHO], 2021).

This is because children, being vulnerable to more long-term health problems are at higher risk due to their immature lungs. More than 60,000 children die from pneumonia annually in Pakistan, due to air pollution, says UNICEF, 2021 as per their recent research.

C. Mental Health and Cognitive Deterioration

There is an increasing interest in concern and approach to air pollution's impact on mental health. A study has shown that stress, anxiety, and sadness increase with increased duration of exposure to polluted air. Pakistani residents who breathe increasingly toxic air in large cities show greater mental health problems compared to inhabitants of less polluted rural areas (Hussain et al., 2022).

Other pollutants such as PM2.5 and black carbon appear to accelerate cognitive aging and increase risks of neurodegenerative diseases such as Parkinson's or Alzheimer's. As for population, Pakistan is becoming older, so it is necessary to work more in this direction.

D. Infectious Diseases as well as Airborne Pathogens

With the effects of air pollution conveyed on the human immune system and facilitating airborne diseases, infectious diseases are more likely to spread. In Pakistan people also suffer from flu and TB lung diseases and both the flu and TB are seen more often during winter when the smog is bad. These infections can easily spread around because the air conditions remain stagnant during such instances (World Bank, 2021).

Climate change makes this even worse by nurturing diseases that are spread through vectors such as malaria and dengue. Another threat is climate change in particular the rise in temperatures and the change in the precipitation that promotes the rise in mosquitoes.

E. Economic Burden on Healthcare

The social cost of negative health implications of air pollution is highly expensive to Pakistan's healthcare system. According to the Asian Development Bank 2020, air pollution in the country accounts for about 8 percent of the GDP per annum in lost production and medical expenses. But as it was observed, the influx of patients with diseases arising from pollution is immense and this puts the already strained public hospitals under immense pressure. This economic burden shows the urgent need for preventive measures that will help to sort out the air quality problems.

F. Weak Regulatory Frameworks

The modern political environment in Pakistan is characterized by slight and non-uniform policies or a lack of policies and enforcement. Although there is legislation such as the Pakistan Environmental Protection Act (1997) they do not work efficiently due to shortage of funds and political intervention and inadequate implementation. Also, actions approved to address the issue of consolidating emissions and supervising air quality are hindered by the often fragmented collaboration between the federal and provincial levels of the environment department (Ali & Ahmed, 2022).

G. Economic and Industrial Orientation

Environmental factors are often left aside in favor of emphasizing speed in development and gaining urbanization. Poor inspection is a result of the industries prevalently practicing ways of evading environmental regulation in most firms associated with production industries such as steel production industries, cement-making industries, and brick kilns. Transportation and energy generation using fossil fuels hurt air pollution and due to limited funds, there is little investment being made into cleaner technologies consumption (Asian Development Bank, 2020).

H. Technological Advancement

The final factor affecting the use of technology and technology-enabled services is the limited technological capacity of the elderly. There is an absence of the technological infrastructure needed for appropriate monitoring and management of air quality in Pakistan. Since there are no extant monitoring networks and most of the sites where data is collected are usually in large cities, rural and peri-urban areas are mostly unmonitored. The absence of real-time information distorts public accountability and knowledge-based decision-making (WHO, 2021).

I. World and Continental Factors

Natural factors such as transboundary haze and contributions from other neighboring countries affect air pollution in Pakistan. Efforts to make improvements in national air quality are marred by the fact that these challenges cannot be addressed at the regional level. Furthermore, climate change arising from local pollution contributes to the worsening of a sub problem that also places pressure on the country's limited resources (Hussain et al., 2021).

10. Results from the Different Surveys at the Public Level

The quantitative results show the impact of air quality and its consequences like Smog, Climate Change, and Public Health Challenges in Lahore; Pakistan. The quantitative results were obtained by collecting data from 222 respondents in Lahore. The analysis is done on IBM SPSS Statistics 23. The data is collected in December 2024.

Table 1: *Cross-tabulation among the Gender and Age of the respondents.*

				Gender		
			1. Male	**2. Female**	**3. Prefer not to disclose**	**Total**
Age Group	**1. Below 18 years**	Count	4	1	0	5
		% of Total	1.8%	0.5%	0.0%	2.3%
	2. 18 - 25 years	Count	40	105	1	146
		% of Total	18.0%	47.3%	0.5%	65.8%
	3. 26 - 35 years	Count	15	25	0	40
		% of Total	6.8%	11.3%	0.0%	18.0%
	4. 36 - 45 years	Count	5	15	0	20
		% of Total	2.3%	6.8%	0.0%	9.0%
	5. 46 - 60 years	Count	2	6	0	8
		% of Total	0.9%	2.7%	0.0%	3.6%
	6. 60+ years	Count	2	1	0	3
		% of Total	0.9%	0.5%	0.0%	1.4%
Total		Count	**68**	**153**	**1**	**222**

	% of Total	30.6%	68.9%	0.5%	100.0%

In **Table 1**, out of 222 respondents, the gender distribution shows that the majority of participants were female, comprising 68.9% (153 respondents), followed by males at 30.6% (68 respondents), with a very small proportion (0.5%, or 1 respondent) choosing not to disclose their gender.
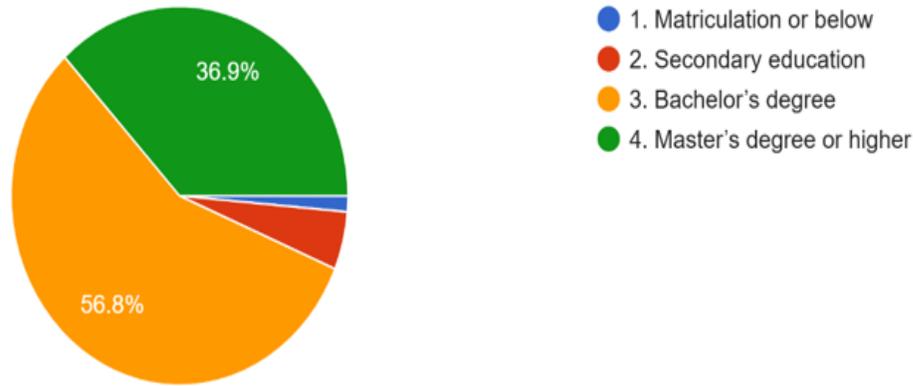

Figure 1: Education level of respondents

This pie chart in Figure 1, shows the distribution of educational levels among a group of individuals. The categories are color-coded as follows:36.9% of individuals have a Master's degree or higher (green segment). 56.8% have a Bachelor's degree (orange segment). A small percentage is represented by those with Secondary education (red) and Matriculation or below (blue). The majority of individuals in this sample hold at least a Bachelor's degree, while a smaller portion has achieved higher education levels.
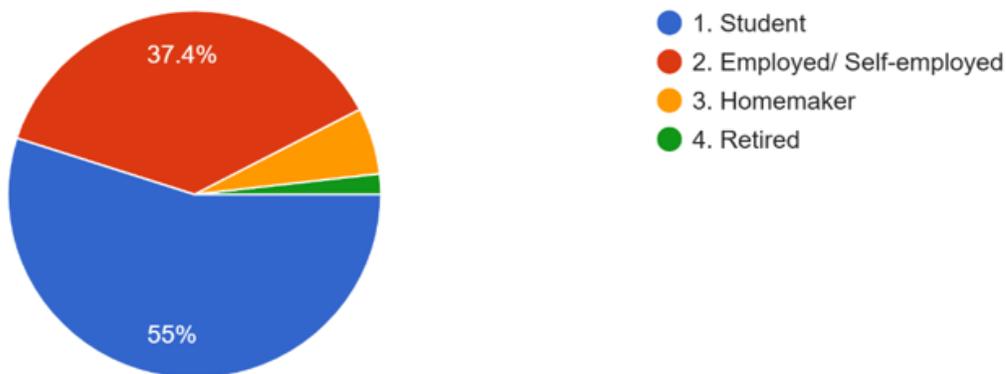

Figure 2: Occupation of respondents

In graph 2, the distribution of individuals based on their primary occupations is as follows: the largest group, comprising 55%, is categorized as "Students." This is followed by "Employed/Self-employed" individuals, who represent 37.4% of the total. A smaller proportion, 7.6%, is listed under "Homemakers," while the "Retired" group constitutes the smallest segment at approximately 1%.

Table 2: *Cross-tabulation among the air quality and the place of residence of the respondents.*

			Place of Residence			Total
			1. Urban area	2. Semi-urban area	3. Rural area	
How would you rate the air quality in your area?	**Average**	Count	45	14	7	66
		% of Total	20.3%	6.3%	3.2%	29.7%
	Excellent	Count	3	0	4	7
		% of Total	1.4%	0.0%	1.8%	3.2%
	Good	Count	15	1	5	21
		% of Total	6.8%	0.5%	2.3%	9.5%
	Poor	Count	53	4	3	60
		% of Total	23.9%	1.8%	1.4%	27.0%
	Very Poor	Count	62	4	2	68
		% of Total	27.9%	1.8%	0.9%	30.6%
Total		**Count**	**178**	**23**	**21**	**222**
		% of Total	**80.2%**	**10.4%**	**9.5%**	**100.0%**

In **Table 2**, out of 222 respondents, the majority resided in urban areas (80.2%, or 178 respondents), followed by those in semi-urban areas (10.4%, or 23 respondents) and rural areas (9.5%, or 21 respondents).

Regarding air quality ratings, the majority of respondents from urban areas rated the air quality as "Very Poor" (27.9%, or 62 respondents), followed by "Poor" (23.9%, or 53 respondents) and "Average" (20.3%, or 45 respondents). Only a small number rated the air quality as "Good" (6.8%, or 15 respondents) or "Excellent" (1.4%, or 3 respondents).

In semi-urban and rural areas, the air quality ratings were similar, with a larger portion of respondents in rural areas rating the air quality as "Average" (3.2%, or 7 respondents) compared to semi-urban areas. Semi-urban areas had fewer respondents overall, with none rating the air quality as "Excellent" or "Good."

These results suggest that urban areas tend to have poorer air quality, with a significant number of respondents perceiving it as "Very Poor" or "Poor."
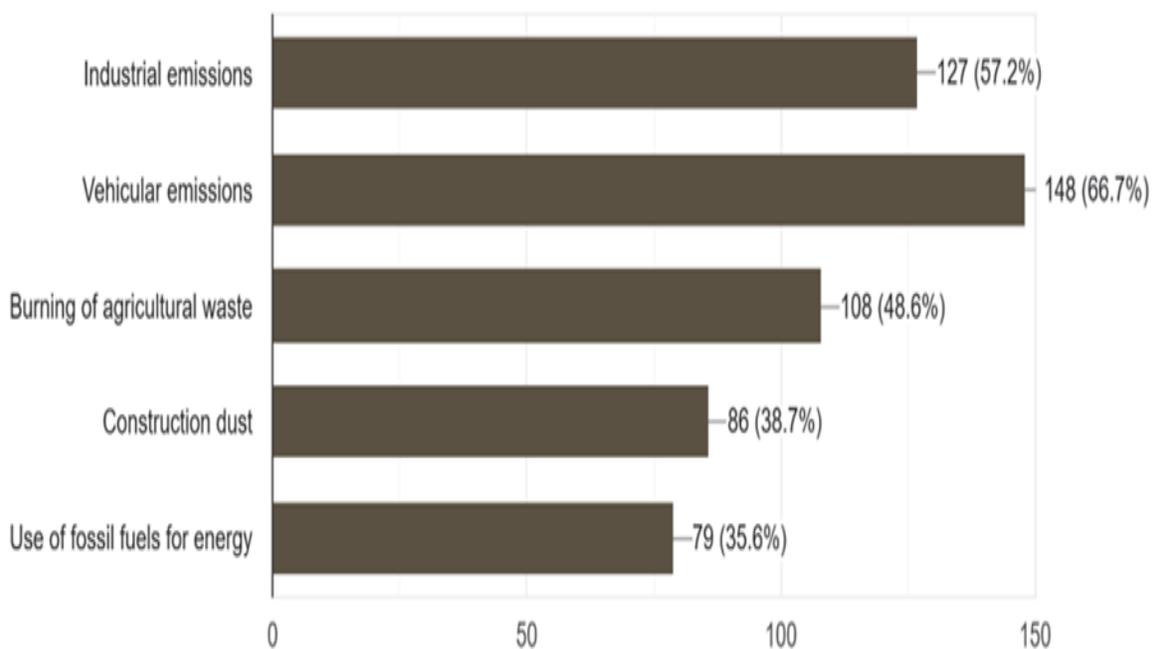

Figure 3: Primary sources of air pollution in Pakistan

In Figure 3, the graph illustrates the primary sources contributing to pollution, with their respective frequencies and percentages. The most significant source identified is "Vehicular emissions," accounting for 148 instances (66.7%). This is followed by "Industrial emissions," reported 127 times (57.2%).

The "Burning of agricultural waste" is the third major contributor, mentioned 108 times (48.6%). "Construction dust" ranks fourth, with 86 instances (38.7%), while the "Use of fossil fuels for energy" is the least frequently cited source, appearing 79 times (35.6%).

Table 3: *Cross-tabulation among the exposure and experiencing health issues by the respondents.*

			Have you or anyone in your family experienced health issues (e.g., respiratory problems) due to poor air quality?		
			No	Yes	Total
How often do you experience smog in your area during the year?	Almost daily	Count	18	62	80
		% of Total	8.1%	27.9%	36.0%
	Frequen tly	Count	18	71	89
		% of Total	8.1%	32.0%	40.1%
	Occasion ally	Count	14	30	44
		% of Total	6.3%	13.5%	19.8%
	Rarely	Count	6	3	9
		% of Total	2.7%	1.4%	4.1%
Total		**Count**	**56**	**166**	**222**
		% of Total	**25.2%**	**74.8%**	**100.0%**

In **Table 3**, out of 222 respondents, the majority (74.8%, or 166 respondents) reported that they or someone in their family have experienced health issues, such as respiratory problems, due to poor air quality. The remaining 25.2% (56 respondents) indicated that they had not experienced health issues related to air quality.

95

Regarding the frequency of smog in respondents' areas, a significant proportion reported experiencing smog "Almost daily" (36.0%, or 80 respondents) or "Frequently" (40.1%, or 89 respondents). Smaller groups indicated that they encounter smog "Occasionally" (19.8%, or 44 respondents) or "Rarely" (4.1%, or 9 respondents).

These findings suggest that smog is a common issue for the majority of respondents, particularly those who have also experienced health problems related to poor air quality.
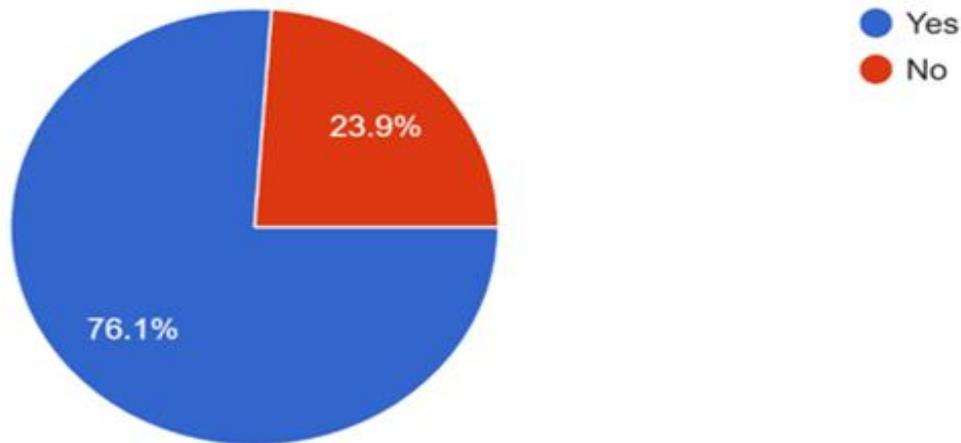

Figure 4: Air pollution-related health issues affected your financial situation

In Figure 4, the pie chart illustrates the impact of air pollution-related health issues on respondents' financial situations. The majority, 76.1%, answered "Yes," indicating that these health issues have affected their finances. Meanwhile, 23.9% of respondents reported "No," suggesting that their financial situation was not impacted by such health issues.

Table 4: *Cross-tabulation among experiencing more extreme weather events and marginalized communities are more affected by air pollution.*

			Do you think marginalized communities are more affected by air pollution?		
			No	**Yes**	**Total**
Do you think Pakistan is experiencing more extreme weather events (e.g., prolonged smog, heatwaves) due to climate change?	**No**	Count	0	7	7
		% of Total	0.0%	3.2%	3.2%
	Yes	Count	35	180	215
		% of Total	15.8%	81.1%	96.8%
Total		**Count**	**35**	**187**	**222**
		% of Total	**15.8%**	**84.2%**	**100.0%**

In **Table 4**, out of 222 respondents, a large majority (84.2%, or 187 respondents) believe that marginalized communities are more affected by air pollution, while only 15.8% (35 respondents) disagreed with this statement.

Regarding the perception of extreme weather events in Pakistan due to climate change, 96.8% (215 respondents) believe that Pakistan is experiencing more extreme weather events, such as prolonged smog and heatwaves, due to climate change. Only a small portion (3.2%, or 7 respondents) disagreed with this view.

These results indicate strong public awareness and concern about both the disproportionate impact of air pollution on marginalized communities and the role of climate change in exacerbating extreme weather events in Pakistan.
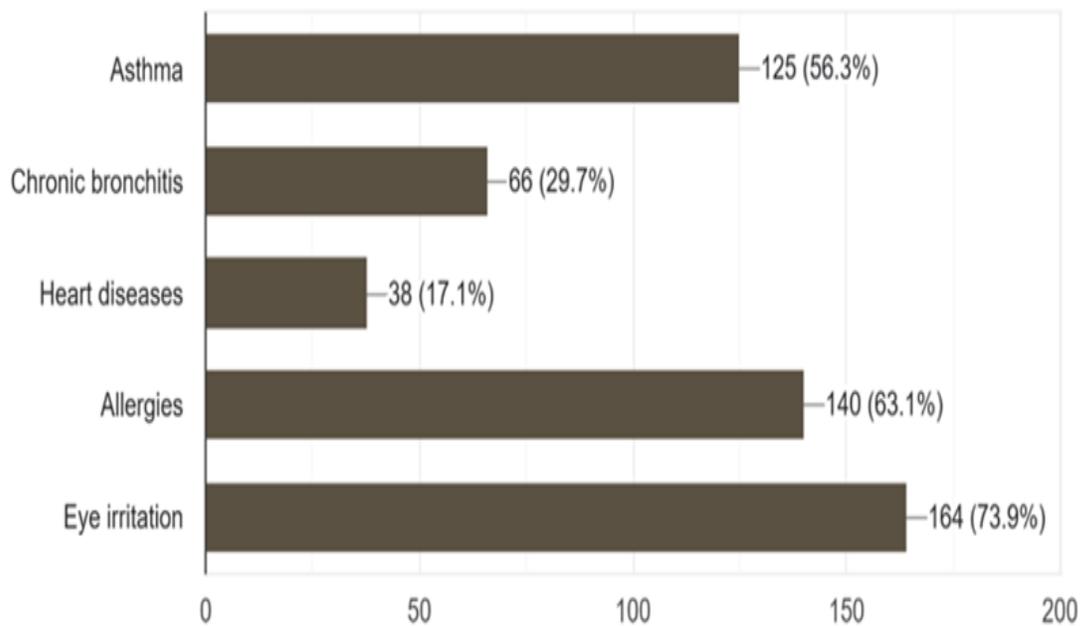
Figure 5: Health issues related to air pollution have you observed in your community

In Figure 5, the chart highlights the prevalence of health issues attributed to environmental factors, along with their frequencies and percentages. The most commonly reported condition is "Eye irritation," affecting 164 individuals (73.9%). This is followed by "Allergies," which impact 140 individuals (63.1%).

"Asthma" is the third most prevalent condition, affecting 125 individuals (56.3%), while "Chronic bronchitis" is reported by 66 individuals (29.7%). The least common health issue identified is "Heart disease," with 38 individuals (17.1%) experiencing this condition.

Table 5: *Cross-tabulation among the government's current efforts to address air pollution and support increased taxation on polluting industries to fund clean air initiatives.*

				Would you support increased taxation on polluting industries to fund clean air initiatives?	
				No Count	Yes Count
How effective do you find the government's current efforts to address air pollution?	Not effective	Do you think Pakistan has sufficient air quality monitoring systems?	No	29	53
			Yes	3	11
	Somewhat effective	Do you think Pakistan has sufficient air quality monitoring systems?	No	16	43
			Yes	7	24
	Very effective	Do you think Pakistan has sufficient air quality monitoring systems?	No	2	4
			Yes	3	27

In **Table 5**, out of 222 respondents, a significant portion (29 respondents) felt that the government's efforts to address air pollution were "Not effective," and a smaller group (3 respondents) found them "Very effective." Most respondents (16) considered the government's efforts "Somewhat effective."

When asked whether Pakistan has sufficient air quality monitoring systems, a majority of respondents (53) felt that the country does not have adequate monitoring systems. However, a smaller group (11) thought that Pakistan did have sufficient systems. Similarly, 43 respondents agreed that the country lacks air quality monitoring systems, while 24 respondents felt that the existing systems were sufficient. Only a few (4 respondents) felt the current monitoring systems

were adequate. These responses highlight a significant concern about the inadequacy of both the government's efforts to combat air pollution and the air quality monitoring systems in Pakistan.
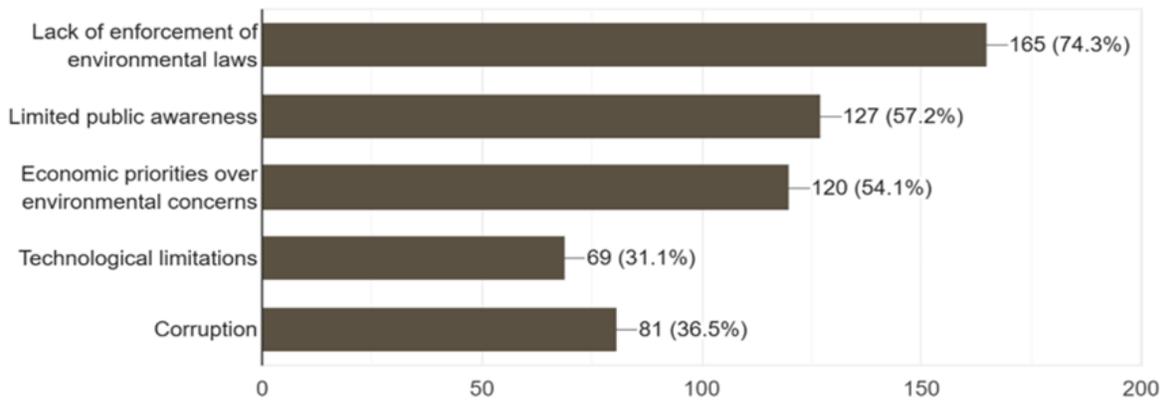

Figure 6: Main barriers to reducing air pollution in Pakistan.

In Figure 6, the chart outlines the perceived barriers to addressing environmental challenges, with their frequencies and percentages. The most commonly cited barrier is the "Lack of enforcement of environmental laws," identified by 165 respondents (74.3%). This is followed by "Limited public awareness," mentioned by 127 respondents (57.2%), and "Economic priorities over environmental concerns," highlighted by 120 respondents (54.1%). "Corruption" is a concern for 81 respondents (36.5%), while the least frequently cited barrier is "Technological limitations," reported by 69 respondents (31.1%).
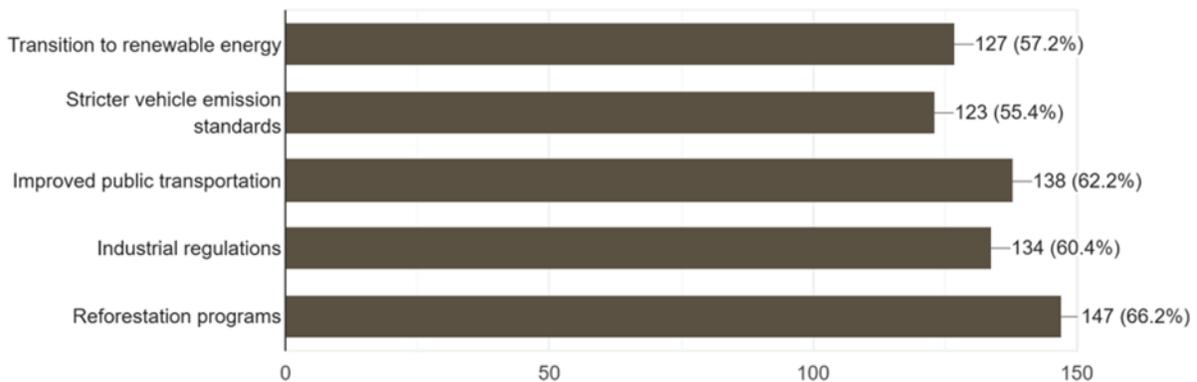

Figure 7: Measures do you think are most effective in improving air quality

In Figure 7, the chart displays public support for various measures to address environmental issues, with their respective frequencies and percentages. The most supported initiative is "Reforestation programs," with 147 respondents (66.2%) endorsing this solution. This is closely followed by "Improved public transportation," supported by 138 respondents (62.2%). "Industrial regulations" also receive substantial backing, with 134 respondents (60.4%). The "Transition to renewable energy" is supported by 127 respondents (57.2%), while "Stricter vehicle emission standards" have the lowest but still significant support at 123 respondents (55.4%).

Table 6: *Cross-tabulation among public education in addressing air quality challenges and Pakistan should adopt lessons from countries like China or Sweden in tackling air pollution.*

			Pakistan should adopt lessons from countries like China or Sweden in tackling air pollution.		
			Yes	No	Total
How important is public education in addressing air quality challenges?		Count	0	1	1
		% of Total	0.0%	0.5%	0.5%
	Not important	Count	2	1	3
		% of Total	0.9%	0.5%	1.4%
	Somewhat important	Count	33	4	37
		% of Total	14.9%	1.8%	16.7%
	Very important	Count	173	8	181
		% of Total	77.9%	3.6%	81.5%
Total		**Count**	**208**	**14**	**222**
		% of Total	**93.7%**	**6.3%**	**100.0%**

In **Table 6**, out of 222 respondents, a strong majority (93.7%, or 208 respondents) believe that Pakistan should adopt lessons from countries like China or Sweden in tackling air pollution, while only a small percentage (6.3%, or 14 respondents) disagreed.

Regarding the importance of public education in addressing air quality challenges, 81.5% (181 respondents) considered public education to be "Very important," while 16.7% (37 respondents) found it "Somewhat important." A smaller group (1.4%, or 3 respondents) deemed it "Not important," and only 0.5% (1 respondent) felt it was "Not important." These results indicate strong support for learning from other countries' approaches to air pollution and widespread recognition of the critical role that public education plays in addressing air quality issues.
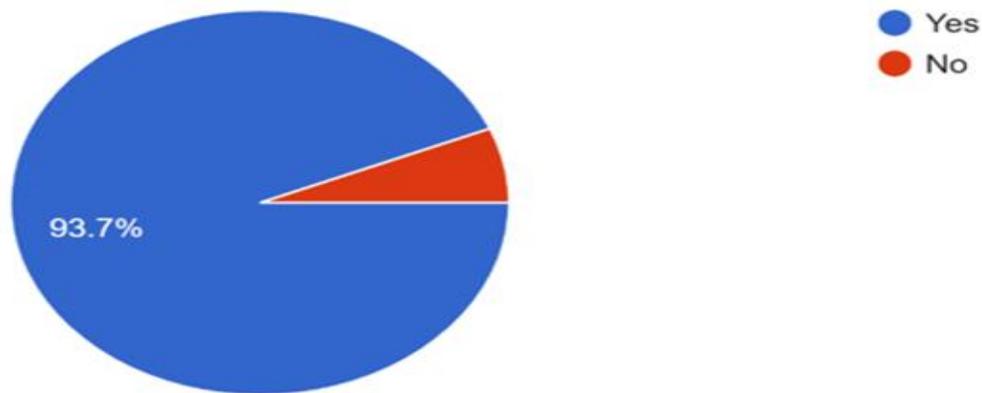
Figure 8: Pakistan should adopt lessons from countries like China or Sweden in tackling air pollution

In Figure 8, the pie chart depicts public opinion on whether Pakistan should adopt lessons from countries like China or Sweden in tackling air pollution. A significant majority, 93.7%, responded "Yes," indicating strong support for learning from these countries' strategies. In contrast, only 6.3% responded "No," suggesting minimal opposition to this idea.

Conclusion

Air pollution uniquely relates to industry, people's well-being, and climate change in Pakistan. Our environment has become alarmingly bad from previous lack of consideration towards environmental factors, increased urbanization, and weak regulatory measures which are very dangerous to human health. As has been said above, smog and related air pollution impact roughly 60% of the population each year worsening the financial and health burdens in the country.

The experience of developed countries such as China, Sweden, and the United States can show that effective policies, people's participation, and innovative technologies can make a difference. Pakistan also needs a similarly all-embracing approach that would provide environmental law enforcement the top priority, switch to sustainable sources of energy, and enhance public awareness. Smart city and air quality monitoring technologies, and regional and international cooperation shall bring the change the impetus that it needs.

Getting to its logical end is important for keeping growth constructed and in addition to being the environmental need, saving the health of the people. Pakistan has the opportunity to regenerate its cities and communities by presenting certain ideas and benefiting from its counterparts' experience. In my part to help generations to come and the development of the country, the time to change/act is now.

References

Ali, M., Khan, N., & Raza, S. (2020). "Industrial growth and environmental challenges in Pakistan: A critical review". *Pakistan Journal of Environmental Science*, *12*(4), 45-60.

Greenpeace. (2021). "Air pollution and climate change: Two sides of the same coin." *Greenpeace International*.

United Nations Environment Programme (UNEP). (2022). *Global trends in air quality and climate change*. UNEP.

World Health Organization (WHO). (2018). "Ambient air pollution: A global assessment of exposure and burden of disease." WHO Press.

World Health Organization (WHO). (2021). *The economic impact of air pollution in South Asia*. WHO Regional Office for South-East Asia

Ali, S., & Malik, A. (2019). "The colonial economy of British India: Infrastructure, industrialization, and environmental impacts". *South Asian Studies*, *45*(2), 125-140.

Government of Pakistan. (2021). *National climate change report: Transportation and emissions overview*. Ministry of Climate Change.

Greenpeace. (2021). *Air pollution and its socio-economic impacts in South Asia*. Greenpeace International.

International Energy Agency (IEA). (2021). "Pakistan energy outlook 2021". Retrieved from [www.iea.org] (https://www.iea.org)

Rashid, T., Khan, M., & Qureshi, F. (2020). "Agricultural residue burning and its contribution to air pollution in Punjab". *Journal of Environmental Studies*, *18*(3), 67-78.

World Bank. (2022). *Urbanization trends in Pakistan: Opportunities and challenges*. Retrieved from [www.worldbank.org] (https://www.worldbank.org)

Environmental Protection Agency (EPA) Pakistan. (2022). *Air quality monitoring report 2022*. EPA Pakistan.

Food and Agriculture Organization (FAO). (2020). *Crop residue management for sustainable agriculture*. FAO Pakistan.

Khan, A., & Ahmed, S. (2020). "Industrial emissions and environmental governance in South Asia: A focus on Pakistan". *Journal of Environmental Policy*, *15*(3), 45-60.

United Nations Environment Programme (UNEP). (2022). "Climate change and air quality: A global report". UNEP.

World Bank. (2021). "Environmental sustainability in South Asia: Air pollution trends and challenges". World Bank Publications.

World Health Organization (WHO). (2021). "Indoor air pollution and health: The case of Pakistan". WHO Press.

Ali, R., Khan, S., & Ahmed, M. (2020). "Smog and climate change: Interlinked crises in South Asia". *Journal of Environmental Studies*, *14*(3), 76-89.

Greenpeace. (2021). "Air pollution and climate resilience: Global lessons for local actions". Greenpeace International.

International Centre for Integrated Mountain Development (ICIMOD). (2021). *Black carbon and its impact on Himalayan glaciers: A regional analysis*. ICIMOD.

United Nations Environment Programme (UNEP). (2022). *Climate change and air quality: A global perspective*". UNEP.

World Health Organization (WHO). (2021). *Air pollution and health: Emerging trends and global priorities*. WHO Press.

Ali, R., Khan, S., & Ahmed, M. (2020). "Smog and public health: An analysis of healthcare challenges in Pakistan". *Journal of Environmental Health Studies*, *14*(3), 56-73.

Asian Development Bank. (2020). *Economic costs of air pollution in South Asia: Policy implications for Pakistan*. ADB Publications.

Greenpeace. (2021). "Air quality and public health: Global insights for local action". *Greenpeace International.*

Hussain, M., Ahmed, S., & Riaz, T. (2022). "Mental health impacts of air pollution: Evidence from Pakistan". *Pakistan Journal of Psychology*, *18*(2), 34-50.

UNICEF. (2021). "The state of children's health in polluted environments: A focus on Pakistan". UNICEF Reports.

World Bank. (2021). "Air pollution and its health impacts in South Asia". World Bank Publications.

World Health Organization (WHO). (2021). *Air pollution and public health: Emerging threats and solutions*. WHO Press.

Ali, R., & Ahmed, S. (2022). "Barriers to effective environmental governance in Pakistan". *Journal of Environmental Policy*, *15*(2), 88-103.

Asian Development Bank. (2020). *Economic challenges of air pollution in South Asia: Implications for policy and practice*. ADB Publications.

Hussain, M., Raza, Q., & Khan, T. (2021). "Regional air pollution challenges in South Asia". *South Asian Environmental Review*, *12*(1), 56-67.

UNICEF. (2021). "Environmental injustice: Air pollution and vulnerable populations in Pakistan". UNICEF Reports.

United Nations Environment Programme (UNEP). (2022). *Air quality and public engagement in developing countries: A framework for action*". UNEP Publications.

World Health Organization (WHO). (2021). *Air pollution monitoring and its role in policy development*. WHO Press.

Environmental Protection Agency (EPA). (2022). Clean Air Act: Progress and impact". EPA Reports. Greenpeace. (2021). "China's air quality improvements: A decade of change". Greenpeace International. International Energy Agency (IEA). (2020). *Sustainable energy transitions: Lessons from Sweden*. IEA Publications.

Environmental Protection Agency (EPA). (2022). *Clean air strategies: Policy recommendations for developing countries*. EPA Reports.

International Energy Agency (IEA). (2020). *Renewable energy policies: Case studies from Sweden and beyond*. IEA Publications.

UNICEF. (2021). *The role of community engagement in tackling air pollution*. UNICEF Reports.

Greenpeace. (2021). *Air pollution mitigation: Global insights and local applications*. Greenpeace International.