

Air Quality Management in Kathmandu

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ABSTRACT

This paper outlines the status of air quality of Kathmandu and efforts being carried out for air quality management. In the past few years, Kathmandu has gone through rapid and haphazard urbanisation and experienced a huge increase in the number of vehicles as well as industries, which has resulted in environmental deterioration. Kathmandu's ambient air quality usually crosses international guidelines by 2/3 folds. Air pollution inventories have shown that the main polluting factor is the vehicle emission caused by large number of vehicles, limited road infrastructure, poor quality of fuel and inefficient transport management system.

Formulation of emission standards, ban on import of two-stroke engines and promotion of electric vehicles are some of the efforts towards better management of Kathmandu's air quality. Kathmandu Metropolitan City (KMC) is playing important roles in activities such as monitoring of air quality of Kathmandu, raising public awareness campaigns etc. Private sectors and NGOs are taking keen interest and their roles are found to be quite encouraging. Unfortunately, the rate of increase of air pollution in Kathmandu and its impact on public health and the city's public life is so high that whatever efforts are made so far, the look like a drop in the ocean. So, a lot more needs to be done in this sector.

Keywords: PM₁₀, Vehicles, Electric Vehicles, Kathmandu, Air quality.

1.0 INTRODUCTION

Kathmandu being the capital city of Nepal has observed rapid urban growth and population inflow for last few years. The city is situated in mid-hill region of Nepal within the Kathmandu valley along with 4 other smaller municipalities and about a hundred Village Development Committees (VDCs). As Kathmandu City is a part of Kathmandu valley, every aspect of air pollution in the city is linked with the Kathmandu valley as a whole.

Kathmandu valley, which provides the physical setting for Kathmandu Metropolitan City (KMC), is situated between the latitudes 27 32' 13" and 27 49' 10" north and longitudes 85 11' 31" and 85 31' 38" east. It covers an area of about 667 sq. km and its mean elevation is about 1350m, above sea level [5]. Population growth in Kathmandu has been critical because of centralisation and migration of the rural people to the capital for different opportunities. Overall country's population growth is 2.27 percent where as in Kathmandu population growth during the same span has been recorded as 4.83 percent. The total area of KMC is about 50.6 sq.km, comprises 35 wards. According to 2001 census, a total population of KMC only is about 701,962.

The valley is especially vulnerable to air pollution due to an exploding population inflow, rapid urbanisation, valley centric industrialisation 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 thermal inversion. Cold air flowing down from the mountains is trapped under a layer of warmer air and acts as a lid. As a result, the pollutants are kept sealed within the valley.

2.0 AIR QUALITY OF KATHMANDU

Status of Ambient Air

The main problem in Kathmandu's air is the high concentration of particulate matter. According to a study conducted by Nepal Environmental and Scientific Services (NESS) in 1999/2000, 24 hour average PM₁₀ (Particulate Matter of size less than 10 micron) value ranges between 49 and 495 µg/m³ and average values were 225, 135 & 126 µg/m³ in core, sub-core and remote part of the valley respectively. Similarly, TSP (Total Suspended Particulate) value has been found between the ranges of 61 and 572 µg/m³ with average value of 379, 214 and 137 µg/m³ in core, sub-core and remote part of the valley respectively. Other air pollutants monitored like SO₂, NO_x, and CO are well below the international guideline value. 24-hour average lead (Pb) values have been found to be within the range of 0.005 to 4.25 µg/m³ [8]. There is also a significant seasonal variation in the concentration of air pollutants. Dry winter periods are the most vulnerable to air pollution while during the rainy season air pollutants are well below the average annual value as the rain flushes pollutants from the air. A recent study conducted by Environment Sector Programme Support (ESPS)/Ministry of Population and Environment (MoPE) during January and February 2002 at the 7 locations in Kathmandu indicated that benzene has also becoming a major air pollutant. Weekly averages of ambient level benzene concentrations using the passive diffusive method were found as high as 77 µg/m³ in *Putalisadak*, a high traffic area [3].

Sources of Air Pollution

Air Pollution Inventory

According to a new inventory conducted by ESPS in 2001, total annual PM₁₀ and total suspended particles (TSP) load in Kathmandu valley is 7580.5 and 19,884.2 tons respectively. This is significantly higher than a previous inventory done by World Bank in 1997, when the total annual load was estimated to be 4,712 and 16,575 tons for PM₁₀ and TSP respectively. These figures indicate that over the past five years or so, there has been a 60 percent increase in the PM₁₀. The main cause of this increase is the remarkable increase in the number of vehicles. A comparison of the two inventories indicates that PM₁₀ from vehicle exhaust has increased from 570 tons to 3,259.6 tons and TSP from vehicles has increased from 1530 tons to 7,008.01 tons respectively. Overall, in the 1997 inventory, vehicles were responsible for about 20 percent of the PM₁₀ but the latest inventory indicates that vehicle emission contributes 67 percent of the PM₁₀ in Kathmandu valley [3].

Vehicle Emission

Vehicle emission is a major source of air pollution in Kathmandu. This is mainly because of the large number of vehicles on congested streets, poor quality vehicles, poor quality fuels and weaknesses in the emission inspection system. Till fiscal year 2001/02, Kathmandu valley had 198,667 registered vehicles and this number is increasing at about 16 percent per year. A study conducted by Department of Transport Management (DoTM), indicated that the number of vehicles in Kathmandu had already exceeded the valley's carrying capacity by about 30,000 in 1999/2000 fiscal year. As more than 50,000 vehicles have been added since then, while the road infrastructure has remained more or less the same, the number of vehicles on Kathmandu's streets is becoming a serious problem. For these 198,667 and other vehicles registered outside Kathmandu valley but being operated within the valley, there exists a total road network of only 1339 km. This is causing serious problems of traffic congestion and air pollution.

Table 1 shows the total number of vehicles registered in Bagmati zone (mainly plying within Kathmandu valley) over the last six years. This table indicates that there is a very small increase in the number of buses and 3-wheelers which are the main public transport vehicles, but phenomenal increases in the number of car/jeep/van and two-wheelers, almost all of which are private vehicles.

Table 1. Total number of vehicles registered in Bagmati Zone over last six years

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

Source: Department of Transport and Management (2002)

Clearly, the dramatic rise in the number of private vehicles is a cause of concern, as public vehicles tend to emit less pollution per passenger [9]. Within the private vehicle category, the most significant increase is in the

number of two-wheelers. The number of three-wheelers has not increased significantly as there has been a ban on new three-wheelers, except electric and LPG operated ones, for the past 10 years [12].

Industrial Emission

Industries situated within the valley, using poorly maintained and old technology, are also responsible for air pollution. Most polluting industries are situated at the south and southwest parts of the valley. Unfortunately, southwest wind in the valley helps to blow air pollutants from remotely situated industries to the urban area [9]. Emission load from the industrial sector in the Kathmandu valley in 1993 was estimated to be 3574 tons of TSP, 5220 tons of CO, 1492 tons of Hydrocarbon, 628 tons of Nitrogen Oxides (NO_x) and 1349 tons of Sulphur Dioxide (SO₂) per year [11].

Now that the Himal Cement factory (previously number one polluting industry) is closed, the brick kilns are the main polluting industry in the Valley. There are about 125 brick kilns operating in Kathmandu valley out of which 113 are bull's trench type, 9 are clap kiln type and 3 Hoffmann kilns [2]. As the brick manufacturing process in Bull's Trench and Clamp Kiln is very poor and inefficient, the amount of smoke spewing from these kilns is very high. Due to its polluting nature, this technology has even been banned in India, the place of its origin. A study carried out by Clean Energy Nepal 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. In *Tikathali* the concentration of PM₁₀ during the brick-making season was found to be 602.16 µg/m³ while in the off-season it was only 217.95 µg/m³. Similarly, in *Jhaukhel*, PM₁₀ concentration in an area with brick kilns was found to be 568.78 µg/m³ while it was only 158.33 µg/m³ at *Sipadol* area, a valley background [13].

Impact of Air Pollution

Impact on Human Health

The health impact of air pollution in the Kathmandu valley can be assessed by the increase in number of patients suffering from diseases related to air pollution. Medical records from hospitals in the Kathmandu valley revealed that urban residents have more respiratory diseases than rural resident [6]. According to a study done by the World Bank, valuation of health impacts due to the PM₁₀ in Kathmandu's air was over NRs 200 million in 1990. It was also estimated that among the sources of air pollution, traffic sources (exhaust emissions and resuspension) might have the largest impact on health [15].

Impact on Tourism

There does not exist any dose response relationship with the tourism and air pollution concentration, but it has been estimated that NRs. 0.5 billion in tourism revenue has been lost due to air pollution in Kathmandu valley [15]. Findings of the Departing Visitors Survey conducted among 1,702 tourists between May and June 2001 by MARG Nepal indicate that the quality of air is the number one area where tourists feel improvement is needed. This shows that Kathmandu's poor transportation system and pollution is not only affecting human health and environmental quality, but also the tourism industry [1].

Impact on Visibility

The atmospheric data obtained from the Kathmandu airport from 1970 onwards shows that there has been a very substantial decrease in visibility in the valley since 1980. The number of days with good visibility (>8000m) around noon, decreased in the winter months from more than 25 days/month in 1970 to 5 days/month in 1992. The trend towards reduced visibility in the valley is quite dramatic for the months November-March, and particularly for December-February. While in the early 70's, visibility greater than 8,000 meters prevailed (at 11:45 AM) for 25-30 days per month, there has been a steep downwards trend since about 1980. Today, the number of days per month in December-February with good visibility at noon approaches zero [10].

3.0 AIR QUALITY MANAGEMENT

Due to the fact that the air pollution has become a major environmental issue in Kathmandu, there have been some efforts for the air quality management. Different organisations including government has been involved in these efforts.

His Majesty's Government of Nepal (HMG)

To curb air pollution problems in the Kathmandu valley, HMG has introduced several policies. HMG first responded to the growing problem of air pollution in Kathmandu in November 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. HMG, then realising the need for an independent body to look after the environmental issues including air pollution, established the Ministry of Population and Environment (MOPE) in 1995. Furthermore, on 26 December 1999, HMG made a public announcement regarding the distribution of unleaded petrol.

In Dec.1999, MOPE introduced the Nepal Vehicular Mass Emission-2056 BS for new vehicles, which is similar to the European Emission - I (EURO - I) Norm [4]. Realising the effect of older vehicles in air pollution level in Kathmandu, MOPE in the later part of 2000 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 so far. The government has, however, banned the import of new two-stroke vehicles since 1999 [12].

MOPE has initiated a program of testing in-use vehicle emissions (Table 2 provides detail of the standard). Almost all vehicles, except two-wheelers plying in the valley have undergone the testing process. Vehicular movement is prohibited in selected areas to those vehicles, which do not comply with the standards. Since 1996, when the program began, a total of 175,792 stickers had been issued up until the 1999/2000 fiscal year.

Table 2. Emission Standard for In-use Vehicles in Nepal

For Gasoline Vehicles	Permissible Smoke Unit (CO in %)
Up to 1980 manufactured four wheeler Vehicle	4.5
1981 and later manufactured vehicle	3.0
Up to 1991 manufactured three wheeler Vehicle	4.5
For two wheeler Vehicle	4.5
For Diesel Vehicles	Hatridge Smoke Unit (HSU)
Up to 1994 manufactured all types of Vehicles	75
1995 and after manufactured vehicles	65

Source: MOPE, 1998

Table 3 indicates the compliance result together with total vehicles (which may include repetition) to have undergone testing in Kathmandu valley. The table further reveals that only 75.96% of the total tests indicate the compliance with the emission standard of CO and HSU [14]. The standard compliance with other toxic chemicals such as HC, NO_x etc. are yet to be determined.

Table 3. Vehicle Emission Test Result (CO Test for Petrol Engines and HSU for Diesel Engines)

Year	Total Vehicle Tested	Pass	Fail
1995/96	486	162	324
1996/97	41466	25220	16246
1997/98	31173	22984	8189
1998/99	28018	24240	3778
1999/2000	42826	34255	8571
2000/2001	31823	26669	5154
Total:	175792	133530	42262

Source: Kathmandu Valley traffic Police, 2001

Recently, HMG has announced to ban polluting Bull's Trench Kilns from Kathmandu valley after one and half year and it has already announced to stop the registration of these kilns. Also, government has decided to shift the Himal Cement Factory outside the valley and currently this industry is not functioning [13].

Similarly, MOPE is currently working on formulation of the Ambient Air Quality Guideline for Nepal. The process for the guideline preparation is at final stage.

Kathmandu Metropolitan City

Kathmandu Metropolitan City (KMC) has put forward many efforts for the air quality management of the city and as a whole controlling the valley's air pollution. Realising the need to address Kathmandu's pollution problems, in 1998, KMC established an Environment Department and an Urban Environment Section within the Department to initiate activities to reduce air and water pollution. The Urban Environment Section got together with various NGOs involved in air quality improvement and formed a Citizens Monitoring Group to co-ordinate activities, interact with one another and monitor Kathmandu's environment quality. In 1999, when citizen groups raised their voices against polluting diesel three-wheelers, KMC supported the campaign. Previously, KMC had also taken the initiative to introduce electric vehicles in Kathmandu.

KMC is also working with close co-ordination with MOPE in identification the locations of monitoring stations, formulate policies on clean air and implement them. Similarly, KMC is also involved in the construction of overhead crossing bridge, subway, traffic intersections and road widening. This infrastructure improvement in the road and transport sector will help to improve traffic flow and reduce the air pollution from vehicles.

Currently, KMC is preparing a separate 1.3 km bicycle lane inline with its aim to prepare a large bicycle lane network in the city to promote this environment friendly technology. KMC has also been involved with the awareness generation work on environment through the FM Radio and Television. KMC has its own FM station and TV programme for the general public to create awareness on urban environment and other issues of concern.

Establishment of air quality monitoring stations in different locations of the city has already been completed and the stations are soon to start with the continuous air quality data. KMC has signed MOU with ESPS/MOPE to work in close co-operation in the establishment and operation of two permanent air quality monitoring stations situated in Kathmandu. The data generated will be helpful to understand the air pollution problem more concisely and formulate policies accordingly. KMC has already provided necessary space in installing the monitoring equipments/ systems for these stations. KMC will provide alternative locations if required in future for the betterment of the monitoring stations and also the most appropriate location for placing the electronic boarding board for dissemination the results from these stations.

KMC's Clean Air Strategy

To achieve the goal of reducing air pollution in the city with its vision for a city where citizens can breath clean fresh air, KMC has been working on following areas:

- regularly monitoring the ambient air quality in various areas of the city,
- building linkages between various organisations and people involved in air pollution control,
- advocate on the behalf of the citizens to ensure the relevant authorities to take part in providing clean air for Kathmandu's residents,
- promote conservation and management of open spaces and greenery in the city,
- encourage the use of environment friendly transportation like electric vehicles and use of mass transportation and
- awareness among citizens on issues related to air quality and pollution control with the long term goal of changing people's behaviour

Private Sector Initiation

Some private companies are also involved in controlling Kathmandu's air pollution. The best example may be the approximately 600 electric three wheelers, locally called 'Safa Tempos', running in the Kathmandu valley as a public transportation [7]. There are potential of lots more such electric vehicles in Kathmandu with the trolley bus expansion as mass transportation. Electric vehicles are very good means for reducing air pollution as they virtually emit zero pollutants and uses the clean hydropower abundant in the country. Stakeholders of the electric vehicle industry have recently formed an umbrella organisation of all entrepreneurs called Electric Vehicle Association of Nepal (EVAN). EVAN is involved in advocacy, research and public education to promote electric vehicles. Similarly using these green vehicles in tourism has recently been initiated. Some private companies are also involved in managing urban greenery and building bus stops to manage public transportation.

National/ International Organisations

There are several non-governmental organisations involved in research, advocacy, public awareness, and pilot project demonstration work related to air pollution control. Environment and Public Health Organisation (ENPHO), Society for Legal and Environmental Analysis and Development Research (LEADERS) Nepal has been involved in air quality monitoring and research. Similarly, Forum for Protection of Public Interest (Pro-Public), Clean Energy Nepal (CEN), and Martin Chautari are being involved in public awareness and advocacy related to air pollution and its mitigation measures. Organisations like Himalayan Light Foundation (HLF) are being involved in demonstration and pilot projects. HLF has recently developed a four wheeler electric vehicle. Last year, 12 organisations working in the field of environment, has formed a informal group, Coalition for Clean Environment (CCE), to work in a co-ordinated manner. CCE has been involved in the public education, advocacy campaigns and research work related to Kathmandu's environment.

A DANIDA supported project ESPS/MOPE is working in air pollution monitoring, research and information dissemination work. It has already completed the work to establish 6 Ambient Air Quality Monitoring stations in Kathmandu valley to gather air pollution data and then plan for its management and improvement. ESPS is also working for the promotion of electric vehicles in Kathmandu valley. ESPS/MOPE is also working for technical and financial assistance to Valley Municipalities for developing and launching various awareness programs and also organising training programs for Municipalities staffs on the assessment of monitoring results and other relevant subjects in the field of air quality management. Vehicle Anti-Pollution Programme (VAPP) of ESPS is working on awareness campaigns on engine maintenance and had established a vehicle engine emission and maintenance training centre. Similarly, Renewable Energy Programme Support Office (REPSO/Nepal) of Winrock International is assisting in promotion and development of alternative fuel vehicles. Recently Kathmandu Electric Vehicle Alliance (KEVA) has been formed with Winrock International as one of the partners, to further promote the use of electric vehicles in Kathmandu.

4.0 CONCLUSIONS

Due to unmanaged urban development, infrastructure, a growing number of vehicles, polluting industries and population growth, Kathmandu's air is getting dirtier day by day. The concentration of particulate matter in the ambient air is already several times higher than WHO guidelines and this is increasing. This growing air pollution is having an adverse impact on human health and the economy of the Valley. Kathmandu is highly susceptible to air pollution due to the bowl effect and the problem is more severe in winter due to thermal inversion. Kathmandu should be treated in a different way keeping the view of its susceptibility to air pollution and human health damage, and more efforts are required to control Kathmandu's air pollution.

There have been different policies regarding the control of Kathmandu's air pollution but its ineffectiveness on enforcement has caused to further increase the problem. KMC along with other government as well as non-government organisations are working in different aspects of air pollution control, but clearly there is a long way to go. In the days ahead more work needs to be done in the following areas:

- Control the number of vehicles in Kathmandu
- Promote the use of electric vehicles
- Ensure that the fuel is clean and unadulterated
- Improve the road condition in Kathmandu
- Improve the efficiency of the public transportation system
- Improve the vehicle inspection and maintenance system
- Facilitate the use of non-motorised vehicles

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