Kathmandu's Air Quality

1. Introduction

Air Pollution

Clean air is vital for human survival. A normal human being breathes about 22,000 times every day and takes in approximately 25 kg of air to sustain its requirement of oxygen.

"Air pollution" refers to the accumulation of any substances in the air in sufficient concentration to effect man, animals, vegetation or other materials. Adverse impacts of air pollution depend on the nature, concentration, and duration of exposure. Main anthropogenic air pollutants of concern are Particulate Matter less than 10 micron (PM_{10}), Sulphur Dioxide (SO_2), Nitrogen Oxides (NOx), Carbon monoxide (CO), Lead (Pb), Ozone (O_3) and Hydrocarbons (HC).

Air pollution is a growing problem, particularly in rural areas where biomass is used for cooking and urban centres where fossil fuel is used for transportation and industries. The World Health Organization (WHO) estimates that air pollution causes approximately 3 million pre-mature deaths per year. Of this, about 800,000 deaths are due to out-door air pollution (150,000 in South Asian cities).

Kathmandu Valley

Kathmandu Valley, the economic and administrative center of Nepal, is about 20km north to south and 30km east to west and has an area of about 667 km^2. It is situated at an altitude of 1300m to 1350m.

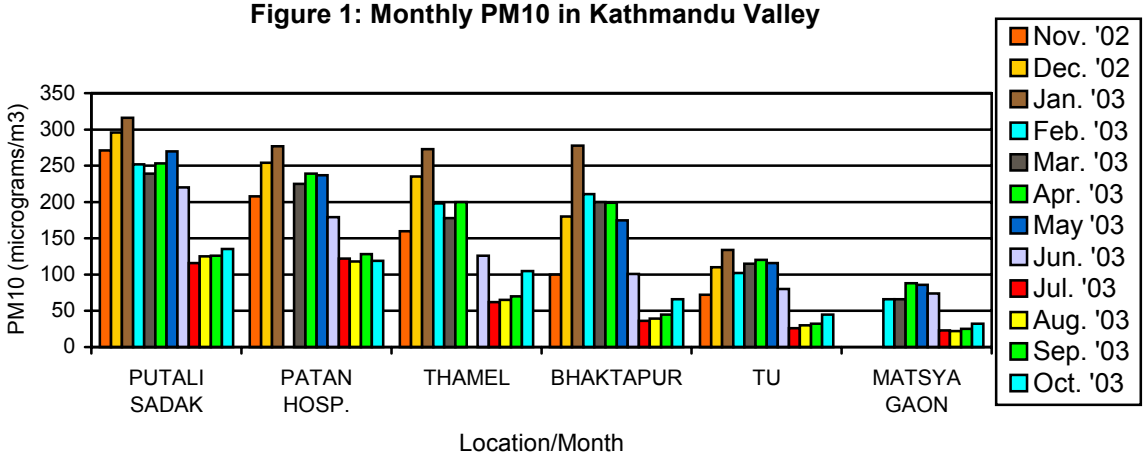
Kathmandu's population is growing at 4.83 percent per annum which is more than double the national rate of 2.27 percent. According to the 2001 census, 1,656,951 people reside in the three districts of Kathmandu valley; Kathmandu, Bhaktapur and Lalitpur.

The valley is especially vulnerable to air pollution due to rapid and haphazard urbanization, valley centric industrialization and significant increase of vehicular transport in narrow streets. Furthermore, the bowl like topography of the valley restricts wind movement and retains the pollutants in the atmosphere. This is especially bad during the winter season when inversion, where cold air flowing down from the mountains is trapped under a layer of warmer air, creates a lid, which keeps the pollutants, sealed within the valley.

2. Status of Ambient Air

The main problem in Kathmandu's air is the high concentration of fine particles. Other pollutants such as CO, SO_2, NO_x are within national and international standards but the PM_{10} is significantly higher than standards, particularly in urban areas during the winter. The average monthly PM_{10} concentrations at six locations in the Valley are shown in Figure 1.

Figure 1: Monthly PM10 in Kathmandu Valley



The following conclusions can be drawn from the air quality data recorded over the past year.

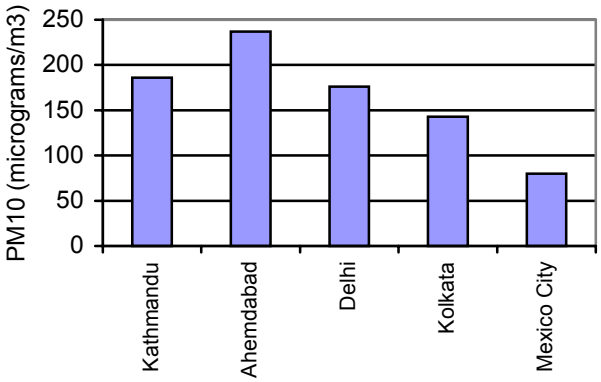
1. In the dry season, PM_{10} level along busy roads such as Putali Sadak and Patan Hospital exceeds National Ambient Air Quality Standards (NAAQS) on 99 % of the days.
2. In the dry season, PM_{10} level in the residential area of Thamel was above the NAAQS during 90 percent of the days. This indicates that Kathmandu residents can not escape the pollution even when they are in their homes.
3. Even in Matsyagaon, which is a village located 150 meters above the valley floor, with very few sources of pollution, the PM10 level occasionally exceeds the national standard.
4. The air is significantly better in Kirtipur (eastern part of the valley) compared to Bhaktapur (West Side of the valley). In the dry months, the air in Kirtipur can be classified as "Unhealthy" in 40 per cent of the days while in Bhaktapur the air was "Unhealthy" in 82 percent of the days. This is due to the westerly winds taking pollutants from Kathmandu over to Bhaktapur and the brick kilns around Bhaktapur.
5. There is a significant seasonal variation air quality. PM_{10} levels are highest in January, which is the peak of the dry winter season, and is lowest in July, which is the peak of the monsoon season. During the monsoon, rains flush down the particles in the air and significantly reduce the pollution level. In January 2003, the average PM10 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 Kathmandu do not operate during the monsoon
6. The seasonal variation in air pollution is especially high in Bhaktapur. In the two months between November 2002 and January 2003, the PM10 level in Bhaktapur rose by 178 percent while during the same period the PM_{10} level in Putali Sadak, Patan Hospital and Thamel went up by only 16 percent, 33 percent and 70 percent, respectively. Because of the brick kilns and the westerly winds from Kathmandu, the air in Bhaktapur gets very polluted in the winter season.
7. In Kathmandu it is clear the vehicles are the main sources of air pollution. This can be verified by the following three observations:

   (I) Areas with heavy traffic (Putali Sadak and Patan Hospital) are the most polluted.

   (ii) Pollution levels drop on weekends when fewer vehicles are on the road. Average PM10 level on the 5 weekends in May, 2003 in Putali Sadak was 219.4 $\mu g/m^3$. However, on weekdays it was 290.4 $\mu g/m^3$, which is 32 percent higher than the concentration on weekends.

   (iii) Pollution levels are very low during Nepal Bandh 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 percent from 332 to 231 $\mu g/m^3$ and then went up to 284 $\mu g/m^3$ again the next day.

The high level of PM10 in Kathmandu is comparable to some of the most polluted cities in the world.



Trends

Although there was very little data on Kathmandu's air quality till about a year ago, few studies that have been done indicate that the air quality is deteriorating rapidly. Comparison of data collected by ENPHO in 1992 to data generated by the recently established air quality monitoring stations, indicates that the PM_{10} level in Putali Sadak has tripled in the last 10 years.

3. Pollution Sources

Vehicles are the main source of air pollution in Kathmandu. A comparison of emission inventories done in 1993 by a World Bank Project and in 2001 by Ministry of Population and Environment shows that PM_{10} from vehicles increased by more than four times in eight years. Vehicle exhaust now accounts for 43 percent of the total PM_{10} load in Kathmandu.

Poor road infrastructure also adds to the problem. A study conducted by Department of Transport Management (DoTM), indicated that the number of vehicles in Kathmandu exceeded the valley's carrying capacity by about 30,000 in 1999/2000 fiscal year. Since then more than 75,000 vehicles have been added to the streets of Kathmandu, while the road infrastructure has remained more or less constant. The total road network within the valley is 1339 km.

Comparison of Emission Inventory in 1993 & 2001

SOURCES	TSP (TONS/YR)			PM10 (TONS/YR)		
	1993	2001	% increase	1993	2001	% increase
Mobile Sources						
Vehicle Exhaust	570	1971	245	570	3259	471
Road Resuspension	1530	7008	358	400	1822	356
Subtotal	2100	8979	328	970	5081	424
Stationary Sources						
Industrial	582			292		
Domestic	2328			1166		
Brick kilns	5180	6676	29	1295	1688	30
Himal Cement	6000	3612	-40	800	455	-43
Industrial boilers		28			15	
Refuse burning	385	687	78	190	339	78
Subtotal	14475	10904	-25	3472	2498	-28
TOTAL	16575	19884	20	4712	7580	61

To control the vehicle emission in Kathmandu valley, there is a provision for emission testing. However, this has not been very effective, as many drivers tamper with the air to fuel ratio to lower the emissions. Although about 25 percent of the vehicles fail the test, there is no system to punish these vehicles. Studies in other cities have shown that about 20 percent of the most polluting vehicles are responsible for about 50 percent of the pollution.

Pollution from vehicles is mainly because of the large number of vehicles on congested streets, poor quality vehicles, poor quality fuels and lubricants and weaknesses in the emission inspection & maintenance system.

In the past five years, the number of vehicles in Bagmati zone, most of which ply in Kathmandu Valley, has been increasing at an alarming rate of 17 percent per year. At this rate, the number of vehicles will double in about five years. This is causing serious problems of traffic congestion and air pollution.

Quality of fuel and lubricants being used in vehicles is another cause for poor vehicle exhaust. Use of diesel with high sulphur content increases emission of fine particles. Use of poor quality lubricants in wrong amounts also causes an increase in emission. A study by CEN indicated that about 98 percent of the two-stroke three-wheelers in Kathmandu are using various quantities of loose oil instead of the recommended quantity of 2T oil.

Brick kilns are another source of air pollution. There are about 125 brick kilns in the valley, out of which 90 percent are Bull's Trench kilns that are inefficient and cause pollution.

Vehicles Registered in Bagmati Zone

VEHICLE	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Bus	1163	1298	1403	1632	1744	1858	2061
Mini bus	1468	1500	1527	1610	1804	2172	2387
Truck/Tanker	4483	4759	4811	5295	5484	6274	6991
Car/Jeep/Van	27153	28915	30919	35993	40674	43409	46114
3-Wheeler	3844	3925	4262	4778	4949	5073	5073
2-wheeler	58029	64142	71612	94217	112000	134852	156410
Tractors	1672	1672	1672	1672	1673	1673	1677
Other	3020	3278	3311	3338	3350	3356	3385
Total	100831	109489	117836	148535	171678	198667	224068

Source: Department of Transport Management

Recent studies carried out by CEN in Tikathali VDC in Lalitpur and Jhaukhel VDC in Bhaktapur indicate the air pollution in brick kiln affected areas are three times higher than normal.

4. Impact of Air Pollution

Impact on Human Health

The main impact of Kathmandu's air pollution is on the health of its residents. Air pollution primarily causes problems in the respiratory system. Health impacts of Kathmandu's air pollution can be assessed by the increase in number of patients suffering from diseases related to air pollution and by using dose-response functions developed in other countries.

Health Impacts of Kathmandu's PM_{10} in 1990

Types of Health Impact	Cases
Excess Mortality	84
Chronic Bronchitis	506
Restricted Activity Days	475298
Emergency Room Visit	1945
Bronchitis in Children	4847
Asthma	18863
Respiratory Symptom Days	1512689
Respiratory Hospital Admissions	99

Source: World Bank, 1997

Records from Kathmandu's hospitals indicate that the number of patients with Chronic Obstructive Pulmonary Disease (COPD) has increased significantly over the past ten years. In Patan Hospital, the number of COPD patients has doubled in the past five years. The records also indicate that the number of COPD patients is highest in the winter season, when air pollution is also at its peak.

The estimated health impact as calculated by a World Bank funded study using dose-response functions is presented in the table below:
The study estimated the cost of this impact to be over Rs. 200 million per year.

Impact on Tourism

Findings of a survey conducted among 1,702 tourists between May and June 2001 indicate that air quality is the number one area where tourists feel improvement is needed.

Data obtained from the Kathmandu airport from 1970 onwards shows that the number of days with good visibility (>8000m), decreased in the winter months from more than 25 days/month in 1970 to 5 days/month in 1992 (World Bank, 1997). This is bound to affect tourism.

5. Response to Air Pollution

His Majesty's Government of Nepal (HMG)

HMG first responded to the growing problem of air pollution in Kathmandu in 1991, by stopping the import of three-wheelers into the valley.

In 1995, HMG introduced tail pipe emission standards of 65 HSU for diesel vehicles and 3 percent CO for petrol operated vehicles in Kathmandu, and started testing in-use vehicles. But in January 1998, HMG relaxed the vehicle emission standards to 4.5 percent CO for petrol four wheelers manufactured till 1980 and 75 HSU for diesel vehicles manufactured till 1994. In 1999, HMG started importing unleaded petrol.

In 1999, the government got rid of more than 600 highly polluting diesel three-wheelers from Kathmandu and provided incentives for importing new diesel and LPG vehicles as replacements.

In 2000, HMG/MoPE introduced the Nepal Vehicular Mass Emission-2056 for new vehicles, which is similar to the EURO - I Norm.

In the later part of 2000, the government announced a ban in all public vehicles older than 20 years and all two-stroke three wheelers in Kathmandu valley effective from 16 November 2001. This decision however has not been implemented. Now, the government has announced that the two-stroke three wheelers will be removed by mid-July, 2004.

HMG has also provided some incentives for electric vehicles such as exemption of customs on chasis and batteries.

To control industrial pollution, HMG has decided to ban polluting Bull's Trench Kilns from Kathmandu valley.

Recently, the government has announced national ambient air quality standards.

Although the steps taken by HMG are to be appreciated, the rising levels of pollutants in Kathmandu's air clearly indicates that a lot more needs to be done.

Private Sector Initiation

The best example of private sector participation in controlling Kathmandu's air pollution is the

investment in approximately 600 electric three-wheelers, locally called 'SAFA Tempos', running in Kathmandu valley as a public transportation. The private sector has also shown interest in operating the trolley bus system.

Municipalities

Among the five municipalities in the Valley, Kathmandu Metropolitan City (KMC) has taken a few steps to manage air pollution. KMC has an Environment Department and it is involved in public education through community groups, schools and weekly radio programmes. KMC is also involved in building infrastructure such as roads and overhead bridges.

Non Government Organizations (NGOs)

A few NGOs are involved in research, advocacy, and raising public awareness to improve air quality. Environment and Public Health Organization (ENPHO) and Society for Legal and Environmental Analysis and Development Research (LEADERS) Nepal are involved in air quality monitoring and research. Similarly, Pro-Public, Clean Energy Nepal (CEN), and Martin Chautari are involved in public awareness and advocacy. Himalayan Light Foundation (HLF) has developed a four wheeler electric vehicle. Recently, 12 organizations working in the field of environment have formed a group, Coalition for Clean Environment (CCE), to work in a coordinated manner.

International Organizations

The Danish government, through its Environment Sector Program Support (ESPS), is supporting MOPE in air quality monitoring, promotion of electric vehicles, strengthening institutions and introducing cleaner production in industries. Similarly, Renewable Energy Programme Support Office (REPSO Nepal) of Winrock International is assisting in promotion of electric vehicles.

6. Conclusions

The high concentration of respirable particles in Kathmandu's air calls for urgent action from all sectors, particularly the government. Now that Himal Cement Factory has been closed and the government has decided to ban the polluting Bulls Trench brick kilns, the focus should be on controlling vehicle emission.

Ten Steps for Better Air Quality:

1. Improve public transportation system.
2. Improve road network and other transportation infrastructure
3. Expand the trolley bus system
4. Promote environment friendly transportation such as electric vehicles, bicycles & walking
5. Ban the use of polluting vehicles
6. Ensure the use of clean fuel
7. Effective planning to reduce transport demand
8. Introduce economic tools (tax and subsidies) to promote clean technologies
9. Improve the vehicle emission inspection and maintenance system
10. Raise awareness on proper vehicle maintenance

Overall, the government needs to make a serious commitment to improve Kathmandu's air by drawing up a comprehensive action plan with the involvement of all stakeholders and then take bold steps to implement the action plan.

Clean Energy Nepal (CEN) is a non-profit organization involved in research based education and advocacy campaigns. Fact Sheets are produced by CEN for informing the public, as well as decision-makers on the current state of affairs and the required actions. This Fact Sheet was prepared by Bhushan Tuladhar in November 2003. For more information please contact us at:

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