3 Air Quality and Traffic Management

Air pollution is becoming a significant problem in urban areas in Nepal, particularly in the bigger cities. Kathmandu Valley is particularly vulnerable to air pollution because of its bowl-shaped topography which restricts air movement. The situation is worse during the winter when temperature inversion during the night and early morning traps a layer of cool air under a layer of warmer air, trapping pollutants close to ground level for extended periods. Besides the topography, the relatively high elevation of the valley also results in increased vehicular emissions. The main elements in the DPSIR framework related to air quality in the Kathmandu Valley are in shown Figure 2.

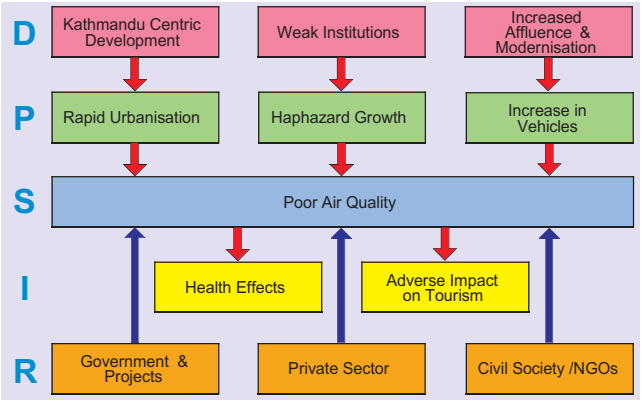


Figure 2: DPSIR framework and urban air quality in Kathmandu Valley

Drivers

In the case of Kathmandu's air quality, the main drivers are Kathmandu-centric development; weak institutional capacities, and increasing affluence and modernisation.

Kathmandu-centric development

Over the years, Kathmandu has become the centre for practically all services and facilities nationally. As the capital city, it is naturally the political and administrative centre of the country. But besides this, it is also the hub for tourism, finance, industry, education, transportation, health care, and sports. Some indicators of this process of centralisation are presented in Table 3.1.

This process of Kathmandu-centric development continues even today. For example, in the national budget for the current fiscal year (2006/07), 35.4% of the fund earmarked for water supply and sanitation is to be spent in Kathmandu Valley. Similarly, the most recent urban development projects, such as the Japan International Cooperation Agency's (JICA) Clean

Table 3.1: **Centralisation of development in Kathmandu Valley**

Function	Indicator
Political	Capital city Due to the insurgency, activities of most political parties have been limited to Kathmandu and other urban centres.
Administrative	Capital city Regional headquarters for various institutions such as SAARC, UNICEF Central Regional Headquarters for various offices District Headquarters for three districts
Finance	Headquarters for all major banks and financial institutions Only share market in the country
Tourism	Major tourist attractions including seven world heritage sites
Industry	Main centre for carpet and garment industries, and these are the largest and most labour-intensive industries Many polluting industries such as brick kilns and stone crushers 14,791 small and cottage industries in Kathmandu Valley
Transportation	The location of the country's only international airport The valley is connected by various highways going north-south & east-west 56 % of the total number of vehicles registered in the country are in Bagmati zone, almost all of which are in Kathmandu Valley
Sports	The only international quality football stadium, covered hall, cricket field and swimming pools in the country are all located in Kathmandu Valley
Education	Largest university and most well-known schools and colleges in the country are located in Kathmandu Valley
Health care	Largest hospitals in the country Specialised health care facilities such as Ganga Lal Heart Centre

Kathmandu Valley (CKV) and Junction Improvement projects and the Asian Development Bank (ADB) funded Kathmandu Valley Development Project have also focused their activities on Kathmandu Valley. Currently, the government is actively seeking funding for the Outer Ring Road project, which many believe will exacerbate urban sprawl. In fact the government's Kathmandu Valley Development Plan, which is the latest plan for managing the valley's urban development, has mentioned that the Outer Ring Road should not be built without considering adverse environmental impacts and the possibility of uncontrolled urban sprawl.

Weak institutional capacity

According to the Local Self Governance Act 1999 municipalities are primarily responsible for urban environmental management. But municipalities have very limited resources, both human and financial, to invest in activities related to urban environmental management. An analysis of the revenue and expenditure of the five municipalities in Kathmandu Valley shows that most municipalities depend on a local development fee provided by the central government for their revenue and most of the revenue is spent on current expenses. Within the current expenses, personnel expenses were the largest component accounting for 27% in Kathmandu Metropolitan City (KMC), 65% in Lalitpur Sub Metropolitan City (LSMC), 18% in Bhaktapur Municipality (BKM), 52% in Madhyapur Thimi Municipality (MTM), and 61% in Kirtipur Municipality (KRM) (Table 3.2) As a result, municipalities have very little money to manage urban growth and environment and the municipalities are often busy in day to day administrative work and crisis management.

Table 3.2: **Actual revenue and expenditure for FY2003/04 (2060/61)**

Items	KMC		LSMC		BKM		MTM		KRM	
	m. Rs	%	m. Rs	%	m. Rs	%	m. Rs	%	m. Rs	%
Revenue	**554**	**100**	**116**	**100**	**128**	**100**	**24**	**100**	**17**	**100**
1) Local Dev. Fee	238	43	52	45	21	16	12	50	12	71
2) Own Revenue	288	52	62	53	106	83	7	29	3	18
3) Grants	28	5	2	2	1	1	5	21	2	11
Expenditure	**580**	**100**	**121**	**100**	**123**	**100**	**21**	**100**	**12**	**100**
1) Current	553	95	68	56	96	78	10	48	7	58
2) Capital	27	5	53	44	25	20	11	52	5	42
3) Debt	0	0	0	0	2	2	0	0	0	0

Key: m. Rs = million Rs; KMC = Kathmandu Metropolitan City; LSMC = Lalitpur Sub Metropolitan City; BKM = Bhaktapur Municipality; MTM = Madhyapur Thimi Mulicipalilty; KRM = Kirtipur Municipality
Note: Opening balance is excluded from revenue.
Source: Compiled from Budget Reports for each municipality, 2004

Although municipalities are spending a large proportion of their income on personnel expenses, they have very little trained manpower. KMC for example has an Environment Department but almost all the staff members in this department are involved only in managing the city's garbage. The Urban Environment Section in the department is responsible for air and water pollution control and greenery, but it has only two staff members. Similarly, other municipalities also do not have any expertise in issues such as transport management and air pollution control.

Other institutions are involved in urban development and urban environmental management, but they have very limited resources and programmes. For example, the Department of Transport Management (DoTM) does not have a transport planner or a transportation management expert. The activities of the DoTM are therefore mostly limited to registering vehicles and issuing route permits for public vehicles.

In many instances, the responsibilities of different organisations involved in various aspects of urban management are not clear, and coordination among different stakeholders to resolve issues and work together is rare. As a result, many problems are ignored and the resources are not used effectively. For example, the seemingly simple issue of digging roads to maintain underground systems, such as water supplies, drainage, or telecommunication cables, often results in converting well-paved roads into patches of dirt and potholes that result in congestion and air pollution. It is estimated that about 25% of the total particles less than 10 microns (PM_{10}) in the air of Kathmandu Valley are from road dust (Gautam 2006).

Most municipalities and other institutions that have responsibilities for urban environmental management do not have plans and programmes to combat pollution. Some plans have been prepared with the support of international agencies, but rarely have these been internalised and implemented.

Another major weakness of institutions is in regular monitoring and enforcing compliance with standards and regulations. Nepal has standards for ambient air quality and vehicle emissions, but these are rarely enforced. Although there is a system for regularly checking the compliance of in-use vehicles, there is no punishment for vehicles that do not

comply. Since 2002, the ambient air quality in Kathmandu has been monitored, but the monitoring results have not yet been used to develop plans and programmes.

The organisational culture prevalent in many municipal and government offices prefers the status quo and does not encourage people to take initiative and be creative. Such a culture hampers institutional performance and prevents institutions responsible for urban management from addressing the challenges of a rapidly growing urban centre adequately.

Increasing affluence and modernisation

There is a growing middle class in the valley which is demanding new modern facilities such as houses in the suburbs and vehicles. To cater to these demands, an aggressive market is supplying easy access to financing and a wide choice of vehicles and housing for consumers. According to Tuladhar et al. (2005), the main reasons for the massive growth in demand for vehicles are as follows.

- Availability of a wide range of different automobile models in the market
- Competitive market resulting in aggressive marketing by auto dealers with attractive promotional schemes
- Attractive auto loans offered by financial institutions
- Expanding city boundary forcing people to travel long distances
- Growing population
- Poor public transportation system

Among these reasons, probably the most significant cause in the growth of car ownership is the financing schemes being offered by banks. In recent years, auto loans have become popular in Kathmandu, and this has contributed to an increase in demand for cars and motorcycles. With interest rates as low as 4.5% with a 10% down payment, a car or motorcycle is now within the reach of most middle class families. Because of the lack of investment opportunities in other sectors and inflow of cash from remittances and other sources, many people are taking advantage of offers provided by the numerous banks and auto dealers. Standard Chartered Bank first introduced auto loan schemes in 1992, but the auto loan sector has really taken off in the past five years with interest rates dropping significantly and many commercial banks entering the market with attractive schemes. Several banks have joined hands with car dealers to offer the best deals. Even the traditionally conservative government sector Nepal Bank and Rastriya Banijya Bank have introduced new auto loan programmes. According to local auto dealers, the banks finance 80 to 90% of the cars they sell.

Along with the demand for vehicles, the market for housing in the suburbs has also boomed in recent years. Many real estate dealers and housing companies are offering 'dream houses' just outside the main city and banks are eager to provide the necessary financing. This has resulted in an expansion in urban sprawl and people having to commute longer distances. In fact, the 2001 census indicated that the population in many of the core areas of Kathmandu has actually gone down as people move out of the core areas into the suburbs.

Pressure

Rapid urbanisation

Kathmandu-centric development has resulted in rapid urbanisation in the valley. Kathmandu Valley has five of the 58 municipalities in the country and is home to about 30% of the total urban population. The city of Kathmandu is by far the largest city in the country, with more than 20% of the total urban population, and the second largest city – Biratnagar – has less than one fourth the population of Kathmandu. The population in the valley is increasing at twice the national rate of 2.2% (Table 3.3).

Table 3.3: **Population increase in Kathmandu Valley**

Census Year	Total	Urban	Rural
1920	306,909	-	
1952/54	410,995	196,777	214,218
1961	459,990	218,092	241,898
1971	618,911	249,563	369,348
1981	766,345	363,507	402,838
1991	1,105,379	598,528	506,851
2001	1,581,234	995,966	585,268
2001*	1,581,234	1,210,127	371,107

* Urban population including urbanising VDCs with annual population growth rates >4%
Source: CBS 2002

The rate of urbanisation has increased also due to the migration of people displaced by the insurgency to urban areas and the Kathmandu Valley, as they are considered to be safer. Although reliable figures on the number of internally displaced people are not available, recent data collected in 12 municipalities indicate that the population growth rate has increased from an average of 3.6 to 5.2% per year in these cities.

The rapid urbanisation in Kathmandu is stretching municipal boundaries and converting open spaces and agricultural fields into concrete jungles. Between 1984 and 2000, agricultural land in the valley decreased from 62 to 42%. If this trend continues, by 2025 there will be no agricultural fields left in this once fertile valley. In 1981, three fourths of the residents were involved in agriculture, but, by 1991, this had gone down to one third.

The Municipal Association of Nepal (MuAN) predicts that the Terai region, Kathmandu Valley, and Pokhara will continue to see maximum urbanisation in the foreseeable future (FCM/MuAN 2002). One of the main reasons for the rapid rate of urbanisation is migration from the villages. Extreme poverty, lack of economic opportunities, and, more recently, the insurgency in rural areas, cause many people, especially the young, to migrate to cities in search of opportunities for employment, education, health, and security. According to the 2001 census, over 30% of the people living in cities are migrants. This figure is highest in the large municipalities (populations higher than 100,000), where 37.8% of the people are lifetime migrants, and lowest in the smallest municipalities (populations less than 20,000) where only 12.9% of the people were born elsewhere. Cities with substantial numbers of migrants are Kathmandu (44.1%), Butwal (52.9%), Dharan (46.1%), Bharatpur (45.2%), and Pokhara (33.4%). This indicates that, when people migrate, they tend to migrate to large cities instead of small towns. Thus the large cities will probably continue to grow more rapidly than small towns.

Haphazard growth

Urbanisation itself is not a problem, if it can be managed. In fact, as urban centres are considered to be engines of growth, the process of well-managed urbanisation can result in economic development and increased access to services to more people. In Nepal, however, institutional weaknesses from the perspective of managing urban development have resulted in haphazard growth, manifested in unplanned settlements, increase in vehicular emissions, polluting industries in or near urban areas, traffic congestion, and poor waste management. All of these result in increased air pollution.

Unplanned settlements

The growth of settlements in an unplanned manner tends to reduce population density and increase the need for travel. Similarly, expansion of urban areas without adequate infrastructure and systems for transportation also results in increased congestion and vehicular emissions. Another problem of unplanned growth is the development of incompatible urban forms, such as polluting industries in the middle of residential areas or near environmentally sensitive areas, or establishment of major traffic-generating activities such as long-distance bus parks in city centres. The wholesale fruit market in Kuleshwor, vegetable market in Kalimati, and bus park for Bhaktapur bound busses at Ratna Park are examples of this problem.

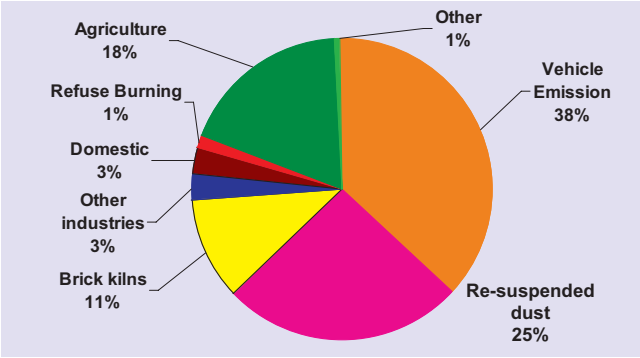
Vehicular emissions

Vehicular emissions have become the main source of air pollution in Kathmandu Valley. An inventory of emission sources by the then Ministry of Population and Environment (MoPE) indicated that exhaust fumes had increased more than four times in the eight years between 1993 and 2001. According to a more recent inventory, vehicular emissions are responsible for 38% of the total PM_{10} emitted in Kathmandu Valley, compared to 18% from the agricultural sector and 11% from brick kilns (Gautam 2006; Figure 3; Table 3.4). Increase in emissions is mainly due to the increase in the number of automobiles, as well as poor transport management and poor vehicle maintenance.

Table 3.4: **Comparison of emission inventories in 1993, 2001, 2005**

Sources	TSP (tons/yr)			PM_{10} (tons/yr)		
	1993	2001	2005	1993	2001	2005
Mobile Sources						
Vehicle exhausts	570	1971	NA	570	3,259	4,708
Road dust re-suspension	1,530	7008	12,239	400	1,822	3,182
Sub-total	*2,100*	*8979*	*12,239*	*970*	*5,081*	*7,890*
Stationary Sources						
Industrial/commercial fuel	582	NA	NA	292	NA	NA
Domestic fuel combustion	2328	NA	630	1,166	NA	347
Brick kilns	5,180	6,676	1,850	1,295	1,688	1,437
Himal Cement	6,000	3,612	0	800	455	0
Stone crushers	NA	NA	1,720	NA	NA	372
Industrial boilers	NA	28	28	NA	15	15
Fugitive Emissions						
Refuse burning	385	687	172	190	339	172
Agricultural sector	NA	NA	NA	NA	NA	2,337
Cremation	NA	NA	158	NA	NA	79
Total	**16,575**	**19,982***	**16,797**	**4,712**	**7,580**	**12,649**

* in original report 19,884
Key: TSP = total suspended particles; NA = not available
Source: Shah and Nagpal 1997; Gautam 2006; MoEST 2005



Source: Gautam 2006

Figure 3: Sources of PM_{10} in Kathmandu Valley

Source: ENPHO

Polluting the environment

Increase in number of vehicles

Out of a total of 472,795 vehicles registered in Nepal by the end of fiscal year 2004/05, 56% (274,805 vehicles) were registered in the Bagmati Zone, most of which covers Kathmandu Valley. In the past five years, the number of vehicles in Kathmandu Valley has been growing at about 12% per year, which is about three times the population growth rate, and this growth is highest in the case of private vehicles such as motorcycles and small cars. The growth in vehicles is shown in Table 3.5. The rapid increase in vehicle numbers, particularly private vehicles, results in traffic congestion and air pollution.

Industrial emissions

About 38% of all industries in Nepal are located in Kathmandu Valley. The records of the Department of Cottage and Small Industries indicate that Kathmandu Valley has 14,791 industries – 10,527 in Kathmandu; 2,933 in Lalitpur; and 13,331 in Bhaktapur. Among these are 111 brick kilns, 89 stone crushers, and 70 industries with boilers (MoEST 2006b). These industries generate stack as well as fugitive emissions directly resulting in air pollution. According to a recent emission inventory, the industrial sector accounts for about 14% of the PM_{10} in the Kathmandu Valley.

Table 3.5: **Vehicles registered in Bagmati Zone**

Types	Bus	Mini bus	Truck/ tanker	Car/ jeep/ van	Pickup	Micro-bus	Tempo	Motorcycle	Tractor	Others	Total vehicles	Growth rate%
1990/91	560	1024	2292	16626	-	-	1854	22359	1156	-	45871	N/A
1991/92	663	1,168	2,631	17,300	-	-	2,186	28,407	1,349	-	53,704	17.1
1992/93	718	1,277	2,950	21,459	-	-	3,844	32,240	1,615	-	64,103	19.4
1993/94	792	1,352	3,343	20,748	-	-	3,844	37,774	1,623	2561	72,037	12.4
1994/95	958	1,388	3,781	22,640	-	-	3,844	43,506	1,635	2678	80,430	11.7
1995/96	1,045	1,430	4,113	22,248	-	-	3,844	49,299	1,670	3,012	86,661	7.7
1996/97	1,163	1,468	4,483	27,153	-	-	3,844	58,029	1,672	3020	100,832	16.4
1997/98	1,298	1,500	4,759	28,915	-	-	3,925	64,142	1,672	3,278	109,489	8.6
1998/99	1,403	1,527	4,811	30,919	-	-	4,262	71,612	1,672	3,311	119,517	9.2
1999/00	1,632	1,610	5,295	35,993	-	-	4,778	94,217	1,672	3,338	148,535	24.3
2000/01	1,744	1,804	5,484	40,674	-	-	4,949	112,000	1,673	3,350	171,678	15.6
2001/02	1,858	2,172	6,274	43,409	-	-	5,073	134,852	1,673	3,356	198,667	15.7
2002/03	2,061	2,378	6,991	45,361	521	232	5,073	156,410	1,677	3,385	224,098	12.8
2003/04	2,214	2,437	7,370	51,541	999	902	5,085	173,646	1,677	3,411	249,282	11.2
2004/05	2,278	2,487	7,607	54,311	999	1,329	5,088	185,593	1,677	3,436	264,805	5.8

Source: Adapted from the Department of Transport Management's records, 2006

Box 1: Burning tyres are injurious to health

Source: ENPHO

Burning tyres is a common form of protest practised by political parties and other groups. Used tyres are readily available and the black smoke released by burning them easily attracts attention and also creates a barrier between the protesters and police. However, most people using this form of protest do not realise the harm they are causing to themselves and others in this process.

Tyres are a consumer product not designed for burning. They are made from natural rubber as well as synthetic rubber consisting of carbon black, extender oils, steel wire, up to 17 heavy metals, other petrochemicals, and chlorine. Burning them emits ultra-fine toxic particles, including metals such as mercury, lead, chromium, beryllium, cadmium, and arsenic, as well as the organic chemicals styrene and 1-3 butadiene. Styrene, a benzene derivative, is a suspected human carcinogen and butadiene also is known to cause cancer in laboratory animals and is a suspected human carcinogen. Studies show a strong association between leukemia and butadiene. Burning tyres also release dioxin which has been recognised by the United States Environment Protection Agency (USEPA) in 1985 as the most potent human-made carcinogen known. Dioxin does not break down in the environment but builds up in the food chain, concentrating in meat and dairy products.

Besides causing immediate air pollution, the fine particles that settle on the ground can pollute groundwater or surface water and can accumulate to toxic quantities in wildlife and degrade the river ecosystem.

Although the Government of Nepal has banned the burning of tyres, this is still a common activity during protests. The public therefore needs to be informed about the health risks associated with the pollution caused by burning tyres, and political parties must take the lead in refraining from burning them.

Emissions from mismanagement of solid waste

Although there has been some improvement in solid waste management in Kathmandu in recent years, waste piles on the streets and burning of waste, both of which cause air pollution, are still fairly common. The situation is especially bad when there is a breakdown in the waste collection system due to strikes or closing of the landfill site.

State

Several studies have shown that Kathmandu's air is densely polluted, particularly in the dry winter months. In the 1990s, projects such as the UNDP-funded Kathmandu Valley Vehicular Emission Control Project (KVVECP), the World Bank-funded Metropolitan Environment Improvement Project (MEIP), and a few NGOs carried out sporadic monitoring at various locations and alerted the government and public to the increasing pollution levels. In 2002, the then Ministry of Population and Environment (MoPE) established six permanent air-quality monitoring stations in Kathmandu Valley (see Table 3.6), and these are monitoring PM_{10} concentrations daily as well as some other key parameters (see Table 3.7).

Table 3.6: **Locations of monitoring stations in Kathmandu**

Location	Classification
Putali Sadak	Urban traffic
Patan Hospital	Urban traffic
Thamel	Urban traffic/residential
Bhaktapur	Urban background
TU, Kirtipur	Urban background
Matsyagaon	Valley background

Table 3.7: **Kathmandu air quality monitoring programme**

Parameter	Methods and Location
PM_{10}	Low volume samplers; 24 hr sampling daily at all 6 stations
$PM_{2.5}$	Since Nov. 2005 at Thamel station, 6 hr campaign performed Nov 05 – Feb 06, since then 24 hr sampling
TSP	High volume sampler at Putalisadak & Patan, one 24 hr sample/ week
CO	Not determined
NO_2	Passive samplers, all stations, monthly sampling
SO_2	Not determined
Benzene	Passive samplers, all stations, monthly sampling
PAH	Campaign monitoring only
Lead	To be determined in 2 samples per station per week

Source: ENPHO

Permanent monitoring station at Tribhuvan University

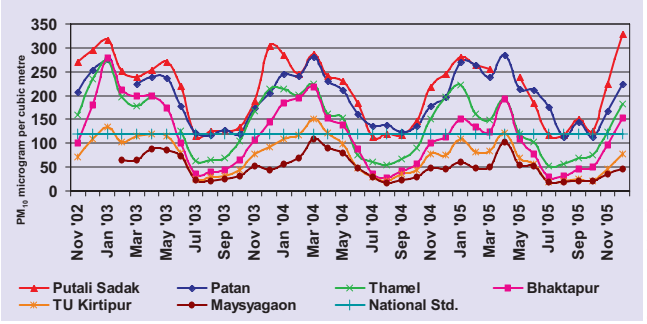
Particulate matter

Air quality data from previous years have shown that a high level of suspended particulate matter (SPM) is a major problem in Kathmandu Valley. Among the particles, the smaller particles such as PM_{10} and $PM_{2.5}$ are of serious concern because they tend to remain in the air for a long time and can enter deep into the respiratory system causing serious health risks to those exposed. Monthly average PM_{10} concentrations measured in the six monitoring stations are shown in Figure 4.

Comparison of 24-hour PM_{10} monitoring data collected by the Environment and Public Health Organisation (ENPHO) from Putali Sadak in 1992 to data collected from the same place ten years later in November 2002 indicates that PM_{10} concentration has tripled over the past decade. Over the past three years, however, the PM_{10} concentration in Kathmandu Valley has stablilised in urban areas of Kathmandu and Lalitpur and has slightly decreased in other areas. The average PM_{10} concentration in Kathmandu Valley went from 132.9 $\mu g/m^3$ in 2003, to 129.2 $\mu g/m^3$ in 2004, and 122.2 $\mu g/m^3$ in 2005 – a decrease of eight per cent in two years (see Figures 4 and 5). This decrease is most significant in the case of Bhaktapur where the average PM_{10} levels fell from 131.0 $\mu g/m^3$ in 2003 to 111.1 $\mu g/m^3$ in 2004 and 96.4 $\mu g/m^3$ in 2005: a decrease of 26.5% in two years. In the roadside stations at Putali Sadak and Patan Hospital, however, the PM_{10} concentration increased by 4.5% over the same period.

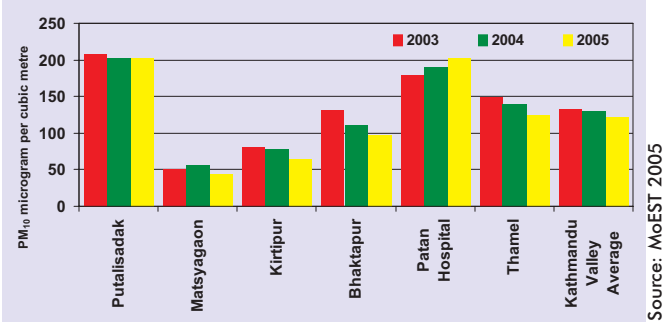
The following conclusions can be drawn from these results.

1. Among the six areas monitored, Putali Sadak is the most polluted. This is mainly because of the dense traffic in this area and the fact that tall buildings on either side of the road tend to have a canyon effect which does not allow pollutants to disperse.
2. In the dry winter months, the PM_{10} levels in Putali Sadak are above the national standard for 99% of the time. With the arrival of monsoon rains in mid-June, the PM_{10} decreases significantly, but is still above national standards on most days.
3. The air is significantly better in Kirtipur (on the west side of the valley) than in Bhaktapur (on the east side of the valley). This is probably due to the westerly winds taking pollutants from Kathmandu over to Bhaktapur.
4. There is significant seasonal variation in the level of PM_{10}. The PM_{10} level is highest in January, which is the peak of the dry winter season, and is lowest in July, the peak of the monsoon season. During the monsoon, rains flush down the particles in the air significantly reducing pollution levels, while, in the winter, temperature inversion causes air pollution to rise. In January 2003, the average PM_{10} concentration in Kathmandu Valley was 255.6 $\mu g/m^3$, but six months later in July 2003 the level had dropped to 64.2 $\mu g/m^3$. An additional factor that keeps the pollution level low during the monsoon is that the polluting brick kilns in



Source: MoEST 2005

Figure 4: Monthly average PM_{10} concentrations in Kathmandu



Source: MoEST 2005

Figure 5: Reduction in annual average PM_{10} in Kathmandu (2003-05)

Kathmandu usually do not operate during the monsoon. The seasonal variation is especially high in Bhaktapur which is surrounded by brick kilns and is located down wind from Kathmandu.

- In Kathmandu, the following data clearly indicate that vehicles are the main source of air pollution.
- Areas with heavy traffic (Putali Sadak and Patan Hospital) are the ones that are most polluted.
- Pollution levels drop on weekends when there are fewer vehicles on the road. The average PM_{10} level on the five weekends (Saturdays and Sundays) in May 2003 on Putali Sadak was 219.4 $\mu g/m^3$. However, in the same month, the average PM_{10} concentration on weekdays (Monday to Friday) was 290.4 $\mu g/m^3$, and this is 32% higher than the concentration on weekends.

5. Pollution levels are very low during 'Nepal Bandh' days (general strikes) when there are almost no vehicles on the road. When there was a Nepal Bandh on April 23, 2003, the PM_{10} level dropped by 30% from 332 to 231 $\mu g/m^3$ and then went up to 284 $\mu g/m^3$ again the next day.
6. Although the number of vehicles in Kathmandu Valley has increased by about 12% a year in the past two years, the PM_{10} concentration in roadside areas has only increased by about 2.2% per year. This may be because the newer vehicles that are coming on the streets of Kathmandu are of EURO I standard and therefore are less polluting than the older vehicles.
7. The 26.5% improvement in air quality in Bhaktapur area between 2003 and 2005 is probably because of the introduction of cleaner brick kiln technology, as most of the brick kilns in Kathmandu Valley are located around Bhaktapur. The fact that much of the improvement has come in the winter months when the brick kilns are in operation also indicates that the government's decision to ban the old bull trench kilns and introduce cleaner fixed chimney kilns and vertical shaft brick kilns has had positive impacts on air quality.

$PM_{2.5}$ is considered to be more hazardous than PM_{10}. Although Nepal does not have any standards for $PM_{2.5}$, some monitoring has been carried out for $PM_{2.5}$ in Kathmandu Valley. $PM_{2.5}$ monitoring in Patan Hospital area and Bhaktapur indicates that more than 60% of the PM_{10} is $PM_{2.5}$. The relatively high $PM_{2.5}$:PM_{10} ratio indicates a significant contribution from combustion sources such as vehicle emissions (Figure 6).

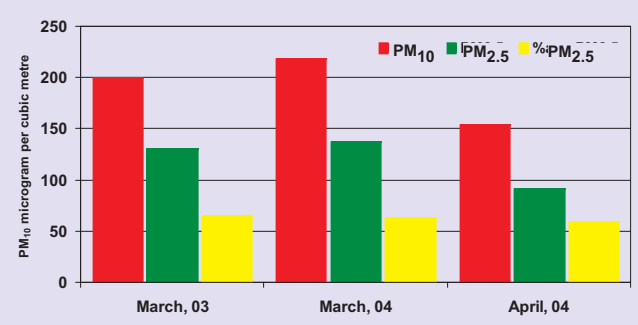


Figure 6: Monthly average PM_{10} and $PM_{2.5}$ in Bhaktapur

Gaseous pollutants

The concentration of NO_2 and SO_2 are generally within the national standards of 40 and 50 $\mu g/m^3$ respectively. NO_2 levels are generally higher in areas with heavy traffic, because vehicles are the main source of NO_2. The SO_2 levels tend to be higher in Bhaktapur, because of the brick kilns in the area which burn high sulphur coal. Data from the winters of 2003/04 and 2004/05 indicate that there has been a slight increase (14.8%) in NO_2 levels in the roadside stations of Putali Sadak and Patan Hospital, while levels have remained constant in urban residential areas (Thamel) and valley background stations (Figures 7,8,9).

Air toxins

Benzene – Benzene is a toxic pollutant of serious concern. The main source of benzene in the air is the benzene mixed in gasoline that is emitted from the fuel and vehicles. Monitoring of benzene in January-February 2002 indicated very high levels of benzene concentration, particularly in roadside areas – up to 77 $\mu g/m^3$ in Putali Sadak. Since then, however, the benzene

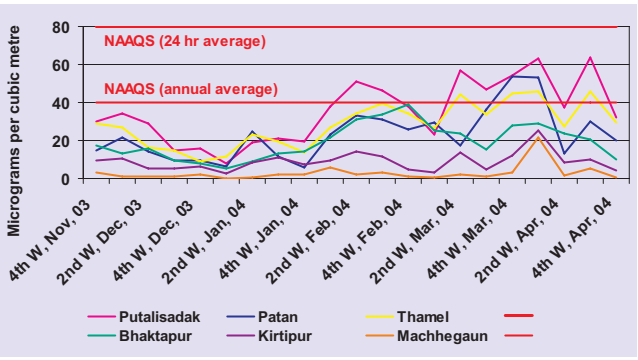


Figure 7: NO_2 concentrations in Kathmandu Valley,weekly averages in 2003/04

level has remained within the national standard of 20 µg/m^3. This is probably due to the reduction in benzene concentration in petrol. The average monthly benzene concentrations measured at the six monitoring stations are shown in Figure 10.

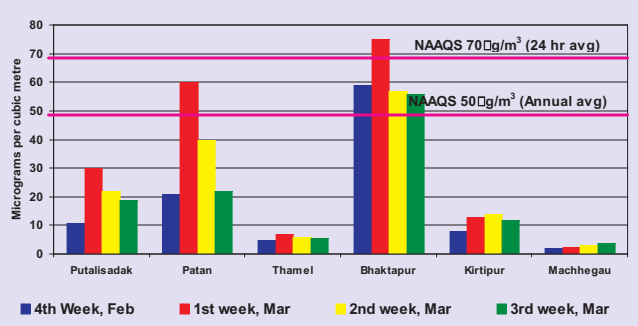
Polycyclic Aromatic Hydrocarbons – Polycyclic Aromatic Hydrocarbons (PAH) are toxic compounds that are mainly formed during combustion. The concentrations of PAH at the monitoring stations were measured by MoPE several times in 2003 and the results showed that PAH concentration in Kathmandu may be a concern (see Figure 11). Although Nepal does not have standards for PAH, the concentration in Kathmandu is much higher than European norms. More monitoring of PAH concentration is required to confirm the findings. Diesel exhausts are a major source of PAH.

Impact

Many studies have shown that air pollution has significant impacts on human health. As the most common route for pollutants to enter the human body is by inhalation, the most common health effect of air pollution is damage to the respiratory system. Exposure to air pollutants can overload or break down natural defence mechanisms in the body, causing or contributing to respiratory diseases such as lung cancer, asthma, chronic bronchitis, and emphysema. Recent studies have also indicated that air pollution can also have adverse impacts on other important systems such as the cardiovascular system and central nervous system (Lahiri 2003). Among air pollutants, fine particles are particularly dangerous because they can become embedded in the human body and they are often coated with toxic substances. As the concentration of fine particles in Kathmandu is very high, this is certainly having adverse impacts on public health. Other impacts of air pollution are the economic impacts due to adverse effects on tourism and loss of human productivity because of poor health.

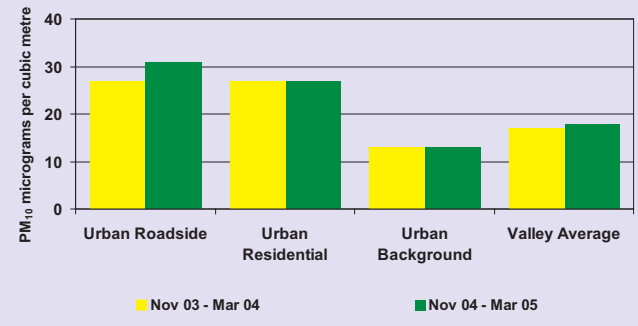
Health impacts from Kathmandu's air pollution

Although there are no long-term epidemiological studies on the impacts of Kathmandu's air pollution, a few studies have carried out preliminary medical examinations of groups of the exposed population or used dose-response relationships that have been developed elsewhere. These indicate that the health impacts of Kathmandu's air pollution can be quite severe.



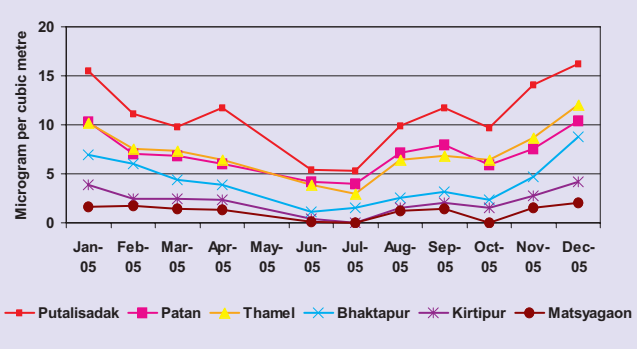
Source: MoEST 2005

Figure 8: SO_2 concentrations in Kathmandu Valley (Feb-March 2003)



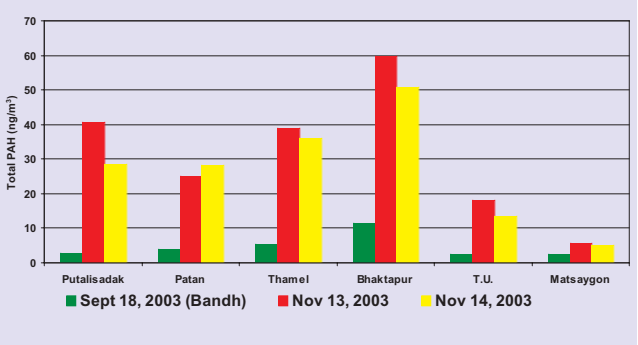
Source: MoEST 2005

Figure 9: NO_2 concentrations in 2003/04 and 2004/05



Source: MoEST 2005

Figure 10: Benzene concentrations in Kathmandu Valley



Source: MoEST 2005

Figure 11: PAH concentrations in Kathmandu Valley, 2003

The first study to examine the health effects of Kathmandu's air pollution used dose-response relationships developed from research in the US, and combined it with estimated frequency distribution of PM_{10} exposure in Kathmandu Valley in 1990 to estimate impacts on mortality and morbidity due to PM_{10} (Shah & Nagpal 1997). Although the use of these functions involves many assumptions and the results can only be speculative at best, it does provide some preliminary figures. The findings of the health impact study are presented in Table 3.8.

The study indicated that the PM_{10} in Kathmandu's air has a major impact on respiratory diseases such as bronchitis in children, chronic bronchitis, and asthma attacks. Chronic bronchitis can lead to chronic obstructive pulmonary disease (COPD).

In 1993, an analysis of the records of all patients admitted to Patan Hospital found that in six years (1985 to 1991), the proportion of admissions for COPD as a percentage of the total number of medical patients had tripled. In 1984-85 the proportion of COPD patients was 5.1% but, in 1991, it had increased to 15.2% (Zimmerman 1993).

A few years later a more rigorous analysis of the records of 369 COPD patients and 315 control patients admitted to Patan Hospital from April 1992 to April 1994 found that the odds of having COPD are 1.96 times higher for Kathmandu Valley residents than for residents outside the valley (Zimmerman 2003; personal communication). An unpublished report of the study stated that over the past decade the proportion of COPD patients had increased more than four fold and that COPD was the number one killer of adult patients in the hospital.

Table 3.8: **Health impacts of PM_{10} in Kathmandu Valley in 1990**

Types of Health Impact	No. of Cases	Value (NRs.)	
		Specific	Total (x 10^3)
Excess Mortality	84	340,000	28,644
Chronic Bronchitis	506	83,000	41,988
Restricted Activity Days	475298	56	26,617
Emergency Room Visit	1945	600	1167
Bronchitis in Children	4847	350	1,697
Asthma Attacks	18,863	600	11,318
Respiratory Symptom Days	1,512,689	50	75,634
Respiratory Hospital Admissions	99	4160	415
Total			**187,480**

Source: Shah and Nagpal 1997

In 1997, Child Workers in Nepal surveyed 60 children working as conductors on three-wheelers in Kathmandu and examined the health of 38 of them. The study found that most of the children suffered from eye problems (84%), chest pains (82%), and headaches (58%). Similarly, 66% suffered from coughs, colds, and problems with the upper respiratory tract, and 45% experienced difficulty in breathing (CWIN1997).

Shakya (2001) carried out a questionnaire survey of 90 traffic police and observed them in the field. The study found that most of the policemen suffered from problems with the respiratory and nervous systems.

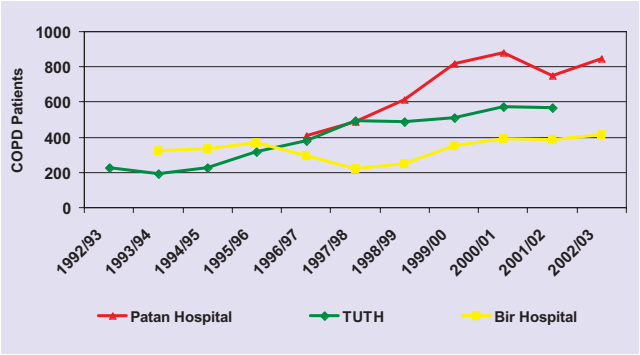
Clean Energy Nepal (CEN) carried out a questionnaire survey of people living near brick kilns and in a control area, and also examined the health of more than 100 children living near brick kilns and in a control area. Out of 290 individuals surveyed, 54% from the area with brick kilns reported symptoms of respiratory disorders compared to 41% in the control area. Similarly, the health examination clearly indicated that young children living in areas with brick kilns suffered from more problems associated with the upper and lower respiratory tracts (Tuladhar and Raut 2002).

Records from major hospitals in Kathmandu Valley also indicate that the number of COPD in-patients in Kathmandu Valley's hospitals has increased significantly over the past 10 years (Figure 12). The increase is most significant in Patan Hospital where the number of COPD patients more than doubled within a period of six years from 407 patients in 1996/97 to 849 patients in 2002/03. In Tribhuvan University Teaching Hospital (TUTH), the number of patients more than doubled from 225 in 1992/93 to 568 in 2001/02.

The records also indicate that COPD patients as a percentage of the total medical patients have also increased over the years (Figure 13). This indicates that the increase in the number of COPD patients is not just because of the overall increase in the number of patients.

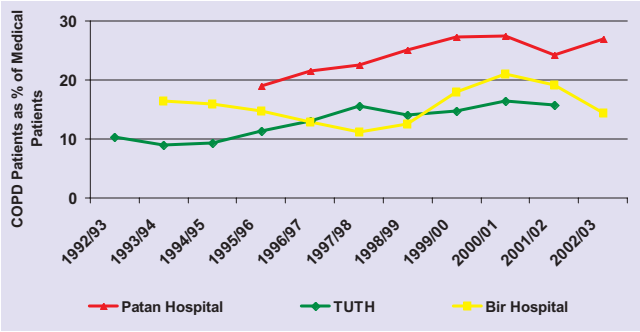
Hospital records and interviews with doctors also clearly indicate that the number of COPD patients admitted to hospitals is highest in the winter season when the air pollution is also at its peak (Figure 14).

Using dose-response functions, CEN/ENPHO (2003) estimated that reducing $PM_{2.5}$ levels in Kathmandu Valley by just half would reduce daily mortality by seven per cent and hospital admissions by 24%. Similarly,



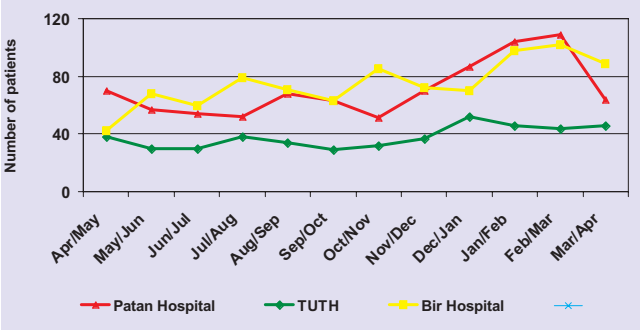
Source: CEN/ENPHO 2003

Figure 12: Number of COPD patients in major Kathmandu hospitals



Source: CEN/ENPHO 2003

Figure 13: COPD Patients as a percentage of total medical patients



Source: CEN/ENPHO 2003

Figure 14: Number of COPD patients admitted to major hospitals in 2002/03 (2059)

reducing the annual average PM_{10} level in Kathmandu to international standards (50 $\mu g/m^3$) would avoid over 2,000 hospital admissions, over 40,000 emergency room visits, over 135,000 cases of acute bronchitis in children, over 4,000 cases of chronic bronchitis, and half a million asthma attacks. Overall this means over five million restricted activity days and 32 million days with respiratory problems would be avoided.

A recent study carried out by the Ministry of Environment, Science and Technology (MoEST) estimates that Kathmandu's air pollution results in approximately 1,600 premature deaths per year (MoEST 2005).

Economic impacts

Valuation of health impacts. The first attempt to calculate the value of the health effects of Kathmandu's air pollution was the World Bank study (Shah and Nagpal 1997). The study estimated the health impacts of PM_{10} in Kathmandu and also attempted to calculate the value of these impacts. The study estimated that the total cost of the health impacts of PM_{10} in Kathmandu in 1990 was approximately Rs. 210 million. Since then the number of vehicles has increased six times and the PM_{10} concentration has tripled. Similarly, the number of people exposed to air pollution has also increased significantly due to urbanisation. Therefore the economic value of health impacts must have increased severalfold since then.

CEN/ENPHO (2003) estimated that the avoided cost of hospital treatment by reducing Kathmandu's PM_{10} levels to international standards was about Rs. 30 million. However, this is not the entire cost of the health impacts of Kathmandu's air pollution, because it does not include the cost of emergency room visits, restricted activity days, respiratory symptom days, treatment at home, and excess mortality.

Impacts on tourism. The high level of air pollution can negatively impact tourism as tourists, especially those with respiratory illnesses, do not want to be exposed to high concentrations of pollutants. A survey of 1,702 tourists leaving Kathmandu indicated that air pollution was the number one area in which tourists thought improvement was required (CEN/ENPHO 2003). Even tourism entrepreneurs and local people living in tourist areas feel that the air pollution is having adverse impacts on tourism. A recent survey of 299 Thamel residents found that 94% of the respondents felt that tourists shorten their stay in Thamel because of environmental problems such as air pollution.

The atmospheric data obtained from Kathmandu airport from 1970 onwards show that there has been a substantial decrease in visibility in the valley since 1980: the number of days with good visibility (>8,000m) around noon decreased in the winter months from more than 25 days/month in 1970 to five days/month in 1992 (Shah and Nagpal 1997). As most tourists come to Nepal to see mountains, the reduced visibility will affect tourism. As tourism is a major industry in Nepal, any adverse impact on tourism will affect the economy of Kathmandu as well as the country as a whole.

Source: P. Dangol

Haze masking the mountains

Source: B.B. Pradhan

Clear day showing the mountains

Response

Key stakeholders

Several agencies within the government and several other stakeholders are involved in air quality management. Some of the key agencies and their responsibilities are shown in Table 3.9.

Over the years, various stakeholders have introduced positive steps to control air pollution in the valley (Table 3.10). The government response includes banning the use of polluting vehicles such as diesel three-wheelers and polluting Moving Chimney Bulls' Trench Kilns. The government has also established vehicular emission standards and ambient air quality standards. Private sector initiatives have primarily been limited to operation of public transportation, including electric vehicles.

The Himal Cement Factory, which had been spewing hazardous soot and dust in the air for 25 years, has been closed down. One of the main factors for the closure

Box 2: Environmental improvements in Kathmandu's brick industry

Source: VSBK Programme

Brick manufacturing is a major source of air pollution in Kathmandu Valley. According to an inventory made in 1993, the industry was responsible for about one third of the PM_{10} in Kathmandu Valley. Since 2004, however, the brick industry has gone through a major transformation as the whole industry switched over from the polluting Moving Chimney Bull Trench Kilns to cleaner Fixed Chimney and Vertical Shaft Kilns. This transformation of Kathmandu's brick industry has resulted in significant improvements in the Valley's air quality. The PM_{10} concentration in Bhaktapur, a town that is surrounded by brick kilns, went down by 26% between 2003 and 2005.

The improvement in the brick industry first started with local people, who were the victims of the pollution from brick kilns, raising their voices against the pollution. In the late 1990s, several local groups in areas such as Jhaukhel in Bhaktapur and Tikathali in Lalitpur started raising the issue of pollution from brick kilns with local government authorities as well as with industrialists through letters, meetings, and protests. Later they were supported by local NGOs carrying out more scientific studies to justify their claims. Clean Energy Nepal (CEN),for example, carried out air quality monitoring and health studies among children in areas with and without brick kilns. The studies found that the pollution levels in areas with brick kilns were about three times higher than in control areas and children studying in a school near brick kilns in Tikathali suffered more from respiratory problems than similar children from a control area.

These results of the environmental and public health studies and the persistent and passionate agitation by local communities were highlighted by the local media, which added fuel to the fire. Continuous pressure from the local communities and NGOs finally forced the government to take action against the brick kilns. Initially several illegal kilns were shut down and later the government took the bold decision to completely ban moving chimney bulls' trench kilns. Although the implementation of the decision was delayed by a year, the government went ahead and implemented the decision in spite of pressure from industrialists. At the same time, DANIDA and SDC supported by demonstrating cleaner technologies for brick production. Ultimately the industrialists agreed to shift to a new technology. Thus the combined efforts of local communities, NGOs, government, donor agencies, and industrialists resulted in a drastic change in an entire industry and improved air quality in Kathmandu Valley.

Table 3.9: **Key stakeholders in air quality management**

Stakeholders	Responsibility
Government agencies	
MoEST	Responsible for formulating air quality related policies and programmes Recently implemented a project on Air Quality Management in Kathmandu, one of the components of the DANIDA supported ESPS Currently monitoring air quality in Kathmandu Valley through six monitoring stations that are being managed by the Environment and Public Health Organisation (ENPHO)
MoLTM	Responsible for formulating policies on transport management
MoICS	Responsible for formulating policies related to industrial development
DoTM	Responsible for transport management, including issuing of route permits to public transport vehicles and testing emissions from vehicles
Traffic Police	Responsible for traffic management and on-the-spot emission testing
DSCS	Responsible for promoting and monitoring small and cottage industries, including brick kilns
DoI	Responsible for promotion and monitoring of industries
Municipalities	Responsible for urban environmental management
Nepal Oil Corporation	Responsible for supplying petroleum products and ensuring quality control
Private organisations	
Various Transport Associations	Responsible for operating public transportation and representing the interests of various public transport operators
Electric Vehicle Association of Nepal (EVAN)	An umbrella organisation for EV manufacturers, owners/operators, and charging station managers
Nepal Automobile Dealers Association (NADA)	Represents the interests of vehicle importers
Industrialists	Owners of various industries including limited vehicle manufacturing
Federation of Nepalese Chambers of Commerce and Industry (FNCCI)	Umbrella organisation of the private sector
NESS	Conducts air quality monitoring and environmental studies
Non-government organisations	
Clean Air Network Nepal (CANN)	A network of professionals involved in air quality management. CANN is also the local network for Clean Air Initiatives for Asian Cities (CAI-Asia).
ENPHO	NGO involved in conducting monitoring, research and education campaigns on air quality, solid waste management, pollution control and other aspects of environmental management.
CEN	Involved in research-based education and advocacy campaigns
NEFEJ	Forum for Environmental Journalists
International organisations	
DANIDA (Danish aid)	Implemented ESPS from 2000 to 2005 which included components on air quality improvement, industrial pollution prevention, and control and institutional strengthening.
ICIMOD	Implementing transboundary air pollution projects on Malé Declaration and Project Atmospheric Brown Cloud
SDC (Swiss aid)	Implementing a project to promote clean brick kiln technology
UNEP	Support to Implement Projects on Malé Declaration and Project Atmospheric Brown Cloud
ADB	Implementing a project on Urban and Environmental Improvement in eight towns. Clean Air Initiative for Asian Cities (CAI-Asia), a joint ADB and World Bank programme provides some support for air quality management
Kathmandu Electric Vehicle Association (KEVA)	Promoting electric vehicles

Table 3.10: **Steps taken to improve Kathmandu's air quality**

Year	Action	Year	Action
Government		**Private sector**	
1991	Ban on import of new three-wheelers	Since 1996	Electric vehicle entrepreneurs have invested more than Rs. 450 million in building and operating more than 600 electric three wheelers.
1995	Introduction of in-use vehicle emission standards and emission testing of vehicles	2006	Hulas Motors has developed a proto type for an electric four-wheeler van
1996	Financial incentives for electric vehicles		
1997	Environment Protection Act and Regulations	**Municipalities**	Public awareness and infrastructural development
1999	Import of unleaded fuel		
1999	Removal of over 600 diesel three-wheelers from Kathmandu	**NGOs**	Air quality monitoring and research
1999	Ban on the import of new two-stroke three wheelers		Public awareness and advocacy campaigns
2000	Introduction of EURO I equivalent norms for new vehicles		Development of an electro-bus
2002	Establishment of six permanent monitoring stations in Kathmandu	**International organisations**	
2003	Introduction of National Ambient Air Quality Standards	2000-05	DANIDA assisted ESPS project set up air quality monitoring stations, promoted electric vehicles, and promoted cleaner vehicles in industries.
2004	Two-stroke three wheelers removed from Kathmandu	2002-06	Winrock International, together with other partners of KEVA, promoted electric vehicles through technical support and advocacy.
2004	Moving Chimney Bull Trench Brick Kilns banned from Kathmandu	Since 2003	SDC is promoting Vertical Shaft Brick Kilns.

being the public pressure of the community residing near the factory, environmental groups, and media. This is one example of civil society's involvement in cleaning the air.

However, in spite of the positive steps taken so far, the high level of pollution in the valley clearly indicates the need for more action. One of the problems has been that the actions have not been carried out in a well-planned and coordinated manner and the overall system for managing air quality is still weak. The government, together with all key stakeholders, should therefore develop a time-bound integrated action plan and take bold action to implement the plan. As the government has already banned the highly-polluting Moving Chimney Bull Trench Kiln technology that was predominantly used in the valley's brick industry, the focus of future air quality improvement programmes should be on controlling vehicle emissions.

International support for AQM

The recently concluded Environment Sector Improvement Programme (ESPS) implemented by MoEST and MoICS with support from Danish International Development Assistance (DANIDA) from 1999 to 2005 has been the main internationally-supported project on air quality improvement in Kathmandu Valley. The project included the following five components.

- Institute of Environmental Management
- Cleaner Production in Industry
- Wastewater Management in Hetauda Industrial District
- Institutional Strengthening of Environmental Authorities
- Air Quality Management in Kathmandu Valley

The component on Air Quality Management in Kathmandu Valley was implemented from 2001 to 2005. Some of the main achievements of the project were establishment of six air quality monitoring stations in Kathmandu Valley and a Vehicle Anti Pollution Programme (VAPP). The challenge now is to continue operating the monitoring stations and VAPP in a sustainable manner and use the results obtained from the monitoring stations for planning and implementing AQM programmes. DANIDA had plans to follow up the Environment Sector Programme Support (ESPS) project with a second phase but that was terminated following the political developments in February 2005. Now in the changed political scenario, although DANIDA has not yet decided to support air quality management once again, if there is strong interest from the government, the support may be forthcoming.

Box 3: Project ABC

The Indian Ocean Experiment (INDOEX) carried out in February 1999, in the islands of the Maldives, revealed that a 3km-thick toxic umbrella of Brown Cloud stretches over Afghanistan, Pakistan, Bangladesh, Bhutan, India, Maldives, Nepal, and Sri Lanka, which are among the most densely populated places in the world. The finding comes from observations gathered by more than 200 scientists supplemented by satellite readings and computer modeling.

The Brown Cloud (haze) puts millions of people at risk not only for various respiratory diseases but also for severe natural disasters as weather patterns are radically altered and become more extreme and unpredictable.

The long-range transport of the haze was an important finding. Cooperation across international boundaries is required to understand the environmental impacts of the haze and for effective mitigation measures.

In response to this, Project ABC was launched with a network of observatories in more than 10 countries. In Nepal, the observatory is in Kathmandu and is known as Nepal Climate Observatory. Radiation measurements are taken at ICIMOD headquarters, Khumaltar, and various aerosol parameters are measured at Godavari. This initiative jointly taken by the Ministry of Environment, Science and Technology (MoEST) and International Centre for Integrated Mountain Development (ICIMOD) with the support of UNEP and Scripps institute of Oceanography provides an excellent example of generating a scientific base to tackle haze and air pollution related problems in a landlocked country with a complex topography of mountains and valleys.

Compiled by B.B. Pradhan

The United Nations Environment Programme's Regional Resource Centre for Asia and the Pacific (UNEP RRC.AP) is supporting two important international projects related to air pollution: The Malé Declaration on Control and Prevention of Air Pollution and Its Likely Transboundary Effects for South Asia and Project Atmospheric Brown Cloud (ABC). The Malé Declaration, now in its third Phase, is looking at the impact due to air pollution on health, crops, and materials. Racks containing various materials of copper, zinc, limestone etc. are placed strategically to study corrosion rates due to air pollution in materials.

Kathmandu Electric Vehicle Alliance (KEVA) was implemented by Winrock International, Padco, City of San Francisco, and Electric Drive Association from 2002 to 2006 with support from the United States Agency for International Development (USAID). The project assisted in policy lobbying and improving technology as well as management of electric vehicles. The project also assisted Hulas Motors in developing a four-wheeler electric van. Although KEVA has been requesting USAID and other potential funding agencies for additional funds to continue the project, these are not yet confirmed.

Swiss Development Cooperation (SDC) is providing technical support to promote Vertical Shaft Brick Kilns (VSBK) because they are energy efficient and environmentally friendly. So far, three such kilns have been established in Kathmandu Valley and a few are being set up outside the valley. Although the project has been promoting VSBK for the past three years, only a few entrepreneurs have invested in the technology because it is more expensive than the Fixed Chimney Kilns which are more popular. The government should therefore support the promotion of VSBKs through tighter emission standards and incentives.

An institutional framework for air quality management

As air quality management is a multidisciplinary issue, it requires the involvement of many organisations from the central government to local government, the private sector, and NGOs. The roles and responsibilities of various organisations need to be clear and there needs to be proper coordination among these organisations. However, one of the main constraints to air quality management in Nepal has been the lack of a clear and effective institutional framework. The current institutional set-up for air quality management is presented in Figure 15. The framework shows that air

quality management responsibilities are mainly shared by three ministries – Ministry of Industry, Commerce & Supplies (MoICS); Ministry of Environment, Science, and Technology (MoEST), which is mainly responsible for environmental protection; and the Ministry of Labour and Transport (MoLT) which is mainly responsible for transport management. Besides these ministries and the various departments within these ministries, other institutions such as municipalities, which are under the Ministry of Local Development (MoLD), and the Traffic Police, under the Home Ministry, also have AQM-related functions. Figure 15 shows many boxes but few linkages between these boxes, clearly indicating the lack of coordinating mechanisms within this framework. The Environment Protection Council (EPC), under the chairmanship of the Prime Minister, is a high-level body that could help in coordinating, but the EPC has not met at all in the past eight years. Therefore coordination among key agencies is a challenge for managing Kathmandu's air quality.

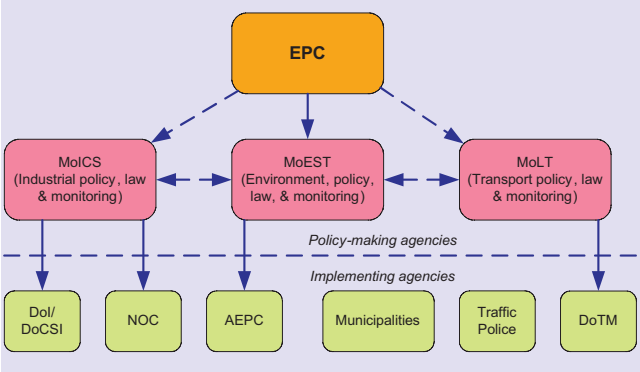


Figure 15: Institutional framework for air quality management in Kathmandu

Policy and legal framework for air quality management

Although Nepal does not have a separate policy on air quality management, some existing policies do address this issue. As these policies are either general policies of the government of Nepal (GoN) or specific policies related to environment, transportation, or industries, they touch upon air quality but do not address it in a comprehensive manner. Some of the key national policies related to air quality management are presented in Table 3.11.

Table 3.11 clearly indicates that several policy documents have touched upon air quality management and some, such as the National Transport Policy, 10th Plan, and the Sustainable Development Agenda, include specific policy statements aimed at ensuring that all citizens have access to clean air. However, there seems to be a clear gap in policy statements and implementation of policies. For example, all Five-Year Plans ever since the 6th Plan have mentioned that the trolley bus system will be expanded. But so far nothing has been done to expand the system; and it has in fact decreased in size. Although the 10th plan has also mentioned expansion of the trolley bus system, this is mentioned as a low priority activity. Similarly, several policy documents clearly mention the need to promote zero emission electric vehicles; but there are no specific plans or programmes to achieve this. Therefore, there is an urgent need to develop and implement plans and programmes to implement these policies.

Legislation

Unlike most other countries, Nepal does not have a separate Act dedicated to managing air quality. However, the Environmental Protection Act and Regulations (1997) have some provisions related to pollution control and the Act also has provisions for the formulation of separate regulations under the Act to deal with specific issues. Some of the key legislative measures are mentioned in Table 3.12.

Table 3.12 shows that legislation related to air quality spread over several Acts and Regulations. Considering the growing problem of air pollution, the complex nature of the problem, and the urgent need for effective action in areas such as Kathmandu Valley, amending some of these legislations and a comprehensive Clean Air Act are essential.

Plans and programmes to combat air pollution in Kathmandu Valley

Plans have been prepared to tackle Kathmandu's air pollution. The World Bank funded URBAIR programme prepared the first action plan for managing Kathmandu's air pollution (Shah and Nagpal 1997). In 2005 IUCN Nepal prepared comprehensive policy guidelines for air quality management (Tuladhar et al. 2005) and a Regional Technical Assistance Programme of ADB prepared a strategy and action plan for air quality management (Giri 2005). Recently, MoEST, through its own efforts, has prepared a draft action plan for air quality management in Kathmandu Valley. The plan aims to meet the National Ambient Air Quality Standards (NAAQS) within five years.

MoEST's latest plan is comprehensive, covering all the main issues such as vehicular emissions, industrial pollution, refuse burning, and land-use planning, and its target of meeting the NAAQS in five years is also reasonable. However, as the plan has a long list of activities covering various sectors, the activities need to be prioritised, and a serious effort made to implement them. Some of the activities mentioned in the plan are quite simple and can be carried out quickly with limited resources, while others require major decisions. The challenge now is to implement the plan in order to improve the air quality in the valley.

Table 3.11: **National policies related to air quality management**

Policy	Description
National Conservation Strategy, 1987	This was the first environment-related policy of the GoN. It mentions the problem of air pollution in urban and industrial areas and highlights the need for Environmental Impact Assessment of proposed projects.
Industrial Policy, 1992	The policy, which aims to promote industrial activities, also mentions the need to minimise adverse environmental effects during establishment, extension, and diversification of industries. The policy also calls for the formulation and implementation of guidelines to control pollution and tax benefits for investments in activities related to pollution control.
Nepal Environmental Policy and Action Plan (NEPAP), 1993	NEPAP recognises the need to address urban and industrial pollution and calls for appropriate legal and institutional mechanisms. It also stresses the need for EIA
National Transport Policy, 2001	The policy has the following provisions related to air quality. ▪ Construction, repair and maintenance of road infrastructure in the context of traffic safety and environmental worthiness ▪ Expand the use of electric vehicles throughout the country. ▪ Make public transport safe, reliable, pollution free and easily accessible to the general public. ▪ Limit the traffic density and movement of vehicles to acceptable levels as per land use and carrying capacity. ▪ Mandatory for vehicles to have appropriate Axle Load Systems (ALS) ▪ Mandatory for vehicles to have roadworthiness certificates ▪ Ban on import of older vehicles ▪ Develop standards for repair and maintenance and road permits. ▪ Tax and customs' rebates for pollution-free vehicles
10th Five Year Plan 2002-07	Strategies, policies, and programmes related to the environment ▪ The responsibility of checking vehicle emissions will be given to municipalities. ▪ Formulate and enforce environmental standards. ▪ Collect pollution fees and establish an Environmental Conservation Trust. ▪ Develop and implement a Sustainable Development Agenda for Nepal ▪ Pollution control and raising public awareness have been identified as priority programmes in the environmental sector. Strategies, policies, and programmes related to transport management ▪ Make transport systems reliable, safe, pollution free, and service-oriented. ▪ Reduce pollution from vehicles in Kathmandu and other urban centres ▪ Enforce Nepal Vehicle Emission Standards, 2056. ▪ Increase public awareness on vehicle emission. ▪ Promote railway and trolley buses through public-private partnerships.
Sustainable Development Agenda for Nepal, 2003	"Every citizen has access to …clean air" is one of the broad goals of Nepal's Sustainable Development Agenda. Section 5.2.5 of the Agenda mentions both indoor and outdoor air pollution. The 15-year objectives include the following. ▪ Setting strictly enforced ambient air quality standards, exceeding which requires immediate cuts in activities responsible for emission. ▪ Encourage shift towards zero-emission vehicles and cleaner fuel in industries. ▪ Create conditions that foster the growth of domestic institutions for research and monitoring local as well as transboundary air pollution. ▪ Promote cleaner stove technology and alternative cooking fuels.
Interim Constitution 2007	Recognises a clean environment as a fundamental right.

Table 3.12: **Legislation related to air quality management**

Legislation	Provisions
Industrial Enterprises Act, 1992	▪ In Section 15, manufacturing industries dealing with energy efficiency and conservation and pollution abatement have been declared 'nationally prioritised' industries and can receive tax rebates of up to 50% of the taxable income
Vehicle and Transport Management Act, 1993	▪ Section 17 makes road worthiness certificatess mandatory, for which vehicles have to comply with the standards prescribed in Section 23 that deal with the following parameters. • Mechanical condition of the vehicle • Emission from the vehicle • Vehicle length, width, height, construction, and appearance • Age of the vehicle ▪ Under Section 23, the government has set standards for emission from in-use vehicles. ▪ Sections 24 and 40 mention the right to refuse registration of a vehicle not complying to standards and certificate provisions. ▪ Section 39 requires prior permission to change specification or fuel types. ▪ Sections 74, 75, 78 and 93 deal with transport management and the public transport system
Environment Protection Rules, 1997	▪ Rule 15 prohibits emission of noise, heat, radioactive material, and waste from any mechanical means, industrial establishment, or any other place in contravention of the standards prescribed by the Ministry. ▪ Rule 16 make it manadatory for 55 different types of industry listed in Annex 7 of the Regulations to obtain Pollution Control Certificates. This has not yet been carried out because of some confusion about how it is to be done.
Environment Protection Act, 1996	▪ Section 7 deals with 'Prevention and Control of Pollution' and restricts people from causing pollution that will have adverse effects on environment and public health. ▪ Section 8 has a provision for the appointment of Environmental Inspectors to carry out inspection and examinations and stop activities that cause pollution. However, Inspectors have not yet been appointed. ▪ Section 15 has a provision to provide additional concessions and facilities to encourage any industry, enterprise, technology, or process that causes positive impacts on environmental protection. ▪ Section 21 allows the ministry to devolve any of its responsibilities to other government agencies. ▪ Section 23 empowers the GoN to frame and implement necessary guidelines under the Act for environmental protection. ▪ Section 24 empowers the GoN to frame necessary rules related to pollution control and standards.
Fiscal Act, 2003/04	▪ Incentives to electrical vehicles ▪ Nepal Vehicle Mass Emission Standard 2056 made compulsory for all imported vehicles. ▪ Ban on import of secondhand and reconditioned vehicles and two-stroke engine vehicles ▪ Pollution tax on diesel and petrol to be sold in Kathmandu Valley