CHAPTER 5

ATMOSPHERIC ECOSYSTEM

Atmospheric Ecosystem

5.1 Introduction

Global climate change and the deteriorating quality of urban air are major issues affecting the atmospheric ecosystem of Pakistan. Urban air quality has deteriorated in the country in the wake of fast increasing traffic, increased energy consumption, growing industrialization, increases in number and type of industries and enhanced use of chemicals. Increased air emissions from vehicles, power plants, and industrial facilities impose health and resource costs both close to and at a distance from the sources of pollution and may have global impacts as is being witnessed in climate change. This chapter reviews the status of urban air pollution and discusses sources and impacts of air pollution. It also highlights various policy measures and programmes that are being undertaken to ameliorate the problem.

5.2 Status of Air Pollution

5.2.1 Urban Air Quality

Data on urban air quality in Pakistan is scarce. According to the information available the main air pollutants in the cities are particulate matter (PM with a diameter of 10 microns or smaller: PM_{10}; or $PM_{2.5}$ or smaller), nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), ozone, volatile organic compounds (VOCs) and lead (Pb).

5.2.1.1 Particulate Pollution

The Pakistan Environmental Protection Agency (EPA) conducted an initial investigation of the air pollution in the country, in cooperation with the Japan International Cooperation Agency (JICA) in 2000 (Table 5.1). It assessed the ambient air quality in Lahore, Rawalpindi and Islamabad. Air quality sampling was conducted using a mobile station that measured hourly concentrations of air pollutants from 07:00 hour to 24:00 hour, taken on different days in April and May 2000. The results showed that the concentrations of PM_{10} were exceeding the WHO guideline limits set at 50 $\mu g/m^3$ (24 hour mean), 20 $\mu g/m^3$(annual mean) greatly. The average SPM for the three cities was 2,000 $\mu g/m^3$, while PM10 averaged 700 $\mu g/m^3$ (Pakistan EPA/JICA 2001). The ambient concentrations of SO_2, NOx and CO were on average found to be within the limits of the WHO guidelines of 2000.

Table 5.1 Pakistan: Hourly Average Ambient Concentrations of Selected Air Pollutants in Three Cities in 2000

Item	Lahore	Rawalpindi	Islamabad
PM_{10} hourly average data in µg/m^3	895.00	709.00	520.00
SO_2 hourly average data in ppb	44.60	30.70	28.50
CO hourly average data in ppm	2.82	1.83	1.55
NO_2 hourly average data in ppb	156.60	74.70	148.50
O_3 hourly average data in ppb	8.50	17.00	10.00

Source: Pakistan EPA/JICA, 2001

Another study on air quality was conducted by SUPARCO under the ENERCON/UNDP Fuel Efficiency in Road Transport Sector (FERTS) programme from 2003 to 2004 in six cities - Karachi, Lahore, Peshawar, Quetta, Rawalpindi and Islamabad. Using mobile stations, data was measured every hour on different dates in 2003 and 2004 usually alongside roads. The climatic conditions when the data were sampled are shown in Table 5.2.

Table 5.2 Pakistan: Climatic Conditions of Six Major Cities for the Four Cycles

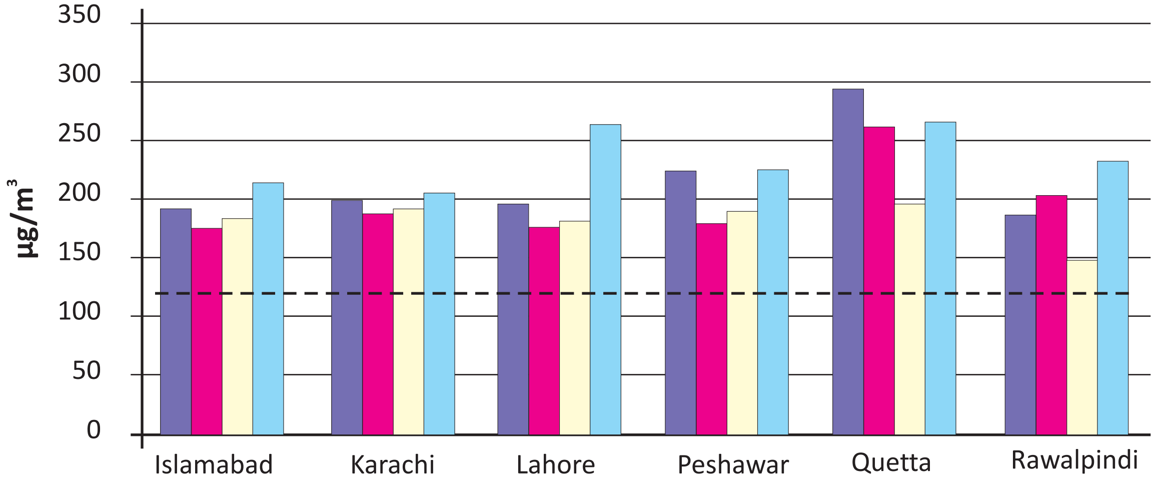
	2003		2004	
City	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle
Islamabad	Monsoon	Winter	Spring	Summer
Karachi	Postmonsoon	Winter	Spring	Summer
Lahore	Monsoon	Postmonsoon	Spring	Summer
Peshawar	Monsoon	Winter	Spring	Summer
Quetta	Summer	Postmonsoon	Winter	Spring
Rawalpindi	Monsoon	Postmonsoon	Winter	Summer

Source: Pakistan EPA/World Bank (2006)

The 48-hour averages of PM_{10} for the six cities included in the study are shown in Fig. 5.1. The findings confirm the results of studies (Pak EPA/JICA 2001, 2003) conducted by Pakistan EPA with the assistance from JICA in five cities (Lahore, Faisalabad, Gujranwala, Rawalpindi, and Islamabad), which revealed that fine PM levels reached 6-7 times the limit set by WHO guidelines. The average SPM concentration in Pakistan exceeded 3.8 times from the Japanese standards of 200 µg/m^3 and 6.4 times the limit set by WHO guidelines limit of 120 µg/m^3 (GOP, 2010).

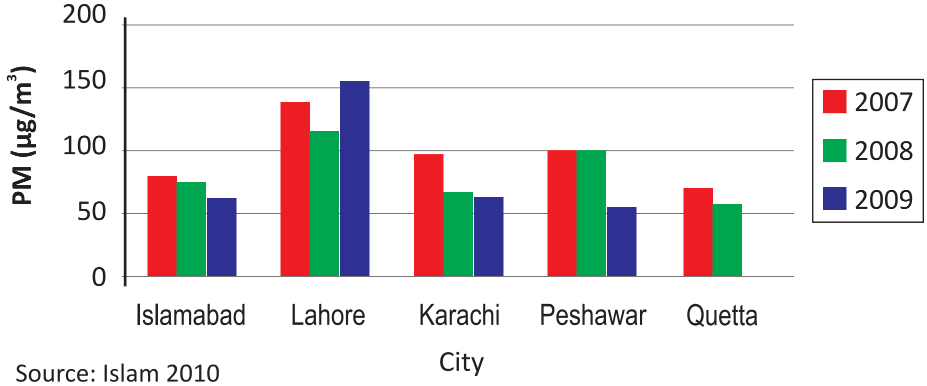
Recent air quality data recorded by continuous monitoring stations in five cities national and provincial capitals (Fig. 5.2), also confirms presence of high concentrations of particulate matter. It shows that the level of $PM_{2.5}$, which is mainly from combustion sources, has reached an alarming level, 2 - 6 times higher than the safe limit (WHO guidelines 10 µg/m^3 annual mean and 25µg/m^3 24 hour mean).

Fig.5.1 Pakistan: 48 Hours Mean of PM_{10} in Six Major Cities



Source: World Bank 2006

Fig. 5.2 Pakistan: Status of Ambient Air Quality in Five Major Cities PM 2.5 (µg/m³)



Source: Islam 2010

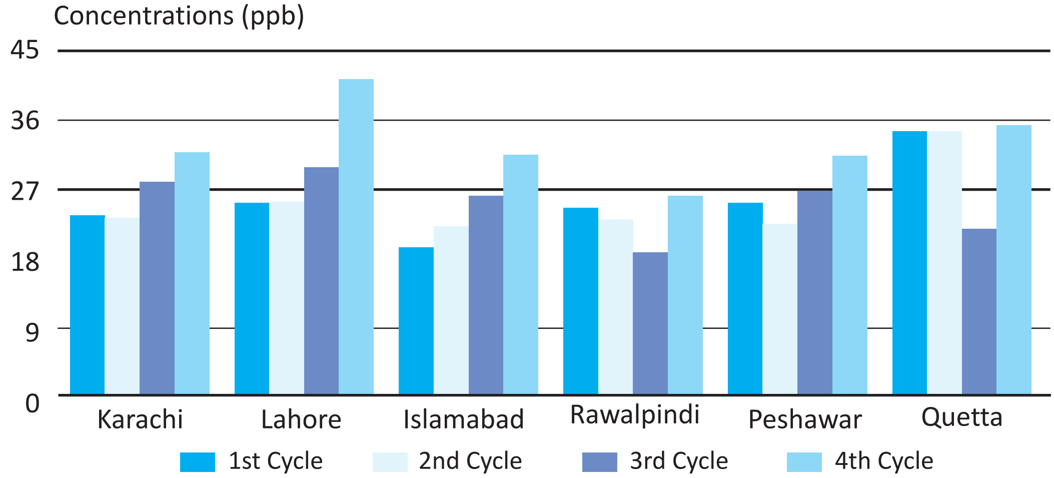
5.2.1.2 Nitrogen Oxides (NOx) Pollution

The next emerging air pollutant in Pakistan after suspended particulate matter is nitrogen oxide. The ambient concentrations recorded in the SUPARCO study are given in Fig. 5.3. In recent years, the world interest in NOx as an air pollutant has grown not only because of its phytotoxic nature but also because of growing evidence of its adverse effect on human health. Pak-EPA has taken the lead and carried out a thorough investigation of NOx in all major cities (Karachi, Lahore, Peshawar, Islamabad and Quetta) to determine its level at present to chalk a future strategy for safeguarding the public from its adverse effects.

Using data of continuous monitoring stations in five cities national and provincial capitals, Lodhi analyzed mean, maximum and minimum values of Nitrogen Dioxide (NO_2). The highest concentration of NO_2 was found in Karachi and then descending to Lahore, Quetta, Peshawar and Islamabad (Fig. 5.4).

Karachi and Lahore show a similar average concentration of NO_2, 76µg/m³, while the average concentration of NO_2 in Quetta, Peshawar and Islamabad were 69.5, 47.3 and 30.4µg/m³ respectively. The lowest value of NO_2

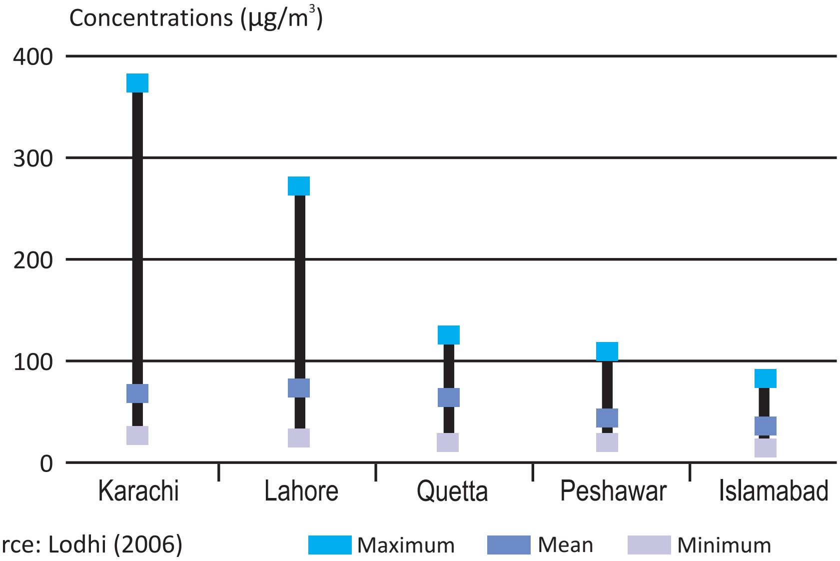
Fig. 5.3 Pakistan: NOx Levels in Six Major Cities



Source: SUPARCO (2006)

in Islamabad was found in the residential area of Embassy Road, 11.7µg/m^3. The highest concentration of NO_2, 399.7µg/m^3 was found at Karimabad Junction in Karachi. Pak-EPA is giving serious attention to carefully monitoring NO_2 concentrations in these cities because it is precursor to secondary particulate formation and also ground level ozone formation, which may become a problem in future.

Fig. 5.4 Pakistan: Ambient Levels of Nitrogen Dioxide in Five Major Cities



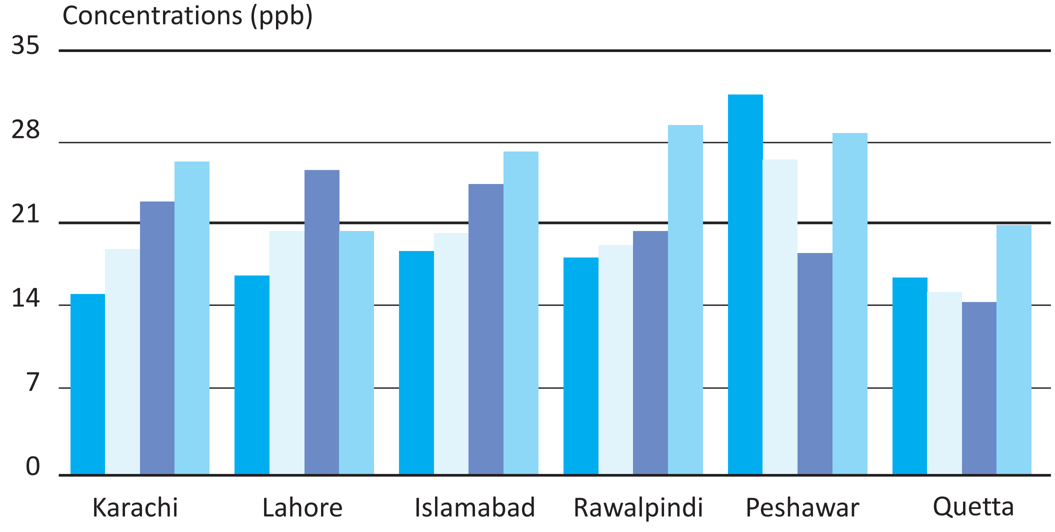
Source: Lodhi (2006)

5.2.1.3 Other Types of Pollution

a. Carbon Monoxide and Sulphur Dioxide

Studies conducted in Lahore, Rawalpindi and Karachi indicated high levels of CO and SO_2 (Qadir, 2002). These levels are lower as compared to the level of total suspended particulates (GOP, 2010). The formation of secondary pollutants like sulphates and photochemical smog was found to be a very common phenomenon.

Fig.5.5 Pakistan: 48 Hourly Mean of Sulphur Dioxide in Six Major Cities



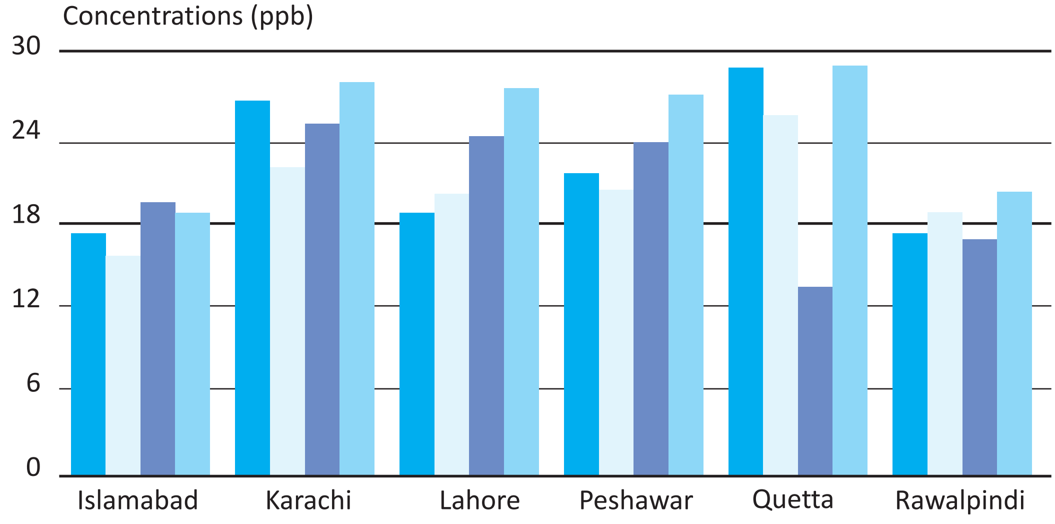
Source: SUPARCO (2005)

Most of the data was obtained from measuring campaigns that were conducted by using mobile units. However, a number of fixed monitoring stations have now been established, but so far, no analysis of the data obtained is available except for that of the particulates mentioned earlier. Figure 5.5 shows the ambient levels of SO_2 observed from the six cities surveyed by SUPARCO. They were found to exceed WHO guideline limits, with Peshawar posting the highest average concentrations. The new WHO guidelines (2005) specify the limit for the annual average at 20 µg/m^3 or 7.56 ppb.

b. Ozone

In recent years, concerns over the concentration of surface ozone have also increased. Impact on the most sensitive species can occur after exposure to 60-µg/m^3 (30.58 ppb) ozone for 8 hours. Ozone has been shown

Fig. 5.6 Pakistan: Ozone Level in Six Major Cities



Source: SUPARCO (2006)

to reduce resistance to disease in laboratory animals. In humans, eye irritation and an increased number of asthmatic attacks and lowered performances of athletes have all been attributed to photochemical oxidant levels around 200 µg/m^3 (101.93 ppb). Most of the ozone in the troposphere (lower sphere) is formed indirectly by the action of sunlight on nitrogen dioxide. In addition to ozone, photochemical reactions produce a number of oxidants including peroxy-acetyl nitrates (PAN), nitric acid and hydrogen-peroxide. The SUPARCO study conducted in 2003-2004 had found ambient ozone concentrations in six cities approximately within the standards set by WHO as shown in Fig. 5.6. However, a more recent study on surface measurements using ground based ozone analyser ML-8810 shows that the surface ozone has increased. It now ranges from 6-40 ppb at Karachi, 8.5-44 ppb at Lahore, 6-32 ppb at Islamabad, 11-24 ppb at Quetta, 3-33 ppb at Rawalpindi and 4-46 ppb at Peshawar (SUPARCO, 2012a).

c. Radiation

Radiation pollution is the increase in natural background radiation. There are many man made sources of radiation pollution such as research laboratories, nuclear power plants and radioactive isotopes. Increase in the levels of radiation has also started demonstrating its harmful effects in Pakistan. Some of the dangers of exposure to increasing radiation include genetic deformities and cancers. One of the commonest sources of exposure to radiation comes from X-rays. In most large cities of Pakistan such as Karachi, Lahore, Peshawar etc. there are hundreds of X-ray clinics and laboratories. Sample surveys have shown that no safety measures are used either for patients or for the operators and technicians. There is also the question of the disposal of radioactive wastes as these can remain active and continue to cause damage for very long periods (over 30 years). In fact, this is a major concern of all countries where nuclear technology is being utilized. Perhaps more dangerous than bulk radioactive wastes are the number of isotopes continually being released into the air and water by nuclear plants. In some areas of the world these isotopes have turned up in potentially serious concentrations. The planners and scientists in Pakistan will have to make serious attempts to ward off these hazards, which may be further aggravated by the increase in nuclear power generation in future.

d. Noise

Increasing noise levels are a different form of air pollution. Noise is generally defined as unwanted sound. It is one of the worst pollutants of the urban environment. Apart from being a nuisance, research has shown that noise has harmful effects on human systems (Pak EPA no date). In repeated exposures to mild levels of noise, the result may be reduction in work output, lack of efficiency or impairment of hearing. Noise interferes with proper sleep leading to fatigue. It can also contribute to stress-related diseases. Pakistani towns are noisier than their western counterparts (Box 5.1).

e. Dust

Pakistan is an arid and semi-arid country with annual rainfall ranging between 90-300 mm in the South and 1000-1600 mm in the north. The high temperature above 40 degree centigrade in summers cause fine dust to rise with hot air and form clouds of natural dust over many cities. The very fact that these dust clouds are over cities point to the fact that they are not natural and caused by human activities such as construction and traffic. Dumping of construction material on streets also cause dust pollution (Box 5.2), which together with particulate pollution is a major cause of allergy and asthma.

Box 5.1 Noise Pollution in Pakistan

Noise affects human health in many ways as it can cause physiological stress, high blood pressure, increased heart rates as well as speech interference. Excessive noise can damage the hearing permanently or temporarily depending on the type, intensity and duration of exposure to noise. During the last three decades noise has been increasing all over Pakistan especially in urban areas. However, no national survey has been conducted to assess the noise level in Pakistani cities. Random tests in different cities showed that the noise level in most of the areas on average was as high as 72-86 dB (A), which is much higher than acceptable limits (See table below). The major sources of noise are traffic, industries, aircraft and railway engines, loudspeakers, construction machinery, workshops and recreational activities including musical shows, fairs and exhibitions, and fireworks.

Noise Levels in Selected Pakistani Cities

City Name	Maximum Recorded Noise Level dB(A)	Minimum Recorded Noise Level dB(A)	Average dB(A)
Gujranwala	100	41	72.5
Faisalabad	100	47	72
Islamabad	104.5	47	72.5
Rawalpindi	108.5	48	72.5
Karachi	88.9	62.4	76.5
Peshawar	108.5	68.2	86

As far as noise management is concerned, there is no specific and detailed legislation to control noise pollution in Pakistan. The government needs to promulgate the 'Noise Pollution Control Act' to meet special conditions in the country. There is also a need for national standards for prescribing noise limits for residential areas, industrial areas, commercial areas and silence zones. In the absence of appropriate legislation and standards, federal and provincial Environmental Protection Agencies are unable to act on frequent public complaints about noise pollution. There is also an urgent need to raise public awareness through television, radio, internet and newspapers and to run campaigns against noise pollution.

Source: Pak EPA no date; Mehdi & Arsalan 2002; Younes & Ghaffar 2012

5.3. Causes and Sources of Air Pollution

The main causes of air pollution are the abrupt increase in the number of vehicles, inefficient automotive technology, use of unclean fuels, uncontrolled emissions of industrial units, emissions of brick kilns, the burning of garbage and the presence of dust.

5.3.1 Vehicular Emissions

Vehicular emissions in all the major cities of Pakistan are the primary source of air pollution. The transport sector is the largest user of petroleum products accounting for 47.4 per cent of consumption. The use of adulterated fuel and poorly maintained vehicles are some of the reasons for excessive and highly toxic emissions from vehicles. Vehicle ownership is also growing rapidly. In 1994, the total number of registered

Box 5.2 Dust Pollution and its Control in Lahore

Dust pollution is very common in Pakistan but very few studies have been conducted to determine the concentration of dust in ambient environments. One such study created estimates with the 'Gravimetric method' using a 'High volume portable dust sampler'. It was conducted at 23 sites in Lahore. The results showed that the airborne dust concentration was quite high ranging on average from a minimum of 0.76 mg/m^3 at Lahore Hotel Chowk to a maximum of 5.04 mg/m^3 at Kanchee Crossing (See table below)

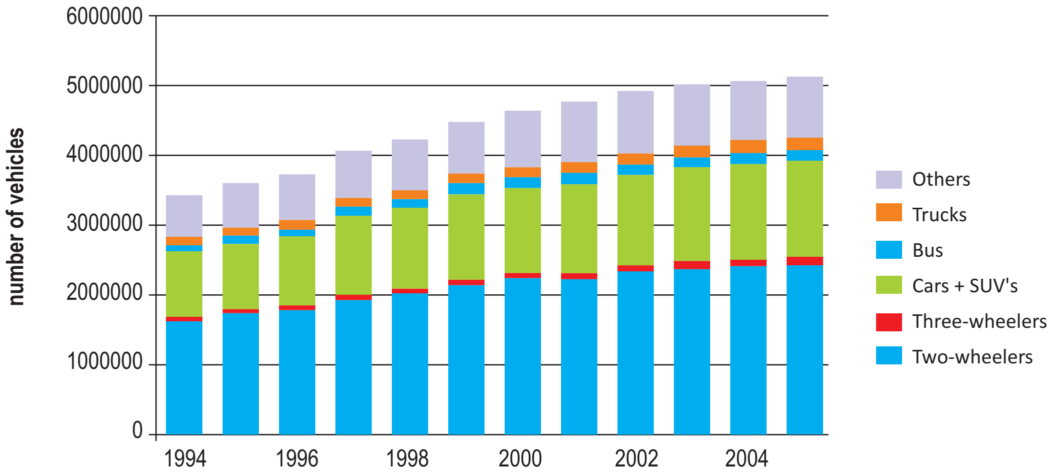
Site Name	Dust Concentrations (mg/m^3)	Site Name	Dust Concentrations (mg/m^3)
Chauburji	2.76	Mochi Gate	4.53
Chowk Yaadgar	2.37	Moon Market Chowk	1.33
Chungi Amer Sidhu	2.72	Muslim Town More	1.43
Club Chowk	1.08	Naulakha Chowk	4.52
Ghazi Chowk	1.68	Qartaba Chowk	1.51
General Bus Stand	3.07	Railway Station	2.89
Kalma Chowk	0.82	Regal Chowk	1.39
Kanchee Crossing	5.04	Samanabad More	1.93
Lahore Hotel Chowk	0.76	Scheme More	2.38
Lakshami Chowk	1.11	Shadman Chowk	1.04
Liberty Chowk	2.21	Yateem Khana Chowk	3.61
Lohari Gate	3.42		

Marble cutting, construction activity, vehicular traffic, usage and dumping of building material and debris are the main cause of this pollution. More than 500 marble-cutting units emitting marble dust and noise are polluting populous residential localities of the provincial metropolis while many units are working in and around the newly established residential schemes where construction of houses is going on. Marble dust is harmful to humans, especially children, as it causes asthma, choking of breath and many other lung-diseases while it can also affect eyesight. About 300 marble cutters were reported on the Ferozpur Road alone. In Johar Town and Township areas many marble-cutting units were installed on empty plots and they often dump residue of marble in nearby drains, which results in chocking them. City District Government Lahore (CDGL) has planned to shift marble cutters in different phases and it has already been working with the association of marble cutters to resolve the issue amicably.

The overloaded trucks and trolleys transporting uncovered sand and earth, debris and construction materials dumped on streets, and open transportation of garbage, are other major sources of dust pollution. In order to control dust from these sources, regulations are being made by the Project Management Unit (PMU) of the ring road, city district government's Solid Waste Management Department and the traffic police. A joint team comprising 50 PMU personnel and the Solid Waste Department officials have already been engaged by the Lahore Commissioner who is also seeking help of the traffic police and the enforcement staff of the Lahore Development Authority (LDA) and the Cantonment Board to check the dust menace. The plan would be implemented mainly on construction activities both in public and private sectors, holding transporters, owners, and contractors responsible for any violations.

Sources: Jafary and Faridi 2006, Sajid 2012 vehicles was 3.5 million, which grew to 5.2 million in 2005 (Fig 5.7). In terms of numbers, two-wheeled motor vehicles dominate. Vehicular emissions are treated as one of the important sources for total emissions in Pakistan but its contribution has not been quantified accurately yet. Total emissions by the transport sector was estimated in 1998 by the National Emissions Inventory of Pakistan in the "Male Declaration on Control and Prevention of Air Pollution and it's likely Transboundary Effects for South Asia" at 324,473 tons of NOx (over 90 per cent by diesel, 9.5 per cent by gasoline; 65 per cent share of total NOx emissions by all sectors); 35,362 tons of PM (93 per cent by diesel, 6.5 per cent by gasoline; 6 per cent share of total emissions); and 120,871 tons of SO_2 (99 per cent by diesel; 16 per cent share of total SO_2 emissions). Emission factors were estimated but with slight inaccuracies since the quality of roads, vehicle age and maintenance, and fuels as important parameters were ignored.

Fig. 5.7 Pakistan: Vehicle Registration Trends 1994 - 2005



Source: Official Statistics from the Government

The pollution problem being generated by the ever increasing traffic is bound to increase in the absence of urban transport policies and sustained investments in public transport. Most urban citizens rely either on their private motor vehicles or two wheelers or the informal transport sector for urban transport. This has led to a sharp increase in private vehicle ownership. New passenger car registrations have continued to soar since

Table 5.3 Pakistan: Two Stroke Motor Vehicles on Roads 2001-2010 (in 000)

Year	Total	Motorcycles/Scooter	Rickshaws
2000-01	2291.3	2218.9	72.4
2001-02	2561.9	2481.1	80.8
2002-03	2737.1	2656.2	80.9
2003-04	2963.5	2882.5	81.0
2004-05	3144.5	3063.0	81.5
2005-06	3868.8	3791.0	77.2
2006-07	4542.8	4463.8	79.0
2007-08	5126.3	5037.0	89.3
2008-09	5456.4	5368.0	88.4
2009-10 (July-March)	5567.2	5469.6	97.3
Percentage increase over 2000-01	143.0	146.5	34.4

Source: National Transport Research Centre the 90s, and the trend is expected to continue (Fig 5.7). The number of two stroke vehicles and rickshaws alone in Pakistan has more than doubled since 2001 (Table 5.3).

The surge in the demand for private vehicles originated from the increasing affordability on the one hand and availability of vehicle financing from the banking system on the other. Amongst these, diesel vehicles using crude diesel oil and motorcycles and rickshaws are of most serious concern. Due to overloading, faulty injection nozzles and weak engines, diesel vehicles emit excessive carbon (visible smoke) while motorcycles and rickshaws, due to their two-stroke engines, are the most inefficient in burning fuel and thus contribute most to emissions.

The two-wheeler industry is growing very fast in Pakistan and it has increased by 143 percent between 2000 and 2010. Rickshaws have grown by more than 34 percent while motorcycles and scooters have more than doubled over the ten years.

5.3.2 Industrial Air Pollution

Like other forms of air pollution, the magnitude of industrial air pollution has not been fully assessed in Pakistan but sporadic surveys have been carried out in the country by some governmental institutions and scientists in a few major cities. Though the industrial sector in Pakistan is small in size compared to other economic sectors, it is likely to expand in the future due to a liberal government policy. Almost all metropolitan cities have industrial estates, where a cluster of industries of different types exist. Cement, fertilizer, sugar units, and power plants are considered to be the most air polluting industries of Pakistan. Many of these are located either in the rural areas or are in the vicinity of secondary towns. Those located in the vicinity of towns cause urban air pollution. A wide range of small- to medium-scale industries (including steel rerolling, steel recycling, tobacco curing and plastic moulding) cause a disproportionate share of pollution through their use of dirty “waste” fuels, such as paper, wood and textile waste. Brick kilns are another source of pollution in many areas. The use of low-grade coal and old tires in brick kilns generates dense black smoke and other kinds of emissions. The main pollutants from these industries are particulate matter, and sulphur- and nitrogen oxides, which are emitted by burning fuels (Pak EPA, 2009).

5.3.2.1 Ambient Conditions at Major Industrial Locations

The United Nations Development Program (UNDP) in collaboration with the Energy Conservation Centre (ENERCON) conducted a comprehensive study entitled “Baseline (Ambient Air Quality) Study in Major Cities of Pakistan in 2003-04”. The study covered six major cities of Pakistan (Karachi: 10 sites, Lahore: 7 sites, Islamabad: 3 sites, Rawalpindi: 5 sites, Peshawar: 5 sites and Quetta: 3 sites). Out of the 33 sites, data from the following five industrial sites is relevant to establish links between the ambient air conditions and industrial emissions:

- Korangi Industrial Area, Karachi
- Sindh Industrial and Trading Estate, Karachi
- I-9, Islamabad
- Attock Refinery, Rawalpindi
- Hayatabad, Peshawar

Table 5.4 presents the summary of major findings of the study and lists major air pollution parameters. It shows that in most of the cases ambient concentrations of pollutants other than total suspended particulate

(TSP) and PM_{10} are within ambient standard limits established by US EPA, WHO and the World Bank. Higher concentrations of PM_{10} are predominantly contributed by vehicular traffic. The industrial sector contributes to TSP through iron, cement and ceramic industries. Industrial emissions are further compounded by the widespread use of small diesel electric generators in commercial and residential areas in response to the poor reliability of electricity supplies (World Bank, 2006).

However, the industrial sector in Pakistan is not the main contributor of ambient air pollution. Even in urban industrial locations, traffic is the main contributor to the poor ambient air conditions. As pointed out earlier, within the industrial sector, the cement, iron, fertilizer, sugar mills, power plants and brick kilns sub-sectors are the principal air polluters of TSP and CO. Emissions from these industries are causing serious environmental impacts on the health of communities and agricultural crops in the immediate vicinities. The Environmental Protection Agencies should focus on air pollution monitoring by these industrial sub-sectors.

Table 5.4 Pakistan: Summary of Ambient Conditions at Major Industrial Sites

Air Pollutant	KIE	SITE	1-9	AR	HYT	Description
TSP	^	^	^	^	^	Main sources are vehicular emissions, road side soil entrainment due to the turbulence generated by heavy vehicular traffic, and industrial processes with iron, cement, and ceramic. Maximum and average concentrations for TSP are higher than the standard limits of USEPA and WHO, but within limits established by the World Bank.
PM_{10}	^	^	^	^	^	Average and maximum concentrations exceeded the standards set by USEPA. PM_{10} emissions are normally attributed to vehicular emissions. Industrial combustion also contributes small amounts of PM_{10}.
NO_X	<	<	<	<	<	Sources are fossil fuel burning in power plants and vehicular exhaust. Average and maximum concentrations are within limits of WHO and the World Bank.
SO_X	<	<	<	<	<	Major source is diesel with higher Sulphur content mainly used by vehicular traffic and in small amounts by power plants. Average and maximum concentrations are within limits of WHO, USEPA, and World Bank.
CO	^	<	^	<	<	Major sources are vehicular traffic, power plants, and other industries. Average and maximum concentrations compared with WHO and USEPA standards.

^ = Higher than the limits, < = Within the limits

Sampling Sites:
KIE=Korangi Industrial Estate-Karachi, SITE=Sindh Industrial and Trading Estate-Karachi, I-9=Industrial Sector of Islamabad, AR=Attock Refinery, HYT=Hayatabad-Peshawar

Air Pollution Parameter:
TSP=Total Suspended Particulates, PM_{10}=Particulate Matter, NOx=Oxides of Nitrogen, SOx=Oxides of Sulphur, CO=Carbon Monoxide

Source: Baseline (Ambient Air Quality) Study in Major Cities of Pakistan, 2003-04

Most of the cement factories in Pakistan have installed electrostatic precipitators and bag filters to control their TSP emissions. Financial viability of electrostatic precipitators is well established on the basis of recovery of fine cement. Under the pressure from EPAs and in some cases from the communities and NGOs, fertilizer industries, sugar mills and power plants have also taken measures to reduce the emission of TSP. EPAs monitoring of these industrial units requires consistency.

Iron and steel mills could not install any such solution due to financial and technological issues. The solution for controlling TSP from iron and steel mills is very expensive and mills cannot financially afford the solution. The alternative is to shift from dirty raw material to cleaner raw material. Under this option, the product prices do not remain competitive in the market. Brick kilns are also facing the same type of dilemma.

Regarding heavy metals, the Pakistan Institute of Nuclear Science, Islamabad, conducted one source apportionment study. The analysis showed high levels of heavy metals, particularly antimony (Sb), in the samples, both for PM_{10} and $PM_{2.5}$. The International Atomic Energy Agency cites motor vehicle emissions, paints, coal and refuse combustion as the probable source of antimony (Ahmad, 2004).

5.3.2.2 Air Pollution at Point Sources

The Cleaner Production Institute (CPI) under the “Programme for Sustainable Industrial Development (PISD)” funded by the Embassy of the Kingdom of the Netherlands (EKN) conducted air pollution monitoring at point sources of industries while conducting energy audits in more than 250 industries representing four industrial sectors: leather, textile processing, sugar, and pulp and paper. In addition the same type of air pollution monitoring was conducted under jointly executed projects of the Pakistan Tanners Association (PTA) and EKN titled “Energy Conservation Program for Punjab Tanneries”, and “Cleaner Technology Program for Korangi Tanneries”. The PTA project conducted energy audits of more than 150 tanneries. Air monitoring was conducted at generator stacks and boilers. Boilers were generally kept operational for approximately 12 hours/day. Values of NOx were almost within the National Environmental Quality Standard (NEQS) limits for

Table 5.5 Pakistan: Air Pollution Monitoring for Four Industrial Sub-sectors

Air Pollutant	Leather	Textile-Processing	Sugar	Pulp & Paper
NO_X	<	<	<	<
SO_X	<	<	<	<
CO	^	^	^	^

Sources:Energy conservation for Punjab Tanneries
Cleaner Technology Program for Korangi Tanneries
Program for Industrial Sustainable Development
Note: ^ = Higher than the limits, < = Lower than the limits

both natural gas and furnace oil fuelled boilers, while the values of CO showed very large variations, 10-1200 mg/m^3 depending on the maintenance of the boiler. The range was less in case of gas-fired boiler. Values of SO_2 ranged from 15-110 mg/m^3 for natural gas and 50-1300 mg/m^3 for furnace oil, both within the NEQS limits. Table 5.5 presents a summary of the results of the air pollution monitoring conducted by the above-stated projects.

5.3.2.3 Indoor Industrial Air Pollution

Indoor industrial air pollution is common in the industries of Pakistan. The health of the industrial workforce is continuously under threat from indoor air pollution. For example, in the dyeing and tan-yard section of tanneries, ammonia emissions are 4.1 mg/m^3. Moreover, hydrogen sulphide and ammonia are emitted during the washing of drums with ammonia. In textile-processing indoor air pollution includes oil and acid mists, dust and lint, solvent vapours and odours. In addition, textile-processing units where printing is carried out extensively, ammonia emissions are most cumbersome. In pulp and paper mills chlorine emissions from the bleaching section are the major indoor pollutant, mostly in diffused form. Moreover, vapours originating from tank vents, wash filters, sewers and similar sources also cause indoor air pollution in pulp & paper mills. These are not usually regulated unless they cause significant impact or hazard. Major sources of indoor air pollution in sugar mills are: bagasse storage yard (particulate matters of bagasse gets dispersed in the air), chemical store (vaporization of chemicals), vacuum filters (vapours of juice mixed with air), and sugar graders that cause sugar dust (Khan, 2010).

Most of the indoor industrial air pollution problems can be managed by adopting in-house improvement measures and cleaner technologies. There is a crucial need to promote and implement indoor air pollution control measures in all industrial sectors.

5.3.3 Energy Use and Pollution

Thermal power plants are the principal polluters in the energy sector, producing sulphur dioxide, nitrogen oxides and particulate matter. The intensity and effects are subject to the location of the plant, type of fossil fuel used, its quality and chemical composition, as well as the technology used. Thus a thermal plant located in a densely populated place will do more harm as compared with one located in an area with a low population density. Similarly, coal fired thermal plants cause maximum pollution while gas fired plants cause the least. Plants with turbines using gas pressure are more efficient than those which combust gas to generate steam for power development. Most power generation is thermal.

Leaving aside the exact magnitude of emissions, the most unfortunate aspect of thermal power generation in Pakistan is the siting of plants in densely populated, major cities such as Karachi, Lahore, Faisalabad, Multan, Hyderabad, Quetta and Sukkur. These cities also happen to be major industrial centres, the plants are

Table 5.6 Pakistan: Trends in Coal Consumption 2000 - 2010

Year	Power	Brick Kilns	Household
2000-01	205.8	2837.9	1.0
2001-02	249.4	2577.5	1.1
2002-03	203.6	2607.0	1.1
2003-04	184.9	2589.4	1.0
2004-05	179.9	3906.2	-
2005-06	149.3	4221.8	-
2006-07	164.4	3277.4	1.0
2007-08	162.2	3760.7	1.0
2008-09	112.5	3205.4	0.8
2009-10 (July-Dec.)	55.1	2379.1	0.8

Source: Hydrocarbon Development Institute of Pakistan - Not Available therefore putting additional stress on the atmosphere which is already absorbing large quantities of industrial emissions in these urban complexes.

In terms of energy use, an encouraging trend from the environmental point of view is that for the last ten years, the use of coal in the power sector has been decreasing. It may be due to the fact that a number of plants have now been converted to natural gas. Likewise, there has been reduction in coal usage for domestic purposes (Table 5.6).

While the dependence on coal has reduced, the principal source of power generation continues to be thermal power. The installed capacity of Pakistan Electric Power Company was 18,233 MW as of March 2010 with the share of thermal at 11,678 MW (64 percent) and hydro at 6,555 MW (36 percent).

5.3.4 Burning of Solid Waste

The burning of municipal solid waste is also a significant source of air pollution in the urban areas of Pakistan. About 48,000 tons of solid waste is generated each day, most of which is either dumped in low-lying areas or burned. The burning of solid waste at low temperatures not only generates PM, but also produces carcinogenic pollutants (World Bank, 2006).

5.3.5 Household Sources

Air pollution from household heating and lighting by burning of both fossil as well as non-commercial fuels is a major health hazard. Indoor air pollution is high in Pakistan and poses a serious problem. The use of biomass fuels such as wood, dung and crop residues is quite common in the country. A majority of rural households (86 percent) and a large proportion of urban households (32 percent) rely on these as their primary cooking fuel (GOP, 1998). Fuelwood consumption for Pakistan is estimated at 10,611,000 tons of Oil Equivalent (TOE). Using the equation of IPCC for fuelwood, carbon is estimated at 10.68Tg, which corresponds to 39.19Tg of CO_2 emissions. Charcoal consumption for Pakistan is estimated at 170,000 tons, for which carbon is estimated at 0.133Tg, corresponding 0.488Tg of CO_2 emissions. Similarly, bagasse/agricultural waste consumption is estimated at 8,120,000 TOE, for which carbon is estimated at 8.04Tg, or 29.48Tg of CO_2 emissions (WHO, 2005). The combustion of domestic fuel contributes a lot of smoke, gaseous materials and particulate matter. No quantitative estimates are available on its magnitude. Biomass burnt in poorly ventilated homes has severe health consequences, particularly for women, young children and the elderly who are most likely to be exposed to indoor pollutants.

5.4 Impacts of Air Pollution

The increase in urban population accompanied by an excessive release of air emissions from vehicles, industries and the burning of municipal waste results in high economic costs. The economic cost of air pollution is estimated at Rs.65 billion/year (or US$ 650 million/year) for urban air pollution (Table 5.7). In the cities, widespread use of low-quality fuel, combined with a dramatic expansion in the number of vehicles on roads, has led to significant air pollution problems causing serious health issues.

The estimated annual health impacts of indoor air pollution, according to the World Bank (2006), accounts for over 28,000 deaths per year and 40 million cases of acute respiratory illnesses. Total annual cost of indoor air pollution is estimated at Rs 60-74 billion (Table 5.8), with a mean estimate of 67 billion, about 1 percent of the GDP.

Table 5.7 Pakistan: Annual Cost of Ambient Urban Air Pollution Health Impacts (Billion Rs)

Health end-points	Attributed Total Cases	Total Annual Costs
Premature mortality adults	21,791	58-61
Mortality children under 5	658	0.83
Chronic bronchitis	7,825	0.06
Hospital admissions	81,312	0.28
Emergency room visits/Outpatient hospital visits	1,595,080	0.80
Restricted activity days	81,541,893	2.06
Lower respiratory illness in children	4,924,148	0.84
Respiratory symptoms *	706,808,732	0.00
Total		**62-65**

Source: World Bank 2006

* Multiple events counted/person

The actual cost may be even more, particularly because adverse environmental effects of air pollution are difficult to quantify in economic terms for a number of reasons. First of all, it is difficult to estimate at what levels of concentration different air pollutants begin to affect human health. Different people are affected to different degrees by the same pollutant concentrations because of factors like age, diet, and smoking habits. Therefore, the protection of human health is a goal more easily articulated than quantified. Second, the pollutants emitted into the atmosphere may not be harmful by themselves, but only after mixing with other pollutants or after being transformed by atmospheric processes. Consequently, it is often difficult to determine what air pollutants have to be controlled and to what degree to protect human health. Third, the atmosphere is a major pathway by which toxic air pollutants reach and contaminate terrestrial and aquatic ecosystems. Sometimes the same ecosystem can be affected by air emissions from a number of different sources at varying distances from the point where the pollutants are deposited. In this case the source of economic damage to terrestrial or aquatic resources (at the given point) can be difficult to identify, and because the damage itself may be long-term, the economic cost is difficult to quantify. Irrespective of economic quantification, health costs of air emissions are enormous.

Table 5.8. Pakistan: Indoor Air Pollution Cost

	Estimated Number of Cases		Estimated Annual Cost (Million Rs)	
	Low	High	Low	High
Acute Respiratory Illness Children (under the age of 5 years)- increased mortality	21,933	31,060	27.83	39.40
Children (under the age of 5 years)- increased morbidity	29,508,800	41,788,200	4.26	6.03
Females (30 years and older)- increased morbidity	10,754,600	15,229,800	2.04	2.89
Chronic obstructive pulmonary disease:				
Adult females - increased mortality	7,408	11,433	25.84	25.84
Adult females - increased morbidity	21,850	33,721	0.12	0.18
Total			**60.08**	**74.34**

Source: World Bank (2006)

High concentrations of suspended particulates adversely affect human health, provoking a wide range of respiratory diseases and heart ailments. The most hazardous are fine particulates of 10 microns in diameter or smaller (PM10). Worldwide, fine particulates are implicated in 500,000 premature deaths and 415 million new cases of chronic bronchitis per year. Ambient concentrations of particulates in Pakistani cities lie consistently above the World Health Organization guidelines and are estimated to cause around 22,000 premature deaths among adults and 700 deaths among young children. In terms of annual Disability Adjusted Life Years (DALYs) lost, mortality accounted for an estimated 60 per cent, followed by respiratory symptoms. The bulk of losses were due to adult premature mortality, which is consistent with evidence from other assessments that found adults to be more vulnerable to respiratory symptoms and in greater danger of lung cancer (World Bank, 2006).

A medical study in 2005 investigated the impact of environmental pollution on the health of nearly 1,000 traffic policemen. Results showed that about 80 per cent of the traffic policemen had chronic ear-nose-throat (ENT) problems and 40 per cent showed signs of lung problems (some of which developed into asthma and tuberculosis). Due to the nearly 10-hour job on the road amidst smoke and blowing horns, almost 90 per cent showed symptoms of irritability and tension; 45 per cent of the cases (ranging from 35 to 50 years of age) suffered from hypertension (Pakistan EPA, 2005).

The air pollution problem through industrialization has consequences for human health and the wellbeing of animals and plants. Epidemiological studies indicate that industrial air pollution has cumulative effects on susceptible people. Many types of industrial emissions produce unpleasant odours and irritation of the eyes, nose and throat. Some may even cause dryness of mucous membrane, headache and dizziness. There is also an undeniable association between the wellbeing of patients with respiratory diseases and air pollution measured in terms of certain specific pollutants. Some pollutants such as lead get stored in the human body and may produce poisoning or other effects. Pollution of indoor industrial atmosphere by synthetic chemicals and their intermediates is often quite common and has hazardous effects on the health of industrial workers. A large number of factory workers in Pakistan are therefore facing serious occupational health hazards.

5.5 Linkages with Global Environmental Issues

The atmospheric ecosystems in Pakistan are also being affected by activities taking place outside the national boundaries. Thus, transboundary pollution from across the international border has consequences for Pakistan in terms of climate change. Various aspects of climate change and their implications for Pakistan have been discussed in chapters 6 and 7. The so-called winter fog phenomenon in Pakistan is also important in this regard.

5.5.1 Winter Fog

During winters, in past few years, widespread fog has frequently occurred in northern India and northeastern part of Pakistan, in a region extending over hundreds of Kilometers (km). Northeastern India and the neighboring sections of Punjab in Pakistan have been under the influence of a high-pressure system, during winters, resulting in dry weather and low wind speed. These conditions are ideal for accumulation of pollutants in the atmosphere. High concentrations up to 100 µg/m^3 were measured in Lahore during last many fog episodes, which extended over a large section of eastern India and Pakistan. The measured ratios of SO_4^{2-}/Se and 925-millibar wind data suggested that the source of SO_4^{2} in Lahore was located several hundred kilometers away to the south (Hameed, 2000).

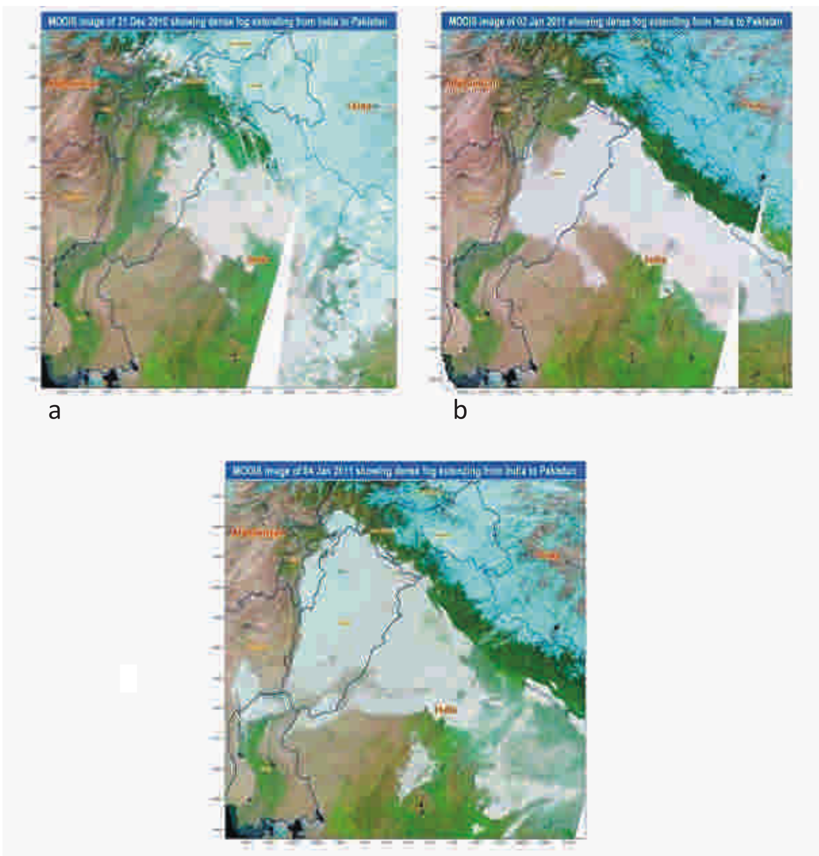
Box 5.3 Winter Fog in Pakistan

Widespread and thick fog has frequently occurred over large parts of India and Pakistan for the last several years. The incidence of this "winter fog" phenomenon in Pakistan, which is a cocktail of toxic gases and particulates, thoroughly disrupts human activities in the affected areas, interrupting commercial flights and rail traffic. It contributed to economic losses and had serious implications for human health aggravating respiratory and cardiovascular diseases, as well as increased cardiac arrest rates. One study in 2002 estimated that approximately 16.28 million people - about 40 per cent of the total urban population in Pakistan - were exposed to this "fog" and health implications amount to Rs 25.7 billion per year. It is suspected that the fog may have had impact on regional and global climate.

The Space and Upper Atmosphere Research Commission (SUPARCO) of Pakistan investigated the causes of the fog. The fog showed extraordinarily high concentrations of ammonium sulphate. Concentrations of SO_4^{2-}, NO_3^-, and selected trace elements were determined at Lahore, Pakistan during and after the fog event. Sulphate concentrations of up to 100 µg/m^3 were observed during the fog. The SO_4^{2-}/Se ratios and trace element data suggest a distant source of SO_4^{2-} aerosols, hundreds of kilometres away. During the fog Lahore was downwind of coal burning in India. The high concentrations of SO_4^{2-} observed require a more extensive investigation of the chemistry and transport processes in this region, necessary to delineate emission sources and develop control strategies.

Sources: Pakistan EPA 2005, SUPARCO 2012b

Fig.5.8 Series of MODIS Images Showing the Transboundary Movement of Fog



Extraordinarily high concentrations of particulate matter during fog days especially due to the formation of ammonium sulphate carried serious consequences for human health (Lodhi et al 2009). Further high particulate matter and extended fog days also affected agriculture, general economy and regional climate. Dense fog also severely disrupted all human activities in the affected areas (Box 5.3). Losses to economy due to particulate matter and related issues including fog were estimated to be in several million dollars (SUPARCO and IPHP 2010, SUPARCO and SUPARCO and M/S ASIANICS Agro-Development 2010, and World Bank 2006). The GIS based maps of Pakistan (Fig. 5.8) show the most affected areas of fog during the year 2011.

The role of transboundary pollution on fog event in Pakistan can be discerned from the satellite images given in Fig. 5.8. All these fog images were acquired from MODIS Rapid Response system. The episode started by dense Fog entering into Pakistan from Indian border on 31 December 2010 (Fig. 5.8a). The dense white patches of fog episode from Indian Territory extended deep into the province of Punjab by 2, January 2011 (Fig. 5.8b). The dense white patches extended to its peak and covered almost the whole province of Punjab and part of Khyber Pakhtunkhwa Province as well as part of Sindh and Baluchistan provinces by 4 January, 2011 (Fig. 5.8c).

5.6 Policies and Programmes for the Management of Air Quality

5.6.1. Institutional Arrangements

Air quality management in Pakistan is handled at the national, provincial, and local (district and city) levels. At the national level, Pakistan EPA is responsible for setting air quality and emissions standards and for defining associated systems for monitoring and enforcement. The 2001 National Environmental Action Plan (NEAP), includes air pollution in its core programmes. Some key objectives of this programme, including the introduction of unleaded gasoline and a reduction of sulphur in diesel, have already been achieved.

To consolidate on-going and proposed initiatives for the management of urban air quality, the Ministry of Environment (now Climate Change Division) had developed the Pakistan Clean Air Programme - PCAP (Table 5.9), which includes short- and long-term measures along with their responsible implementing agencies. The wide range of short- and long-term actions is to be implemented by all levels of government and by a variety of agencies (World Bank, 2006).

Provincial EPAs have almost complete authority to handle environment and air quality management of their respective provinces. Among other functions, they implement Rules and Regulations of the Pakistan Environmental Protection Act (PEPA) 1997 and prepare additional legislation as per the needs of the province. They also have the responsibility to prepare and implement provincial standards, develop provincial systems for the implementation of pollution charges, conduct research & development for viable environmental technologies, and engage local governments in the implementation of PEPA 1997.

The cities of Lahore in Punjab Province and Karachi in Sindh Province have been in the forefront in improving urban air quality. Both cities have established Clean Air Commissions involving high-level representatives from the city and national government and other stakeholders, headed by the City Mayor (now replaced by the Administrator).

5.6.2 Legislation and Standards

The Pakistan Environmental Protection Act 1997 is the umbrella legislation that also covers general provisions

Table 5.9 Pakistan Clean Air Programme: Proposed Measures and Responsibilities

Short-term Measures	Responsible Agencies	Long-term Measures	Responsible Agencies
General Air Quality Management			
Baseline data collection on ambient air quality using fixed and mobile laboratories	Federal and Provincial EPAs	Creation of public awareness and education	Ministry of Environment and Provincial Environment Department
Launch of effective awareness campaign against smoke-emitting vehicles	Provincial Governments	Setting up continuous monitoring stations in cities to record pollution levels in ambient air	Ministry of Environment and Provincial Government
Reducing Emissions from Mobile Sources			
Stop import and local manufacturing of 2-stroke vehicles	Ministry of Commerce and Ministry of Industry	Improvement of energy efficiency in vehicles and industry	Ministry of Environment
Restriction on conversion of vehicles from gasoline engine to second-hand diesel engines; launch effective awareness campaign against smoke-emitting vehicles	Provincial Governments	Introduction of low-sulfur diesel and furnace oil and promotion of alternative fuels, such as CNG, LPG, and mixed fuels, in the country	Ministry of Petroleum and Natural Resources
High pollution spots in cities may be identified and control through better traffic management, such as establishment of rapid mass transit and traffic-free zones	Provincial Governments	Review Motor Vehicle Ordinance to provide for inspection of private vehicles	Federal and Provincial Governments
Capacity building of Motor Vehicle Examiners	Provincial Governments	Establish vehicle inspection centers	Ministry of Communication and Provincial Government
Regular checking of quality of fuel and lubricating oils sold in the market	Ministry of Petroleum and Natural Resources	Identify pollution control devices/additives for vehicles and encourage their use	Ministry of Environment and Ministry of Petroleum
Phasing out of 2-stroke and diesel-run public service vehicles	Federal and Provincial Governments		
Giving tariff preference to CNG-driven buses	Ministry of Industries and Ministry of Finance		
Adoption of fiscal incentives and a financing mechanism to provide resources to transporters	Ministry of Communication and Provincial Government		
Establishment of environmental squad of traffic police in all major cities to control visible smoke	Provincial Governments		
Reducing Emissions from Stationary			
Covering of buildings/site during renovation and construction to avoid air pollution	Provincial Governments	Promotion of waste minimization, waste exchange, and pollution control technology in industries	Federal and Provincial EPAs, Federation of Pakistan Chamber of Commerce and Industries and Ministry of Industries and Production
Reducing Emissions from Area Sources (Open Burning) and Dust			
		Proper disposal of solid waste in cities/provinces	Capital Development Authority and Provincial Governments
		Block tree plantation in cities, forestation in deserts and sand dune stabilization	Ministry of Environment and Provincial Forest Department
		Paving of shoulders along roads	Ministry of Communication and Provincial Government

Source: Adapted from Pakistan EPA, Pakistan Clean Air Program (2006); Pakistan EPA/World Bank (2006).

on air quality. Detailed vehicle emissions standards in Pakistan were notified in the 1993 National Environmental Quality Standards for Vehicle Exhaust and Noise. They were revised in the recently approved National Environment Quality Standard (NEQS) for Motor Vehicle Exhaust and Noise 2010. Under the new standards, it has been decided that: (i) all petrol driven vehicles imported or manufactured locally will comply with Euro-II emission standards. Existing models if not complying with Euro-II emission standards will have to switch over to Euro-II models (ii) all diesel driven vehicles imported or manufactured locally were to comply with Euro-II emission standards with effect from July 2012.

Local notifications have also been promulgated to limit or totally ban the operation of highly polluting vehicles. These include the ban on old and poorly maintained city buses and 2-stroke auto-rickshaws. Such notifications have been made in Lahore and Karachi banning 2-stroke auto-rickshaws from operating in these cities. In Lahore, some roads have been closed for operations of 2-stroke rickshaws: Mall Road was closed on 17 April 2006, Jail Road on 27 September 2006, and Main Boulevard (Gulberg) on 18 October 2006 (Khan, 2006). A complete ban on 2-stroke rickshaws is now being implemented in Lahore.

5.6.3 Monitoring

In 2007 the Pakistan EPA established fixed and mobile Air Monitoring Stations in five major cities of Pakistan Karachi, Lahore, Peshawar, Quetta, and Islamabad, with the cooperation of Government of Japan (See Chapter 8 for details). The air quality data obtained from these stations has led to the development of NEQS for ambient air quality.

5.6.4 Measures to Improve Emissions from Mobile Sources/Traffic

The country does not have an established inspection and maintenance system in order to regulate emissions from in-use vehicles. However, motor vehicle examiners who operate within the transport departments in each province conduct arbitrary inspections and issue a certificate of fitness for public and commercial vehicles. EPAs and the provincial traffic police are implementing a provincial motor vehicle ordinance that allows them to apprehend private and public transport vehicles emitting visible smoke, vapour, grit, sparks, ashes, cinders or oily substances and fine them Rs. 500 for such violation (ADB, CAI ASIA and Pakistan Clean Air Network 2006).

5.6.4.1 Voluntary Inspection and Tune-up

A voluntary inspection and tune-up programme was included in the UNDP-Global Environment Facility "Fuel Efficiency in Road Transport Sector" (UNDP-GEF-FERTS) project and a German Agency for Technical Cooperation (GTZ) supported project in Peshawar. According to the ENERCON (2002) component of the UNDP-GEF-FERTS project, thousands of vehicles were tuned up at several stations. Following that, the private sector has started a centralized system which is controlled and overseen by the Government. This handles emissions and safety issues as well and is in operation for all commercial and other types of vehicles

A successful pilot activity of a Vehicle Emission Testing System (VETS) was undertaken in Islamabad. Under this, Pakistan EPA and the Islamabad Traffic Police (ITP) carried out emission tests for 39,057 vehicles between 2005 and 2008, out of which 34,203 (87.6per cent) vehicles were cleared and accordingly issued green stickers, whereas 4,854 (12.4 per cent) vehicles causing pollution were issued red (warning) stickers (Table 5.10).

Table 5.10 Islamabad: Vehicular Emission Testing Results

Fuel Type	Green/ Compliance	Red/ Non Compliance	Total Checked Vehicles
Diesel	18,988	2,865	21,853
CNG	14,295	1632	15,927
Petrol	920	357	1277
Total	**34,203**	**4,854**	**39,057**

Source: Pak, EPA, MoEnv May 2005 - September 2008

A major success achieved in the transport sector is the switching of vehicles to use of CNG (Box 5.4). The current gasoline specifications monitored in Pakistan are research octane number (RON) at 90, lead at zero levels, and sulphur content at 0.1 per cent (or 1,000 ppm). For diesel, it is 1.0 per cent, with the actual levels ranging from 5,000 ppm to 10,000 ppm (0.5 to 1.0 per cent) of sulphur. Various steps to improve the specification of petroleum products have been taken since 2000. Unleaded gasoline, introduced in the country in July 2002, has been improved to 90 RON unleaded gasoline and is produced and marketed since 2003. Several national refineries, such as Attock Refinery Ltd, are in the process of further reducing sulphur levels in diesel (Azam, 2006).

Box 5.4 Pakistan's Success in Switching Vehicles to CNG

Pakistan is the largest user of Compressed Natural Gas (CNG) for running vehicles in the world, as per the statistics issued by International Association of Natural Gas Vehicles on CNG. Presently, 3,105 CNG stations are operating in the country and 2.4 million vehicles are using CNG as fuel (see the table below). Use of CNG as fuel in the transport sector has observed a quantum leap, replacing traditional fuels and lowering the pollution load in many urban centres. After the successful CNG for petrol replacement programme, the government is now looking to replace the more polluting “diesel fuel” in the road transport sector. The government has planned to offer incentives to investors to introduce CNG buses in the major cities of the country.

Growth of CNG Stations and Vehicles 1999 - 2009

As on	CNG Stations (No.)	Converted Vehicles (No.)
December, 1999	62	60
December, 2000	150	120,000
December, 2001	218	210,000
December, 2002	360	330,000
December, 2003	475	450,000
December, 2004	633	660,000
December, 2005	835	1,050,000
December, 2006	1,190	1,300,000
16th May, 2007	1,450	1,400,000
February, 2008	2,063	1,700,000
April, 2009	2,760	2,000,000
December, 2009	3,105	2,400,000

Source: HDPI http://ww.hdp.com.pk, OGRA, IANGV http://www.iangv.org

Box 5.5 Self-Monitoring and Reporting System for Industries (SMART)

The Pakistan EPA, in collaboration with the industry and other stakeholders, has implemented the "Self-Monitoring and Reporting Tool for Industry" (SMART) System. Under the system, launched formally by the Minister for Environment in March 2006, the industries in Pakistan systematically monitor their environmental performance and report the data to EPAs. The self-monitoring and reporting guidelines were developed through a long and exhaustive series of consultations and roundtable discussions among all stakeholders, including representatives from the government, industry, NGOs, civil society organizations, universities and research and development institutions (See Chapter 8 for details).

It is expected that entrepreneurs who are well aware of their social and legal responsibilities will respond adequately to this new system, which does not involve any role for environment inspectors. The self-monitoring and reporting system took into account the interests and resources of both the public and industry. Executed properly, on one hand it can save considerable money, time and efforts of the government and on the other it involves industry in evaluating environmental performance, leading to pollution control measures. By implementing the system, the Government in fact transferred its responsibility for examining and evaluating the industry's environmental performance to individual industrial facilities.

The SMART System classifies industries into categories A, B, and C, each corresponding to a specified reporting frequency. Category A industries report their emission levels every month; category B industries, quarterly and category C industries, biannually. Industrial units get their emissions tested from a laboratory and enter the results in electronic form included in the software package SMART Self-Monitoring and Reporting Tool.

The response of the industry to SMART is not encouraging; out of 8,000-10,000 industrial units only 113 are registered and reporting under the programme. Four sectors are strongly represented i.e. oil & gas, chemicals, pharmaceutical, and power generation. Most of the industry in these four sectors is either multinational by corporate structure or are internationally financed. Pakistan's major industrial sectors such as textile, sugar and leather are very weakly represented.

Representatives of industry surveyed on SMART indicated that the most important reason for not reporting was that industry believed that EPAs would use the SMART information to penalize the firms in the future. Secondary reason stated was that there was no such requirement from the international buyers. It was also noted that for reporting under SMART industry needed written guarantee from EPAs that they would not start undue inspection and penalize firms on the basis of SMART data. In addition, the need for training of industry and making SMART software user-friendly was also mentioned. Finally, it was pointed out that industry and EPAs should have negotiated SMART reporting on a formal forum where modalities, mechanisms, and conditions could be agreed among parties by consensus, which could ultimately lead to making SMART reporting mandatory.

Pak EPA, 2006b and Khan, 2010

The Ministry of Petroleum and Natural Resources eliminated lead from petrol, reduced sulphur in HSD & Fuel (sulphur in high speed diesel from 1.0 to 0.5 per cent by weight and in fuel oil from 3.5 to 2 per cent), introduced catalytic converters for all new cars, restricted import of vehicles without catalytic converters, and imposed restriction on 2-stroke engine technology for fitting catalytic converters. The improvement in fuel quality will be addressed by modification of the configuration of existing oil refineries, setting up of new refineries with the latest technology and import of low sulphur and fuel oil. The Committee on Clean Fuels also recommended fitting catalytic converters in all 2-stroke engines and testing of all public and private vehicles for compliance with the standards.

5.6.5 Management of Stationary Sources

The management of emissions from stationary sources is also the responsibility of Pakistan EPA and provincial EPAs, for which a self-assessment and monitoring tool (SMART) system has been launched (Box 5.5).

Other proposed measures suggested for management of stationary sources include the introduction of low-sulphur diesel and furnace oil, promotion of alternate fuels, waste minimization and energy conservation and efficiency, as well as promotion of pollution control technology.

5.6.5.1 Energy Conservation and Alternate sources of Energy

Energy conservation measures are being promoted by Energy Conservation Centre (ENERCON) by undertaking energy audits and various other measures. An Alternative Energy Development Board (AEDB) was also established by the government, which apart from promoting mega wind projects has launched a project on ethanol as an alternative fuel for vehicles. Furthermore, it has successfully implemented a project on the production of biodiesel and the first-ever commercial biodiesel facility has been setup in Karachi by the private sector. This biodiesel refinery has a capacity of producing 18,000 tons of Biodiesel yearly. AEDB has also initiated a project for carrying out detailed studies for biomass and waste-to-energy projects in 20 cities of Pakistan. Work is in progress to install 103 micro hydro power plants at Chitral and other places in Gilgit Baltistan. Small hydropower projects with a cumulative capacity of 142 MW are also being promoted at different locations in Punjab. AEDB recently launched a Consumer Confidence Building Programme for the promotion of Solar Water Heaters in the country. The programme was designed to create awareness of solar water heating technology and to build the consumer confidence for the product through a number of incentives to buyers including a money back guarantee.

5.6.6 Management of Other Sources and Dust

Widespread burning of garbage in several urban areas creates a critical air pollution problem in Pakistan. EPAs are charged with removing sources of pollution and exercise control over these kinds of pollution. Currently they are actively engaged in controlling emissions by prohibiting roadside incineration of municipal waste and are taking steps to introduce sustainable waste management practices (ADB, CAI ASIA and Pakistan Clean Air Network 2006). A comprehensive waste management programme is also being developed by Pakistan EPA in order to address the issue of rampant open burning in Pakistani cities.

5.7 Conclusion

Based on existing air quality monitoring data, Particulate Matter (PM10 and PM2.5) is the main pollutant of concern in Pakistan. PM concentrations were found to exceed the limits set by WHO guidelines considerably. Nitrogen-oxides are also found to exceed the limits set by WHO guidelines in localized areas. High concentrations of particulate matter introduce a heavy burden of air pollution-induced diseases in the population. The incidence of the "winter fog" phenomenon in Pakistan, which is a cocktail of toxic gases and particulates, is another serious problem. It has contributed economic losses, and aggravated health problems particularly respiratory and cardiovascular diseases. About 40 per cent of the total urban population in Pakistan is exposed to this “fog” that has health implications amounting to Rs. 25.7 billion per year. Open solid waste burning enhances this phenomenon.

Brick kilns, tobacco curing, cement, fertilizer, sugar units and power plants are the most air polluting industries of Pakistan. The use of low-grade coal and old tires in brick kilns generates dense black smoke and other kinds of emissions. The other main industrial pollutants are particulate matter and sulphur- and nitrogen-oxides, which are emitted by burning fuels.

The estimated health costs from air pollution in Pakistan fall in the range from Rs. 62 to Rs 65 billion per year, about 1 per cent of GDP. It underscores the urgent need to effectively implement and enforce measures to reduce air pollution. Institutional and regulatory measures exist but their effective enforcement is the main problem. There is also a need for the involvement of stakeholders in the formulation and amendment of standards and relevant policies. Additionally linkages and roles of the national, provincial, and local level institutions should be clearly and firmly stipulated as to avoid overlapping of roles and to ensure coordination and cooperation. Raising awareness and seeking cooperation of NGOs and public at large in enforcement is also crucial.

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