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DEPARTMENT OF ENVIRONMENT (DoEnv)
SahidSukra Marg, Kupondole, Lalitpur
Nepal

Air Quality Management Action Plan for Kathmandu Valley

Submitted by

Quest Forum Pvt. Ltd.
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Acknowledgement

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Quest Forum

2017

The Study Team

The following Experts and Staffs were involved in this study:

1. Mr. Chiranjibi Gautam, Team Leader,
2. Dr. Rashila Deshar, Environmental Expert
3. Mr. Dinesh P. Sah, Monitoring Expert
4. Mr. Pankaj Kumar Shah, Electrical Engineer
5. Mr. MukeshGoswami, Mechanical Engineer
6. Mr. Prakash Dhakal, Monitoring Assistant

Abbreviations

APP	:	Agriculture Perspective Plan
BC	:	Black Carbon
BTK	:	Bull's Trench Kilns
CBS	:	Center of Bureau Of Statistics
CEQ	:	Council On Environmental Quality
CO	:	Carbon Monoxide
CO_2	:	Carbon Dioxide
CP	:	Cleaner Production
DCSI	:	Department of Cottage and Small Industries
DG	:	Diesel Generator
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
EPA	:	Environment Protection Act
EPI	:	Environment Performance Index
EPR	:	Environment Protection Regulation
ESPS	:	Environment Sector Program Support
FBTK	:	Fixed Chimney Bull's Trench Kilns
FSMP	:	Forestry Sector Master Plan
GCV	:	Gross Calorific Value
IEE	:	Initial Environmental Examination
LPM	:	Liter Per Minute
m/s	:	Meter per Second
m^3	:	Cubic Meter
mg	:	Miligram
mg/Nm^3	:	Milligram per Normal Meter Cube
MOPE	:	Ministry of Population and Environment
NCS	:	National Conservation Strategy For Nepal
NEIA	:	National Environmental Impact Assessment
NEP	:	National Environmental Policy
NEPA	:	National Environmental Policy Act
NEPAP	:	Nepal Environmental Policy And Action Plan
NOx	:	Oxides Of Nitrogen
^oC	:	Degree Celcius
PM	:	Particulate Matters
PM10	:	Particulate Matter less than 10 micron
PM2.5	:	Particulate Matter less than 2.5 micron
SDC	:	Swiss Agency For Development And Cooperation
SO_2	:	Sulphur Dioxide
SOx	:	Oxides of Sulphur
SPM	:	Suspended Particulate Matters
VSBK	:	Vertical Shaft Brick Kiln

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Chapter One

1. Introduction of Kathmandu Valley

1.1 Location and Land Use of Kathmandu Valley

Kathmandu Valley comprises three districts- Kathmandu, Lalitpur and Bhaktapur with 395 Km^2, 385 Km^2 and 119 Km^2, respectively and making the valley agglomeration with the total area of 899 square kilometers. It is located between $27^o37'30"$ N and $27^o45'0"$ N latitude, and $85^o15'0"$ E and $85^o22'30"$ E longitude and lies between the Himalayas in the north and the Mahabharat range in the south. It is about 1400 m above m.s.l with bowl –like structure surrounded by Phulchowki Hill (3132m) in South West, Shivapuri (2713m) in North, Champa Devi (2400m) in South West and Nagarjun (2100m) in the West. The river Bagmati, and its tributaries- Vishnumati, Manohara, HanumanteKhola, Dhobi Khola and NakhuKhola drain the valley in a centripetal pattern converging on the center and existing via the narrow Bagmati George near Chobbar in the Southern part of the valley.

Land use change in Kathmandu Valley

Unplanned rapid urbanization is a major issue on the development of the Kathmandu Valley (Figure 1). Figure 1 shows the five land use maps for the years 1967, 1978, 1991, 2000 and 2010 as studied by Thapa (2012). All together twelve land use classes are mapped for each year. Looking at the spatial patterns, the built-up area and the agricultural area have noticeable expansion from 1967 to 2010. The agricultural area has stretched far away since the 1960s while built-up area has swallowed the primary agricultural areas steadily. The agricultural landscape is still occupying almost half of the valley landscape with small changing variation in different decades. However, the forest cover around the valley still makes a significant portion of the total area of the valley. The built-up area has expanded rapidly and consistently, mostly in valley floor, increasing from 3% to 21% of the total landscape. A significant decreasing trend is observed in shrubs land. However, the natural forest landscape had low decreasing trend in the later decades. The water areas covering less than 2% areas remained somewhat unchanged. The open space occupies a least share (<0.3%) of the landscape in the valley in all period (Figure 1.2 and Table 1.1).

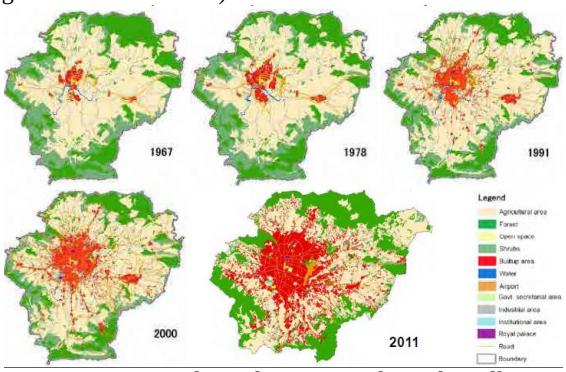
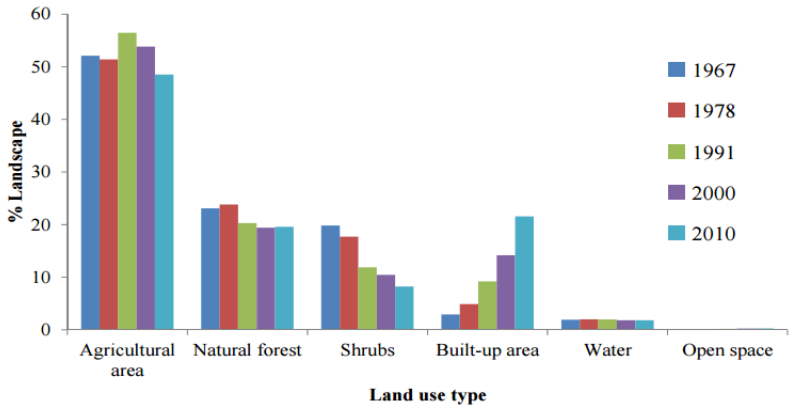


Figure 1.1: Land use change in Kathmandu Valley

Source: Thapa, 2008



Source: Thapa, 2008

Figure1.2: Quantification of land use patterns (1967-2010)

Table 1.1: Land use statistics

Land use Type	**1967 (%)**	**1978 (%)**	**1991 (%)**	**2000 (%)**	**2010 (%)**
Urban/Built up*	2.94	4.91	9.22	14.19	23
Open space	0.15	0.14	0.20	0.25	0.2
Water	1.95	2.02	1.96	1.85	0.9
Agriculture	52.07	51.40	56.46	53.83	47
Shrubs	19.81	17.71	11.87	10.44	9
Forest	23.08	23.83	20.29	19.43	20

Source: Thapa, 2012

*Includes built up areas, industrial areas, roads, airport, institutional areas, government secretariat area, and royal palace

1.2 Kathmandu Valley Population and Projection

As mentioned above, Kathmandu Valley comprises three districts namely Kathmandu, Lalitpur and Bhaktapur with two metropolitan cities out of six such cities of Nepal and sixteen municipalities. Population in Kathmandu Valley is increasing rapidly. Total population of valley of 766345 in 1981 increased to 1105379 in 1991 with around 44% growth in the decade. The trend of high growth continued in the following decades with 49% from 1991 to 2001 and with 51% from 2001 to 2011and that led the population in the valley to 1656951 in 2001 and 2510788 in 2011. With 51% growth from 2001 to 2011, the total population of Kathmandu Valley is expected to reach 5744964 by 2031. The population growth and projection for Kathmandu valley is shown in Figure 1.3.

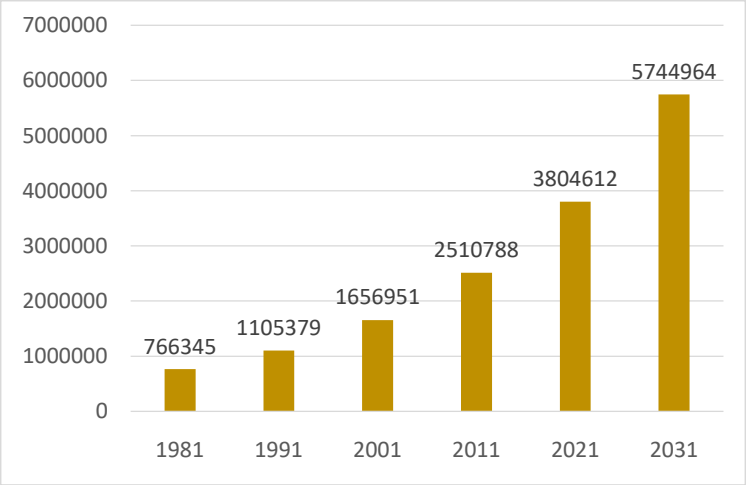


Figure 1.3: Population growth projection in Kathmandu Valley

Population of Kathmandu Valley is 2.5 million with annual population growth rate of 4.2% and population density 2799.8/Km^2 (CBS, 2011). The high population growth can be seen outside the Ring Road, especially in the north and east. Four VDCs showed more than 12% annual growth rate in the last decade (Figure 1.4). On the other hand three quarter of population density inside the Ring Road have over 200 person/ha in 2011. Similarly, old town area has over 1,000 person/ha density and outside the Ring Road reached 80 person/ha (Figure 1.4).

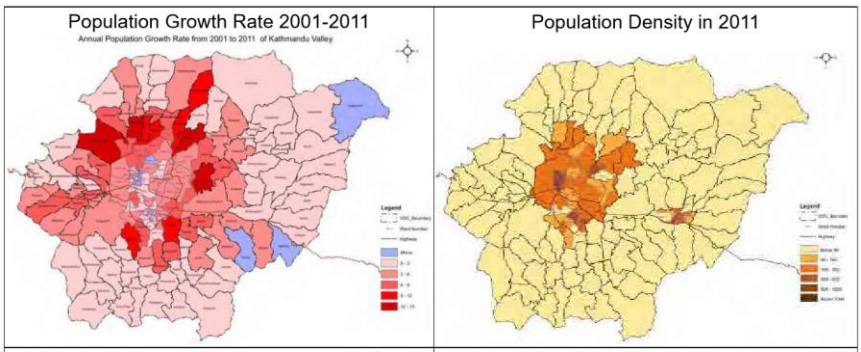


Figure 1.4 Population Growth Rate and Population Density in Kathmandu Valley

1.3 Cultural and Religious Importance of Kathmandu Valley

Kathmandu valley is known to the whole world for its rich cultural heritage illustrated by seven groups of monuments and buildings which displays the full range of historic and artistic achievements. Out of the ten UNESCO world heritage sites in Nepal, Kathmandu Valley hosts seven of them, namely Kathmandu Durbar Square, Patan Durbar Square,

Bhaktapur Durbar Square, Swayambhu, Bauddhanath, Pashupatinath and Changu Narayan. As Buddhism and Hinduism developed and changed over the centuries throughout Asia, both religions prospered in Nepal and produced a powerful artistic and architectural fusion beginning at least from the 5th century AD, but truly coming into its own in the three-hundred-year period between 1500 and 1800 AD. These monuments were defined by the outstanding cultural traditions of the Newars, manifested in their unique urban settlements, buildings and structures with intricate ornamentation displaying outstanding craftsmanship in brick, stone, timber and bronze that are some of the most highly developed in the world.

1.4 Socio-Economic Importance of Kathmandu Valley

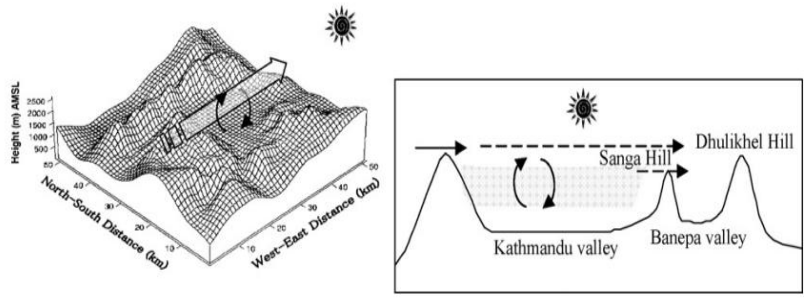
Nepal known to the world for its natural beauty and cultural heritage has been recommended by Rough Guides, the British Publication as the number one destination to visit in 2016. Tourism is the largest industry in Nepal and the one of the main source of foreign exchange and revenue. Kathmandu is the capital city of Nepal, and the only international airport of the nation being in the middle of the Valley, it is the first destinations for the hundreds of thousands of tourists visiting Nepal. Kathmandu valley in itself with its natural beauty, cultural diversity, archeological and heritage sites, and religious importance is amongst the most favorite place in the world where many people dream to visit. On the other hand, being the capital city and proximity to international market, is the center for administrative and commercial activities. Almost half of the industrial units are located in Kathmandu valley, nearly 500 tourists' standard hotels with over 4000 beds are in the valley, and approximately 65% vehicles registered in Nepal are plying in the streets of the valley. Degradation to the environmental qualities in the valley will not only have the direct impact on the health of people living here but also will seriously hamper the national economy particularly the tourism sector and damage the invaluable archeological and heritage site.

1.5 Climate Condition in the Kathmandu Valley

A temperate climate prevails in Kathmandu valley. There are three dominant seasons in the valley; winter, spring, summer and autumn; with three months each season and December is the harbinger of winter. The range of temperature is below 0^{o}C in winter and reaches more than 30^{o}C in summer. The Kathmandu Valley experiences four distinct seasons: pre-monsoon, monsoon, post-monsoon and winter. The rainy season is from June to September when 80% of the rainfall occurs. The annual rainfall of the valley is around 1300 mm.

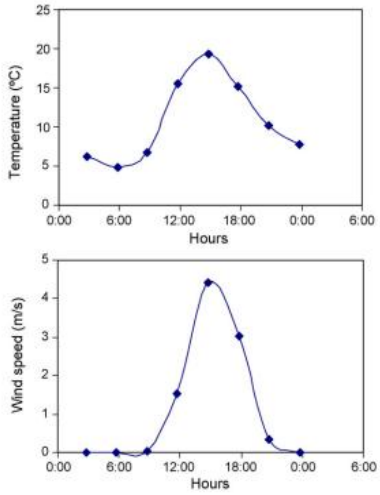
The bowl shaped Kathmandu Valley is located in the middle section of the Himalayan range and is surrounded by Phulchowki Hill (3132 m) in south west, Shivapuri (2713 m) in north, Champa Devi (2400 m) in southwest and Nagarjun (2100 m) in west. The central part of the valley is flat at an elevation of 1300 m above sea level. The valley is completely surrounded by rather steep rising mountains and hills ranging from 500 m to 3000 m above the valley floor (Ramana and Ramanathan, 2004). The valley has two narrow river gorges in the southwest and northwest edges and low lying hills on the southeast edge separate the Kathmandu Valley from the neighboring Banepa Valley (Figure 1.5). Winds usually enter into the valley through the southwest or northwest gorges and exit through the southeast Sanga Hill (Figure 1.5). As the valley is surrounded by high hills and mountains, horizontal dilution of the air emissions from the valley area is restricted or limited especially with low temperature and calm winds. The

air pollutants become trapped and accumulate in the valley without dilution by vertical dispersion (Sapkota and Dhaubadel, 2002).



Source: Aryal et al. 2009

Figure 1.5: Wind pattern of Kathmandu Valley and sketch in vertical west-east cross section.



Source: Aryal et al. 2009

Figure 1.6: Average wind speed and temperature profile of Kathmandu Valley in winter.

Figure 1.6 shows the average diurnal temperature and wind speed profiles in the Kathmandu Valley during winter (December 2006–February 2007). The diurnal temperature profile shows that the temperature sharply rises during the day and reaches its peak value at around 14:00 LST. Temperature drops slowly after 14:00 LST and reaches the lowest value in the morning at 5:00 LST. Similarly, surface wind in the valley is calm from18:00 LST to 10:00 LST. The wind speed also increases throughout the daytime period and peaks at around 14:00–15:00 LST. The wind speed is strongly correlated with temperature. Owing to temperature and wind features, the Kathmandu Valley experiences a strongly stable and stratified cold air pond at night during winter (December–February).

Chapter Two

Assessment of Ambient Air Quality of Kathmandu Valley

2.1 Ambient Air Quality Monitoring System in Kathmandu Valley

Air quality monitoring in the valley have started in the early 90s using the high volume and medium volume samplers as campaign monitoring. In late 90s and early 2000s, with increasing public concerns on the deteriorating air quality in the valley, Ministry of Population and Environment with support from DANIDA established the permanent air quality monitoring system with six permanent stations- 2 as roadside stations, 1 residential stations, 2 urban background stations and 1 background stations. This system started in 2002 continued till 2006 and the monitoring data are available for the period. The system used continuous monitoring for PM10 or PM2.5 and used passive samplers for the gaseous pollutants. More recently in late 2016, Ministry of Population and Environment established two roadside stations in the valley with focus on particulate pollutants-TSP, PM10, PM2.5 and PM1.0. In addition to this some civil society organization are also continuously monitoring PM2.5 and publishing the results in newspaper daily basis, the authenticity of the results obtained are yet to be verified. In order to understand the high level of particulate pollution in the valley in the dry day of May 2017, 24-hour average data for TSP, PM10 and PM2.5 are collected using the high volume samplers. The status of the air quality of Kathmandu Valley is assessed with the data obtained from the following sources:

- Two roadside stations established by MOPE in late 2016
- Campaign monitoring using high volume sampler in the dry days of May 2017
- Published results of the civil society monitoring
- Three years' data (2002 to 2004) from the air quality monitoring system of MOPE/DANIDA

2.2 Status of Particulate Pollution in the Kathmandu Valley (TSP, PM10, PM2.5, PM1)

Total Suspended Particulates (TSP):

The results obtained from the monitoring station established by Ministry of Population and Environment are being disseminated through the webpage of MOPE (www.pollution.gov.np), and the results obtained on June 9, 2017 are presented in Figure 2.1 which shows the one hour average, 8-hour average, 24-hour average, and the annual average. Lots of construction activities are going these days in the valley in the form of expansion of roads, construction of new roads, excavation of paved roads for drinking water pipe lying, and construction of residential and commercial buildings. Because of these construction activities and the movement of vehicles suspended dust is the major concern of general public and everyone visiting the Kathmandu Valley. In order to understand the level of dust pollution for a particular dry day, 24-hour monitoring was carried out in 10 different locations in the valley (roadsides, residential areas, background areas) using a high volume sampler. The results obtained are presented in Figure 2.2 (these are the only one dry day averages). TSP has always been a problem in the roadsides.The monthly and annual averages results obtained during 2003 to 2005inPutalisadak roadside station is shown in Figure 2.3.

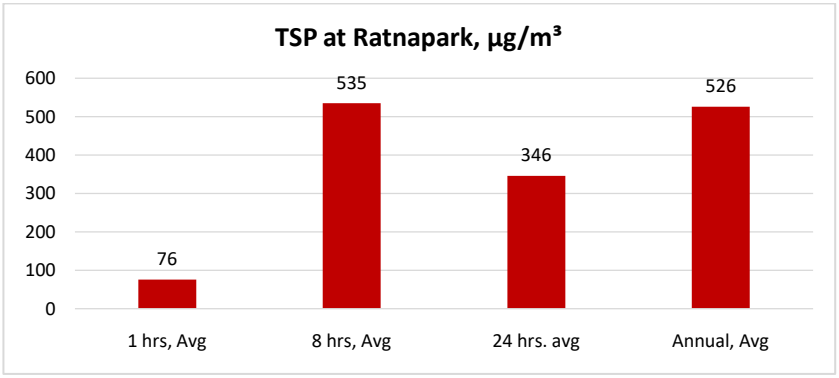


Figure 2.1: TSP Concentration at Ratnapark on June 9, 2017 (www.pollution.gov.np)

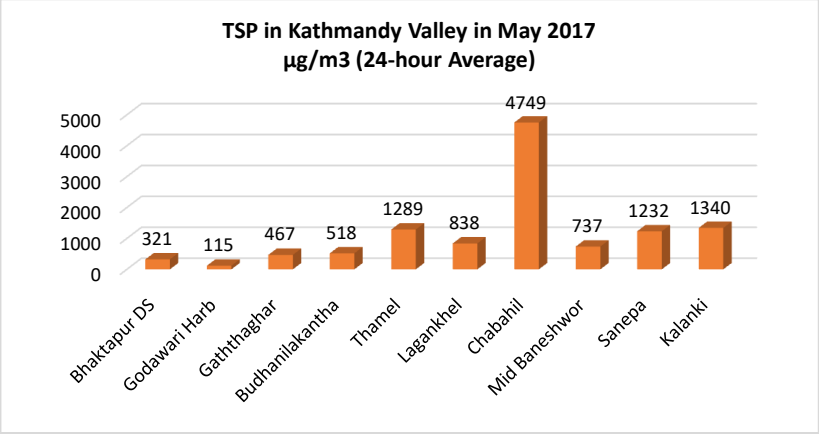


Figure 2.2: 24-Hour Average TSP (one-day data only) in Kathmandu Valley in May, 2017 (QUEST Nepal)

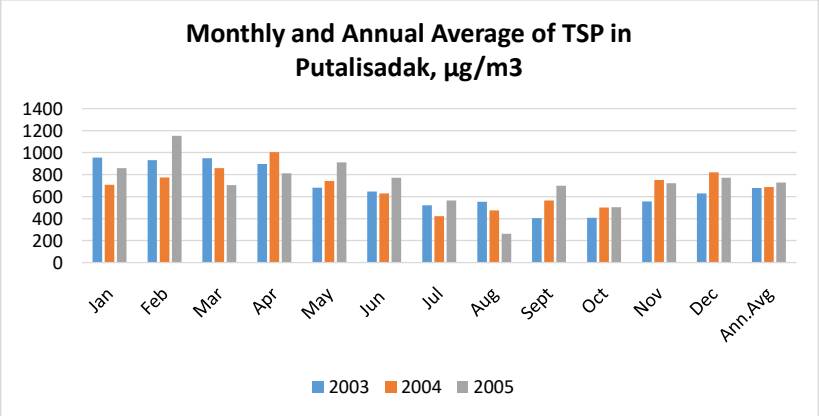


Figure 2.3: Monthly and Annual Average of TSP in Putalisadak, 2003-2005 (MOPE/ESPS)

PM10 (Particulate Matter with Aerodynamic Diameter 10 Micron or Less)

From the human health point of view, smaller particulates are the main concern specially PM10 and the smaller ones. The status of the PM10 in the Kathmandu Valley on June 9 2017 from the MOPE station at Ratnaparkis presented in Figure 2.4.The results of PM10 concentration of one-daycampaign monitoring in 10 different location of Kathmandu Valley in the month of May 2017 are shown in Figure 2.5. This monitoring was only done to understand the highest level of pollution in a very dry day, and the high level of pollution observed are therefore for a day only. The annual averages of PM10 for the year of 2003, 2004 and 2005 in the road side stations (average of two stations at Putalisadak and Patan), the residential station (Thamel), urban background stations (average of two stations at Kirtipur and Bhaktapur), valley background station (Matchhegau) and also the whole valley averages (averages of all stations) are presented in Figure 2.6.The monthly variation of PM10 in 2005 in all the six type of stations mentioned above are presented in Figure 2.7. The results of campaign monitoring of 6 hourly concentrations of PM10 conducted during November 2004 to February 2005 are presented in Figure 2.8 which show a very consistent pattern, related to the meteorological conditions, and to the intensity of emissions.

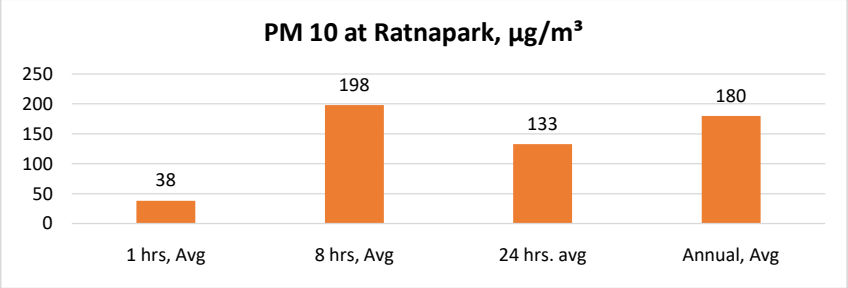


Figure 2.4 PM10 in Ratnapark and Pulchok in January 2017 (MOPE)

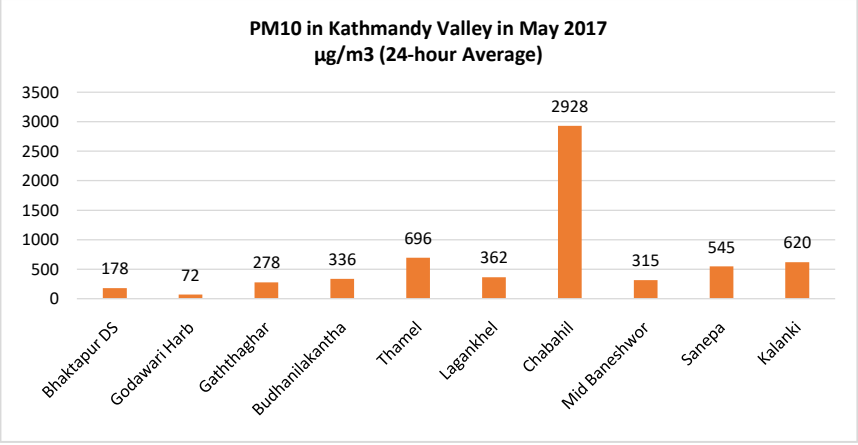


Figure 2.5: 24-Hour Average PM10(one day data only) in Kathmandu Valley in May, 2017 (QUEST Nepal)

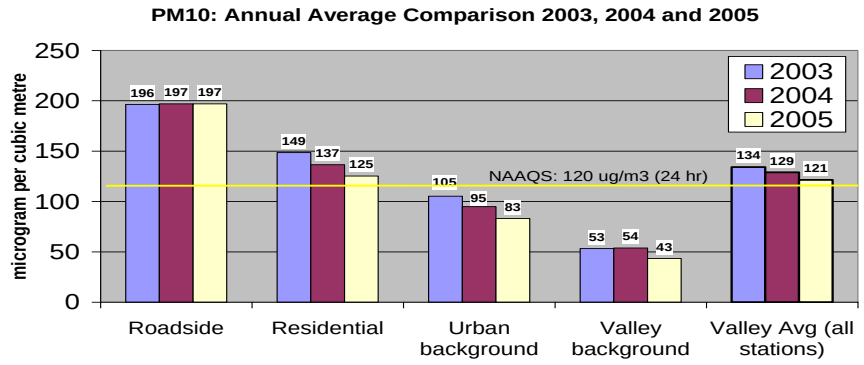
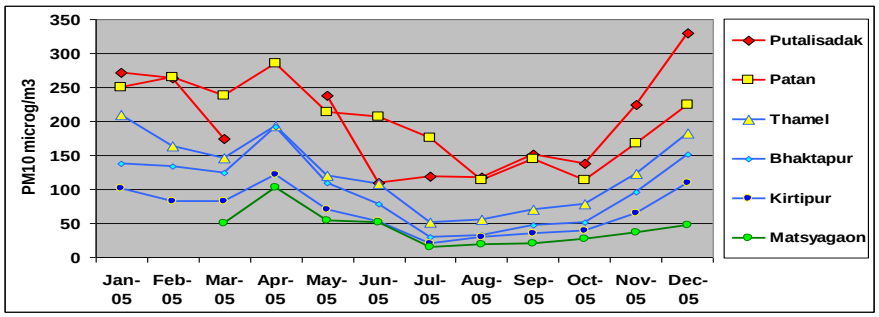


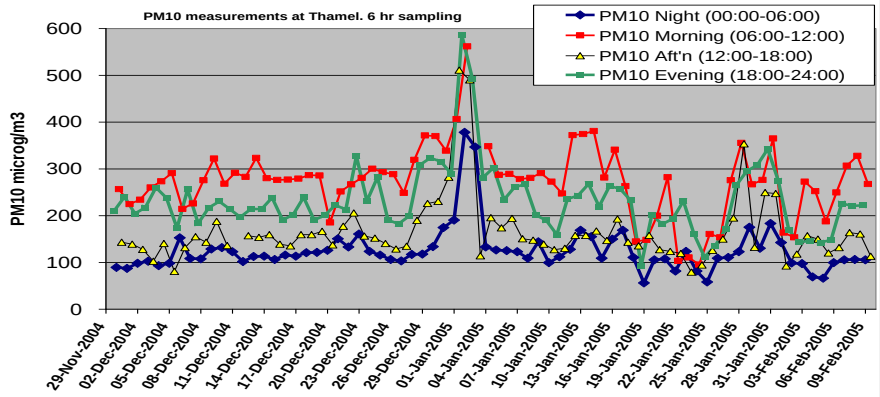
Figure 2.6 Annual average PM10 concentrations: Results from 2003, 2004 and 2005. Roadside areas are represented by PU and PA (averaged), residential areas by Thamel, urban background areas are represented by BHA and TU (averaged), and Valley background by MA. (MOPE/ESPS)

Figure 2.7 Monthly averages for PM_{10} in 2005 for all stations in the Kathmandu Ambient Air Quality Programme



Source (MOPE/ESPS database)

Figure 2.8Results of PM_{10} measurements at Thamel residential station during winter season: 6 hourly sampling, 29 Nov – 9 Feb 2005. For each day, data are shown separately for nighttime (00 – 6am), morning (6am-12), afternoon (12-6pm) and evening (6pm – 00).



Source (MOPE/ESPA database)

PM2.5 (Particulate Matter with Aerodynamic Diameter 2.5 Micron or Less)

In recent years, more focus has been provided in the monitoring of the smaller particles, like the PM2.5, about one-thirtieth of the width of a human hair, can penetrate deep into the lungs and the cardiovascular system, posing the greatest risks to human health. The monitoring stations recently established by MOPE also provide highest priority in monitoring PM2.5 and even the system monitors PM1.0. The results of this system obtained on June 9, 2017 are presented in Figure 2.9. The results of PM2.5 concentrations of one-day campaign monitoring in 10 different location of Kathmandu Valley in the month of May 2017 are shown in Figure 2.10. This monitoring was done to understand the highest level of pollution in a very dry day, and the high level of pollution observed are therefore for a day only. The air quality monitoring system established in 2002 also had the provision of monitoring PM10 and PM2.5 alternatively. For the year 2005,two systems were used at Thamelto monitor PM10 and PM2.5 and the obtained results are presented in Figure 2.11. Results of $PM_{2.5}$ measurements at Thamel residential stationduring winter season: 6 hourly sampling, 29 Nov – 9 Feb 2005 for each day (nighttime (00 – 6am), morning (6am-12), afternoon (12-6pm) and evening (6pm – 00)) are shown in Figure 2.12. As mentioned earlier, the results published in a Newpaper on daily basis for PM2.5 as hourly averages are presented in Figure 2.13.

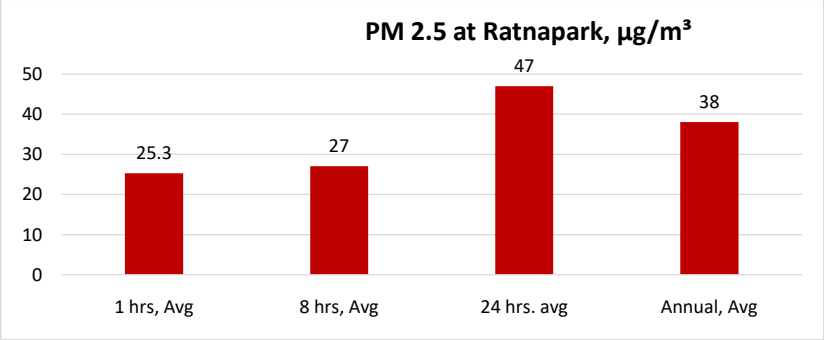


Figure 2.9 PM2.5 in Ratnaparkin January 2017 (MOPE)

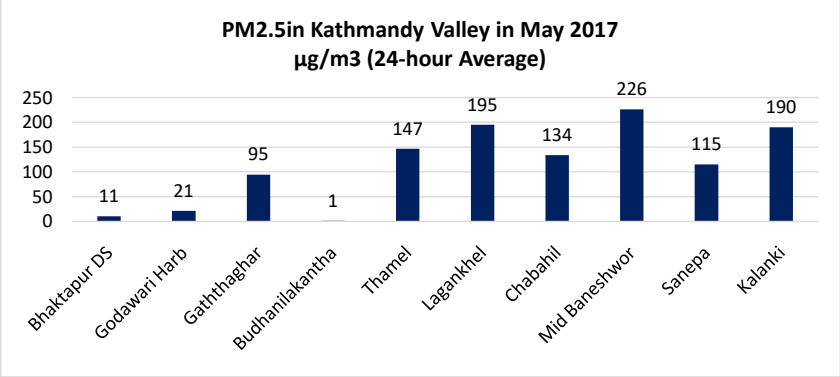


Figure 2.10: 24-Hour Average PM2.5(one-day data only) in Kathmandu Valley in May, 2017 (QUEST Nepal)

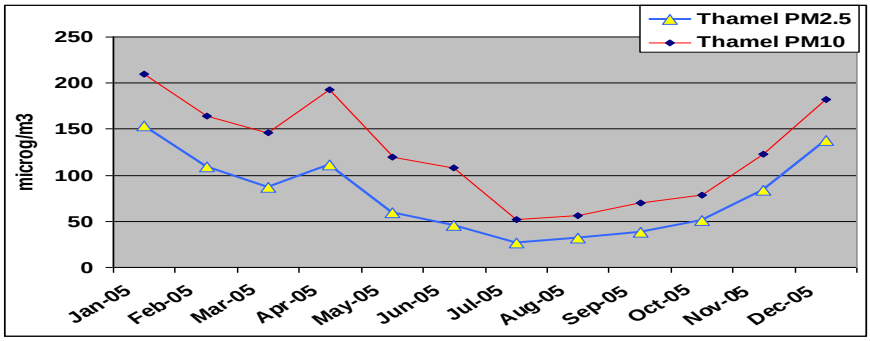


Figure 2.11 PM2.5 monthly averaged concentrations for 2005, Thamel residential station, compared with monthly PM_{10} concentrations

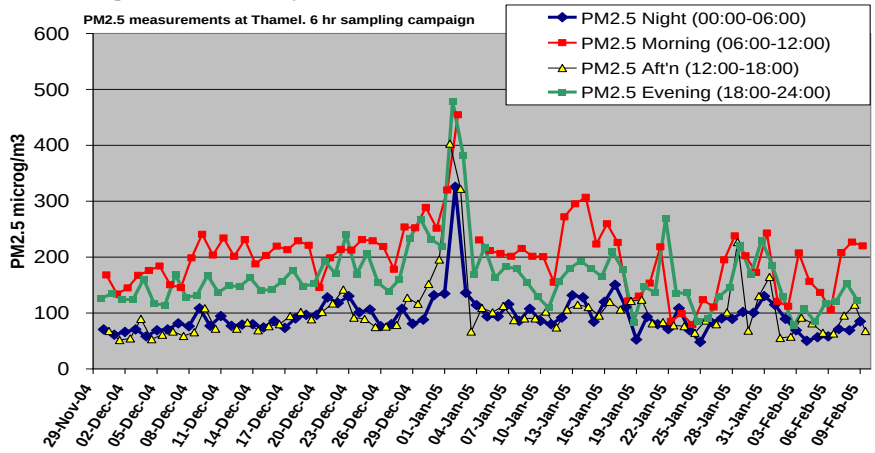


Figure 2.12Results of $PM_{2.5}$ measurements at Thamel residential stationduring winter season: 6 hourly sampling, 29 Nov – 9 Feb 2005. For each day, data are shown separately for nighttime (00 – 6am), morning (6am-12), afternoon (12-6pm) and evening (6pm – 00).

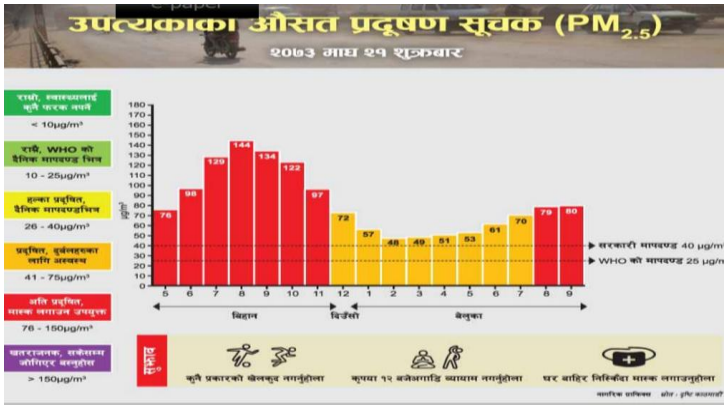


Figure 2.13 PM2.5 shown in the newspaper of Nagarik Daily

2.3 Assessment of the Level of Particulate Pollution in the Kathmandu Valley

Ministry of Population and Environment in 2003 has set the National Ambient Air Quality Standard for Nepal through widespread consultation with stakeholders on the basis of regional practices and WHO recommendations. This standard was reviewed in 2012and the PM2.5 parameters were added. The amended standard for Nepal is presented in Table 2.1 and the WHO guideline values with the basis for the selection of the level are presented in Table 2.2. WHO does not have the TSP values and the focus is on PM10 and PM2.5.

Table 2.1: National Ambient Air Quality Standard for Nepal

Parameter	***Unit***	***Time Weighted Average***	***Max. Concn. in Ambient Air***	***Method of Measurement***
TSP	µg/m3	Annual		High Volume Sampling (avg flow ≥ 1.1 m3/min
		24-hour	230	
		8-hour		
PM10	µg/m3	Annual		Low volume sampler or β- Ray Absorption Method
		24-hour	120	
		8-hour		
PM2.5	µg/m3	Annual		Low volume sampler or β- Ray Absorption Method
		24-hour	50	
		8-hour		
Oxides of Nitrogen (as NO2)	µg/m3	Annual	40	Diffusive Sampling or Gas Phase Chemiluminescence
		24-Hour	80	
		1-Hour		
Sulfur Dioxide (SO2)	µg/m3	Annual	50	Diffusing Sampling or Ultraviolet Fluorescence method
		24-Hour	70	
		1-Hour		
Ozone (O3)	µg/m3	24-hour		Non dispersive UV absorption method
		8-Hour	100	
		1-Hour		
Carbon Monoxide (CO)	mg/m3	8-hour	10	Non Dispersive Infra Red (NDIR) method
		1-Hour		
		15-minute	100	
Lead (Pb)	µg/m3	Annual	0.5	ASS Method after using EPM 2000 or equivalent filter paper
		24-Hour		
		1-Hour		

Note:

- *Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform intervals*
- *24 hourly values shall be met 95% of the time in a year. 18 days per calendar year the standard may be exceeded but not on two consecutive days.*

Table 2.2WHO Air Quality Guideline Values and Interim Targets for Particulate Matter (Annual Mean Averages and 24-Hour Average)

	24-Hr Average µg/m3		***Basis for selected level***	***Annual Average µg/m3***		***Basis for selected level***
	PM10	***PM2.5***		***PM10***	***PM2.5***	
Interim Target-I	150	75	Based on the published risk coefficients from multi-	70	35	These levels are associated with about

	24-Hr Average µg/m3		*Basis for selected level*	*Annual Average µg/m3*		*Basis for selected level*
			centre studies and meta-analysis (about 5% increase of short-term mortality over AQG value			a 15% higher long term mortality risk relative to AQG level
Interim Target-II	100	50	Based on the published risk coefficients from multi-centre studies and meta-analysis (about 2.5% increase of short-term mortality over AQG value	50	25	In addition to other health benefits, these levels lower the risks of premature mortality approximately 6% (2-11%) relative to IT-I level
Interim Target-III	75	37.5	Based on the published risk coefficients from multi-centre studies and meta-analysis (about 1.2% increase of short-term mortality over AQG value	30	15	In addition to other health benefits, these levels lower the risks of premature mortality approximately 6% (2-11%) relative to IT-I level
Air Quality Guideline (AQG)	50	25	Based on relationship between 24-hour and annual PM10 and PM2.5 levels	20	10	These are the lowest level at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term response to PM2.5

The level of TSP in the valley specifically along the roadsides is significantly high. The results of one-day monitoring for a dry day in the month of May 2017 show as high as 4749 µg/m^3 which is more than 20 times higher than the national standard. The latest annual average (June 9, 2017) at Ratnapark is as high as 526 µg/m^3 which is slightly better than the previous annual averages obtained in the similar location (Putalisadak)-728 µg/m^3 in 2005, 687µg/m^3 in 2004 and 677 µg/m^3 in 2003. The results from 2003 to date shows Kathmandu valley is highly polluted in terms of suspended particulates, and it is visible and troublesome to see children and elderly citizen with masks in the streets.

The smaller particles that are the real concern from human health point of view are also found significantly high. The annual averages result of PM10 and PM2.5 from the MOPE station at Ratnapark are 180 µg/m^3 and 38 µg/m^3, respectively. Nepal does not have the standard for annual averages, it is significantly high compared to the above mentioned WHO guideline values. PM10 is 9 times and PM2.5 is 3.8 times higher than WHO guideline values. Annual averages during 2003 to 2005 shows good improving trend coming down to 121 uµ/m^3 in 2005 from 129µg/m^3 in 2004 and 134 ug/m^3in 2003, although these values are also 6 to 7 times higher than the WHO guideline.

A status on the compliance with the national standard of PM10 for the year 2003 to 2005 is shown in Table 2.3. Ambient air quality in the roadsides of the Valley exceeded the national standard more than 240 days to 310 days in a year.It is clear that the number of days with non-compliance is far too high. Of special concern are the high number of days with non-compliance at the urban residential (Thamel) and the urban background

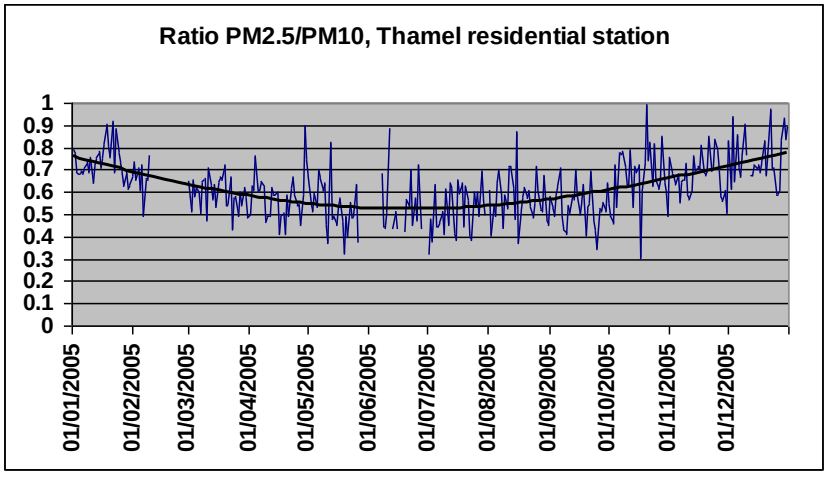
station Bhaktapur, as these stations represent the outdoor air quality that a large part of the population in the Valley is exposed to. It must be noted here that compared to WHO guideline value of 50 µg/m^3, the national standard 120 µg/m^3 is almost 2.5 times higher.

Table 2.3 Compliance Status of PM10 with NAAQS of Nepal (NAAQS for PM_{10} is a 95-percentile for 24 hr averages, up to 18 days per year with exceedances of NAAQS is allowed).

Year	Share of days on which PM10 > 120 □g/m^3 (NAAQS) out of total number of days with valid results. No. days on which PM10>120 □g/m^3 is shown in brackets.					
	Putalisadak	**Patan**	**Thamel**	**Bhaktapur**	**Kirtipur**	**Matsyagaon**
2005	77% (227 days)	81% (285 days)	46% (157 days)	32% (81 days)	9% (30 days)	3% (10 days)
2004	83% (304 days)	85% (310 days)	54% (190 days)	40% (139 days)	20% (72 days)	7% (22 days)
2003	83% (289 days)	76% (240 days)	57% (187 days)	48% (174 days)	20% (71 days)	5% (16 days)

source: MOEST database

MOPE has recently reviewed the NAAQS for Nepal to include PM2.5 which is now the main pollutants highly focused in many developed and developing countries because of its impact on human health.MOPE/ESPS in 2005 has monitored PM2.5 in parallel to PM10 continuous for one year to determine the PM2.5/PM10 ratio and the obtained results are presented in Figure 2.13.



source: MOEST database

Figure 2.13 Ratio between measured concentrations of PM2.5 and PM_{10}, based on 24 hour results during the year 2005. The trend line illustrates the yearly variation in the ratio.

The trend line in above figure 2.13shows that day-to-day ratio may vary quite a lot (following changes in meteorology and emission patterns), the ratio seems to vary around 0.50-0.75. The ratio is clearly higher during the dry season, and it falls gradually during the wet season, with a minimum of around 0.5 during the month of July. A possible explanation for this phenomenon is the higher turbulence in the lowest part of

the atmosphere during the wet season. The months of the wet season (May-June-July and August) also introduce high temperatures at ground level in the valley, creating a vertical mixing to much higher altitudes of the air than during the dry (and colder) season. This will have a higher effect on smaller particles ($PM_{2.5}$) than coarse (PM_{10}) particles, and therefore tend to reduce $PM_{2.5}$ concentrations more strongly than PM_{10} concentrations, causing the ratio of $PM_{2.5}/PM_{10}$ to drop during these months. Further investigation of this phenomenon should be sought (ESPS/MOPE).

ESPS/MOPE has also done the campaign monitoring of 6 hourly concentrations of PM2.5 and PM10 and the results (Figure 2.12) show a very consistent pattern, related to the meteorological conditions, and to the intensity of emissions. At nighttime and in the afternoon, both PM2.5 and PM10 are lowest which can be explained by the low emissions occurring between midnight and 6am. However, the outdoor PM2.5 and PM10 concentrations are not much lower during nighttime than in the afternoon, and the emissions are high in the afternoon. This is due to the occurrence of thermal inversions in the winter season: During evening, nighttime and morning, cold air close to the surface of the valley will be "trapped" by warmer air at higher altitudes, causing a very low mixing layer. As the sun rises in the morning and slowly heat the air at the valley floor, the mixing layer increases, and the air close to the valley floor will be mixed and diluted with air masses from higher altitudes, causing the outdoor air concentrations to fall in the afternoon. This pattern is particularly consistent during December for PM2.5.The general pattern for PM10 in the nighttime and afternoon is slightly different than for PM2.5. The heavier PM10 particles have a higher sedimentation rate than PM2.5 particles. As the wind speeds is typicallyvery low during nighttime, the larger particles will have a tendency to deposit on surfaces, whereas smaller particles (PM2.5) will stay suspended for longer periods of time. This may explain why PM10 is reduced more significantly than PM2.5 at nighttime (ESPS/MOPE). This pattern is seen in the hourly averages published daily in NagarikNewpaper (Figure 2.13)

2.4 Assessment of Gaseous Pollution in Kathmandu Valley

The focus of ambient air quality monitoring in the Kathmandu Valley is on particulate pollutants and the recently established two stations by MOPE also does not monitor the gaseous pollutants although the National Ambient Air Quality Standard of Nepal (Table 2.1) has included gaseous pollutants. The national standard for Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Carbon Monoxide (CO), lead and benzene are taken from the WHO air quality guideline. The continuous air quality monitoring station established in 2002 by MOPE/ESPS also did not have the continuous monitoring system for gaseous pollutants. However, that system included monitoring of NO_2, SO_2, and Benzene by using the passive samplers which were analyzed in Denmark by an internationally accredited laboratory and also by national private accredited laboratory. There are no other efforts that can provide reliable information on the status of these gaseous pollutants, therefore the results of MOPE/ESPS are presented and analyzed here.

Nitrogen Dioxide (NO2)

The NO_2 measured from November 2003 to March 2004 and November 2004 to March 2005 are compared in the following figure 2.14.From the figure the level of NO_2 concentrations are found to be quite constant from the winter season (dry season) in 2003/2004 to the winter season in 2004/2005, and it was found that NO_2 concentration is quite below to the national annual average value of NAAQS. However, over the years there have been significant rise in the vehicular numbers, there is the need to start

monitoring of NO_2 using the same method used by MOPE/ESPS utilizing the developed capacity of national laboratories.

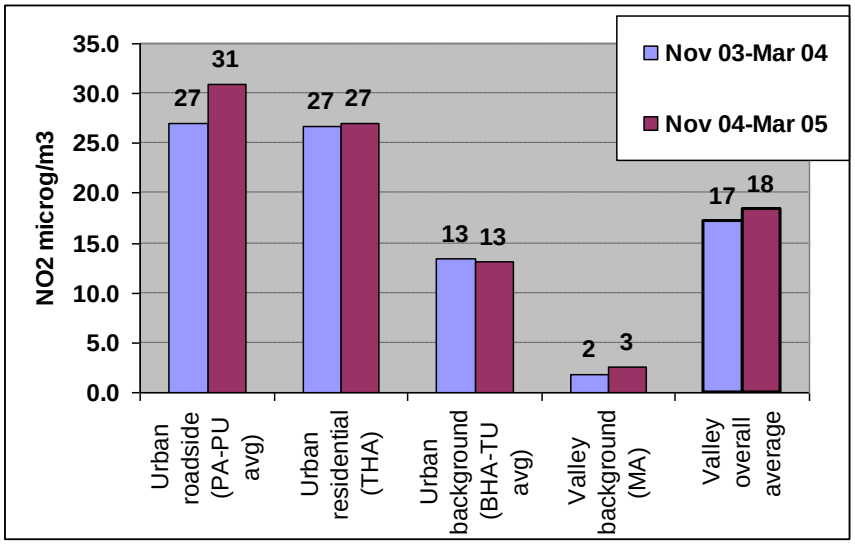


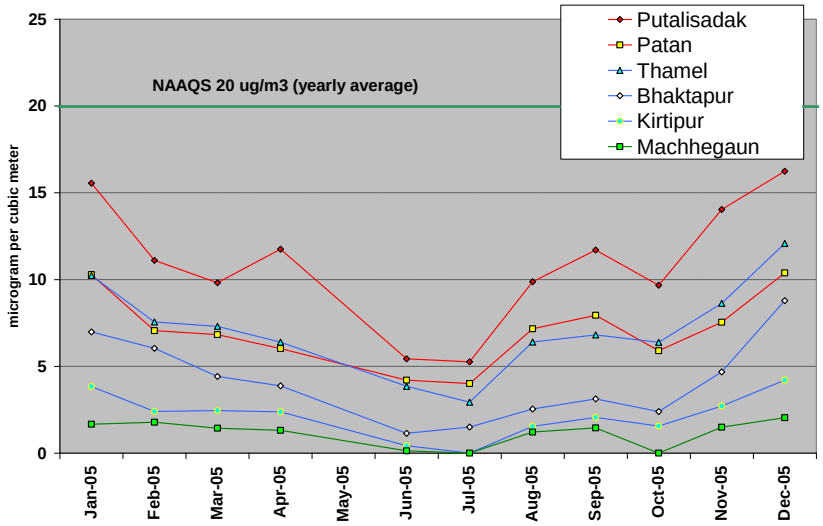
Figure 2.14 NO2 average concentrations measured during the winter season in 2004/2005 compared to 2003/2004 (*source: MOPE/ESPS)*

Sulfur dioxide (SO_2)

MOPE/ESPS only did campaign monitoring of SO_2during September 2004 for two weeks in three stations-Patan, Thamel and Kirtipur and the results show that the level of SO_2 varied from the lowest of 0.13 µg/m^3 at Thamel to maximum of 5.31 µg/m^3 at Kirtipur. This clearly shows that the level of SO_2 during that period was quite low as compared to national standard. Over the years, there have been significant rise in the use of fossil fuel but the quality of the fuel has also been significantly improved in terms of sulfur content. These days the EURO IV quality diesel is being imported with sulfur content of 50 ppm.

Benzene

The monthly averages for the benzene for the year 2005 in all the six monitoring stations of MOPE/ESPS is presented in Figure 2.15 which shows that all the results are below the NAAQS standard for benzene with20 µg/m^3 annual averages in Kathmandu Valley. Benzene concentrations tend to increase during the winter season. This is explained by the fact that benzene concentrations is generally higher during the dry and cold season, when there is no precipitation to wash out benzene. Benzene is partly soluble in water and thus quite effectively removes from the gaseous phase during rainfall, and it is more prominent in those areas where the occurrence of thermal inversion is higher. As now the fuel quality imported is significantly improved compared to 2005 with significant reduction of benzene in petrol, it can be said that the air quality of Valley is in compliance with NAAQS in terms of benzene. However, it is recommended to continue monitoring benzene as part of the AQM system.



source: MOPE/ESPS

Figure 2.15 Monthly average benzene concentrations measured in Kathmandu Valley 2005.

2.5 Impact of Air Pollution in Kathmandu Valley

It can be concluded from the assessment of particulate and gaseous pollutants done in the above headingsthat the main concerns of pollutants are the particulate pollutants. However, in the context of the valley becoming a mega city and due to its bowl-shape and climate conditions, all the pollutants will be of concern for future.Therefore a list of pollutants of Kathmandu Valley concern to human health and environmental impacts are presented in Table 2.4.

Table 2.4: Main Pollutants of Concern with Health/Environmental Impacts

Pollutant	Health/Environmental Effects
Particulate Matter-Total Suspended Particles (TSP)	TSP, the large particles, can corrode metals and masonry, soil structures and motor vehicles. Incurs huge costs for cleaning of clothes, windows, floors, repainting, etc. And demand more other resources like water and soaps for cleaning and generate wastewater effluents. Dust the leaf surfaces of crops, trees and shrubs, which may injure or inhibit the growth of these valuable plants. Impair visibility and reduce solar radiation. It can also adversely affect property values; aesthetics in urban, country-side; transportation safety; etc
Particulate Matter-(PM10 and PM2.5)	Both short-term and long-termexposure to ambient levels of PM isconsistently associated with respiratoryand cardiovascular illness and mortalityas well as other ill-health effects. Recent reviews byWHO havesuggested exposure to a finerfractionof particles (PM2.5, which typicallymake up around two thirds of PM10emissions and concentrations) give astronger association with the observedillhealth effects, but also warn that

Pollutant	Health/Environmental Effects
	there is evidence that the coarse fractionbetween (PM10 – PM2.5) also has someeffects on health.
Nitrogen Oxides (NOx)	At high levels NO2causes inflammation of the airways.Long term exposure may affect lungfunction and respiratory symptoms.NO2also enhances the response to allergensin sensitive individuals. High levels of NOx can have an adverse effect on vegetation,including leaf orneedle damage and reduced growth. Deposition of pollutants derivedfromNOx emissions contribute to acidificationand/or eutrophication of sensitivehabitats leading to loss of biodiversity,often at locations far from theoriginal emissions. NOX also contributes to theformationof secondary particles and ground levelozone, both of which are associatedwith ill-health effects. Ozone alsodamages vegetation.
Sulfur Dioxide (SO_2)	Causes constriction of the airways of thelung. This effect is particularly likely tooccur in people suffering from asthmaand chronic lung disease. Precursor to secondary PM andthereforecontributes to the ill-health effectscaused by PM10 and PM2.5. Potential damage to ecosystems athigh levels, including degradation of chlorophyll, reduced photosynthesis, raised respiration rates and changesin protein metabolism. Deposition ofpollution derived from SO_2emissionscontribute to acidification of soilsand waters and subsequent loss ofbiodiversity, often at locations farfrom the original emissions.
Carbon Monoxide (CO)	Reduces capacity of blood to carry oxygen to tissues and blocks important biochemical reactions in cells. People with heart and brain problems are at particular risk.
Ozone (O3)	Common health effects are irritation to eyes and nose, and it also reduces lung function and increases respiratory symptoms leading to increased mortality.
Benzene	A known human carcinogen and therefore there are no safe limits.
Polycyclic aromatic hydrocarbons (PAHs)	A known human carcinogen and therefore there are no safe limits.
Lead	High exposures lead to adverse effects on kidneys, gastrointestinal tract, the joints and reproductive systems, and damage to nervous system. Also affects intellectual development in young children.
Ammonia (NH_3)	It is precursor to secondary PM and thus will have health effects of PM2.5/PM10. It can cause damage of aquatic ecosystem due to eutrophication and acidification.

Impact on Human Health:

There is a close, quantitative relationship between exposure to high concentrations of small particulates (PM_{10} and $PM_{2.5}$) and increased mortality or morbidity, both daily and over time. Conversely, when concentrations of small and fine particulates are reduced, related mortality will also go down – presuming other factors remain the same. Small particulate pollution has health impacts even at very low concentrations – indeed no threshold has been identified below which no damage to health is

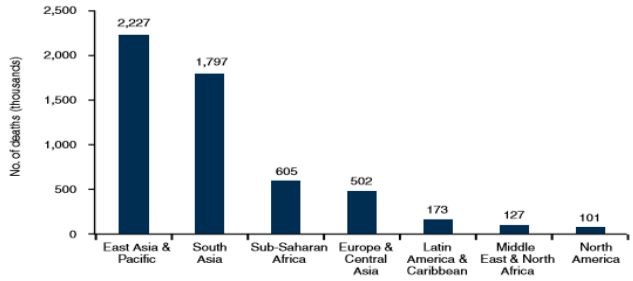
observed. The WHO 2005 guideline limits aimed to achieve the lowest concentrations of PM possible. “WHO Air Quality Guidelines" estimate that reducing annual average particulate matter (PM10) concentrations from levels of 70 µg/m3, to the WHO guideline level of 20 µg/m3, could reduce air pollution-related deaths by around 15%. In addition, there are serious risks to health not only from exposure to PM, but also from exposure to ozone (O3), nitrogen dioxide (NO2) and sulfur dioxide (SO2), and other hazardous air pollutants like PAH, benzene, and lead. Ozone is a major factor in asthma morbidity and mortality, while nitrogen dioxide and sulfur dioxide also can play a role in asthma, bronchial symptoms, lung inflammation and reduced lung function. PAH and benzene are known carcinogens. High concentration of lead besides impact on kidneys, gastrointestinal tract, the joints and reproductive systems, and damage to nervous system, also affects intellectual development in young children.

Health impacts have two facets, excess mortality and morbidity. The dose response relation of excess mortality and morbidity can be calculated if the information on the time series air quality data and corresponding demographic information, hospital records are available for reasonable period. In order to understand the seriousness of problem of air pollution, two figures from the book “The Cost of Air Pollution: Strengthening the Economic Case for Action” published by the World Bank Group are reproduced below. In South Asia alone 1.79 million deaths in 2013 are from air pollution and it is 13.7% of total deaths in the region.

In the context of Kathmandu Valley, the health burden estimates of PM_{10} (NHRC, 2004), based on Ostro's method for the year 2004 estimates an excess premature mortality per year to be around 212 at the current level of concentrations against NAAQS values. The 2005 study of MOPE/ESPS using the WHO’s Air Quality Health Impact Assessment Tool (AirQ 2.2.2) to estimate the health impact on PM10 in Kathmandu Valley in 2005 shows the excess mortality due to air quality situation in Kathmandu is 900 per million populations. This study estimates 1600 avoidable deaths every year in Kathmandu provided the PM_{10} level is brought down at 50 $\mu g/m^3$. As the level of PM10 is similar to 2005 and even higher, and around 3.5 million people exposed to high level of pollution, addition 3150 death can be avoided if the level of PM10 is brought to 50 µg/m3.

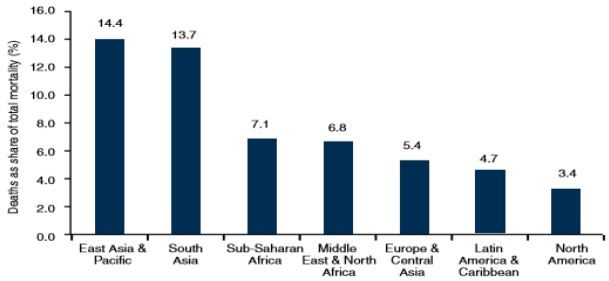
Global Burden of Diseases Study estimates that lower respiratory infections, diarrheal diseases and neonatal encephalopathy remain the main causes of premature death in Nepal, it highlights that Nepal is facing increasing burden of non-communicable diseases (NCDs) and injuries. NCDs account for “more than 44% of deaths, 80% of outpatient contacts, and 39% of DALYs lost. Major NCDs in Nepal are cardiovascular diseases, diabetes, cancer, chronic respiratory diseases, oral diseases, and mental disorders. (NEPAL HEALTH SECTOR STRATEGY 2015 – 2020 (MOHP,2015). According to the annual report of 2071/72 of the DoHS, upper respiratory tract infection (URTI) is the leading one with 5.7% in the outpatient’s consultation in the FY 2071/72 followed by Gastritis (APD) with 5.4% and Lower Respiratory Tract Infection (LRTI) with 5% (Figure 2.17). And air borne diseases in 2071/72 are detailed out in Figure 2.18.

FIGURE 2.2 Total Deaths from Air Pollution by Region, 2013



Sources: World Bank and IHME, using data from IHME, GBD 2013.

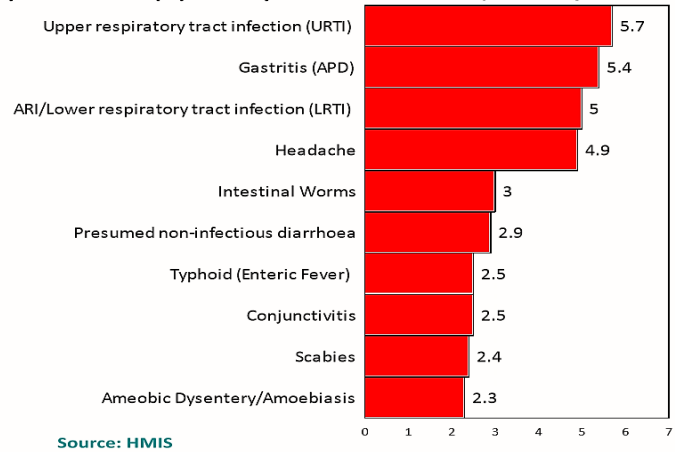
FIGURE 2.3 Percentage of Total Deaths from Air Pollution by Region, 2013



Sources: World Bank and IHME, using data from IHME, GBD 2013.

Figure 2.16: Total and Percentage Death by Air Pollution by Region

Figure 5.12: Top ten reasons (%) for outpatient consultations, FY 2071/72



Source: HMIS

Figure 2.17 Top ten reasons for outpatients visit in Nepal

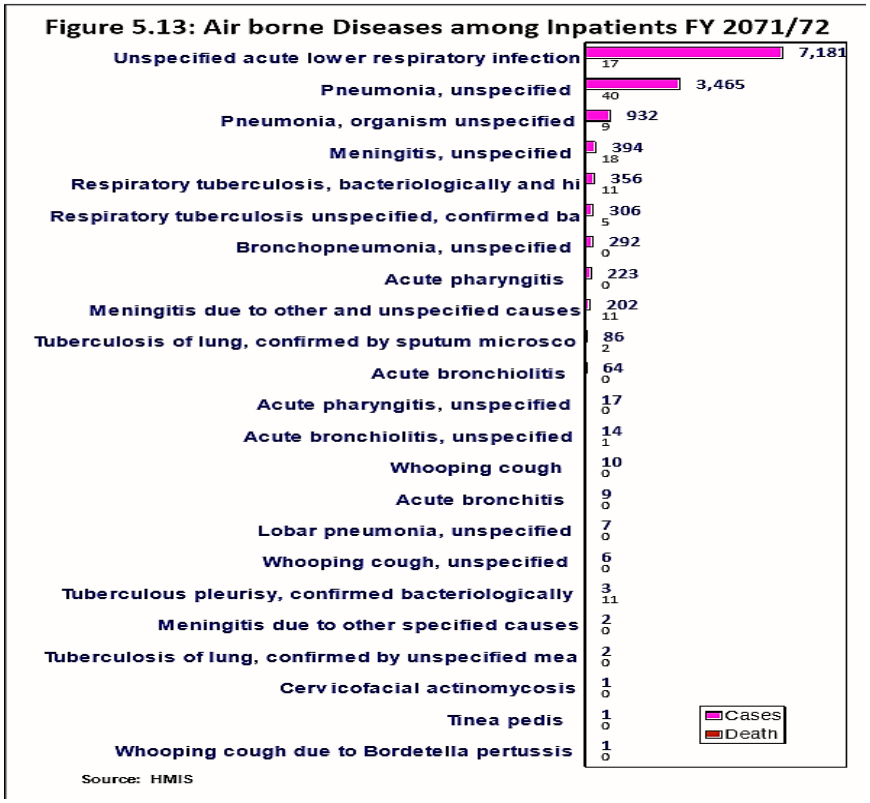


Figure 2.18: Air Borne diseases among inpatients in Nepal 2071/72.

Impact of Air Pollution on Economy

Air pollution is not just a health risk but also a drag on development. By causing illness and premature death, air pollution reduces the quality of life. By causing a loss of productive labor, it also reduces incomes polluted countries. Air pollution can have a lasting effect on productivity in other ways as well—for example, by stunting plant growth and reducing the productivity of agriculture, and by making cities less attractive to talented workers, thereby reducing cities' competitiveness.

As Nepal's economy is dependent on tourism due to its natural beauty and rich cultural and archeological significance, the high level of particulate pollution will directly impact our beauty and damage the physical structure, archeological and monuments. High level of pollution in the valley where there is only one international airport, can have negative impact about the image of the city with direct impact on tourism industry.

These days' citizen in Kathmandu valley have to double or triple the cost for cleaning of houses, laundry, and additional burden of mask to family members, whose actual impacts are not evaluated. Impact of air pollution on agriculture, forestry and biodiversity are clearly established, however in absence of data for Kathmandu it is not possible to estimate the damage. However, the findings of the report "The Cost of Air Pollution:

Strengthening the Economic Case for Action, 2016" by the World Bank and Institute for Health Metrics and Evaluation, University of Washington is compared here with our neighboring countries (Table 2.5). It clearly shows the impact of air pollution on our health and economy. Compared to our neighbors, Nepal is also facing similar challenges to minimize the impacts of air pollution on human health and economy.

Table 2.5: Mean Annual PM2.5, Total Deaths from Pollution, Total Welfare Losses, and Total Forgone Labor output, in Nepal and Its Neighbors

Country	Mean Annual Ambient PM2.5		Total Death from Air Pollution		Total welfare losses (mill US$) (% GDP)		Total Foregone labor output(mill US$) (% GDP)	
	1990	2013	1990	2013	1990	2013	1990	2013
Nepal	29.68	46.09	16436	22038	1033 (4.60)	2833 (4.68)	195 (0.87)	287 (0.47)
Bangladesh	29.92	48.36	92880	154898	6379 (4.66)	27452 (6.14)	1195 (0.87)	2579 (0.58)
China	39.30	54.36	1518942	1625164	126592 (7.35)	1589767 (9.92)	12558 (0.73)	44567 (0.28)
India	30.25	46.68	1043182	1403136	104906 (6.80)	505103 (7.69)	28742 (1.86)	56390 (0.84)

Chapter Three

Assessment of Sources of Air Pollutants in the Valley

3.1 Transport Sector

3.1.1 Growth of Vehicles and Fuel

Transport sector is one of the rapidly growing sectors not only in Kathmandu Valley but throughout the country. The load of pollution is not only related to the vehicles but it is directly related with the carrying capacity of roads and quality of the roads.

There has been significant rise in the vehicle numbers in Nepal as a whole and in the Kathmandu Valley. Figure 3.1 presents the current status of registered vehicles in Bagmati zone. It is assumed thatall vehicles are registered in Kathmandu Valley and considering some of the vehicles registered in other zones are also coming to Kathmandu. Total number of vehicles that used to be around 34,000 in 1990 but now around one lakh vehicles are added every year in Kathmandu Valley.

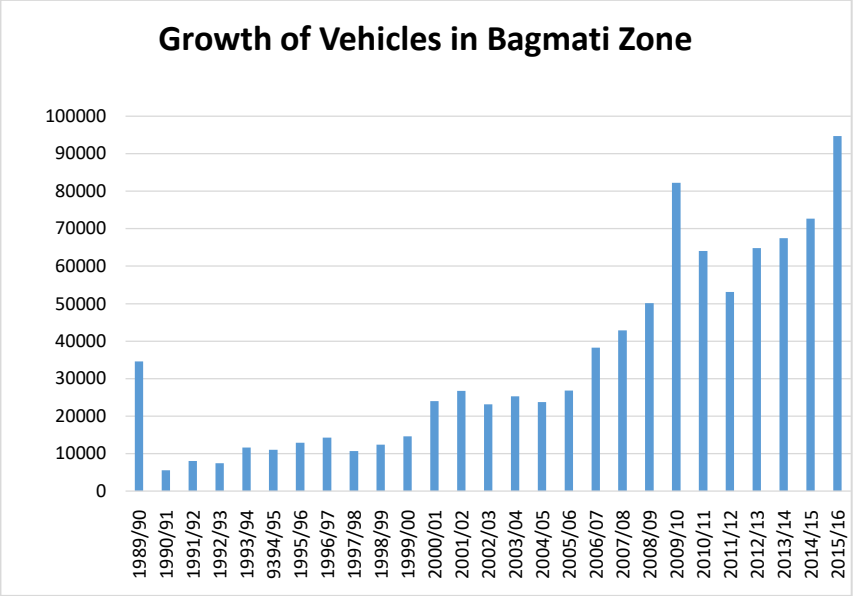


Figure 3.1: Growth of Vehicles in Bagmati Zone (Source-DOTM)

Over the years there have been significant improvement in the technology of vehicles in terms of pollution load per distance travelled and Nepal also has moved to EURO-IV standards recently. The status of vehicles in terms of mass emission standards pre-EURO, EURO-I and EURO II and EURO-III are presented in Figure 3.2.

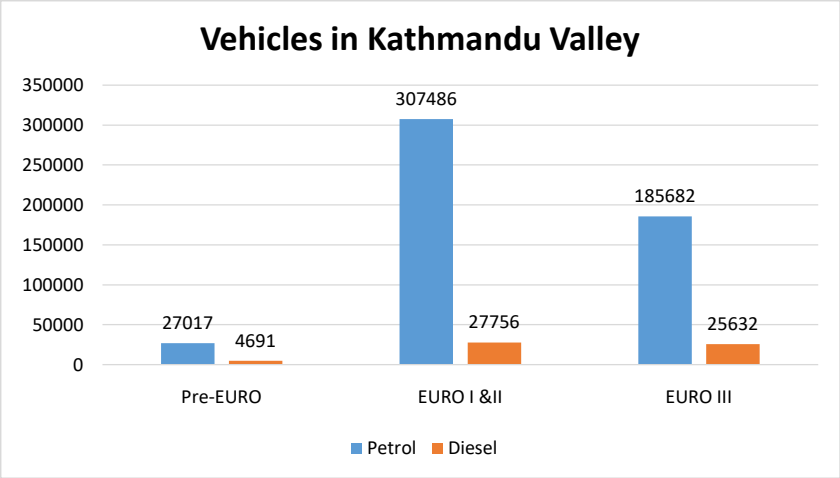


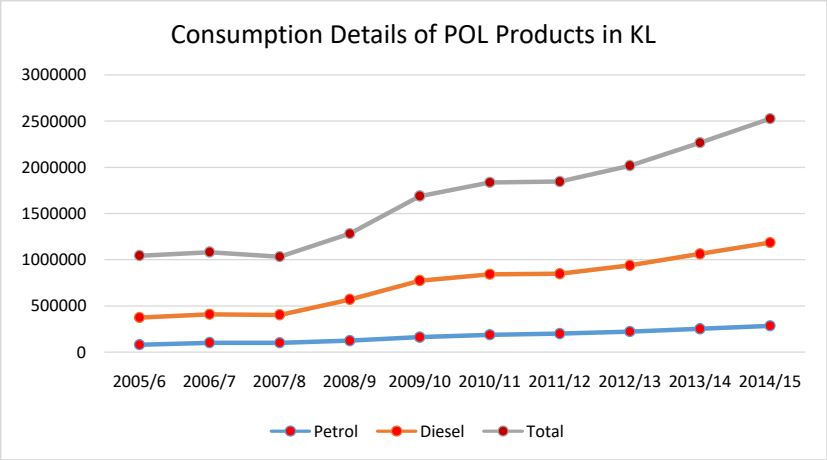
Figure 3.2: Vehicles with EURO standards and without EURO standard (source-DOTM)

In parallel to the growth of vehicles, the use of gasoline and diesel has also growing significantly over the years (Figures 3.3).

Table 10 (e): Consumption details of POL Products

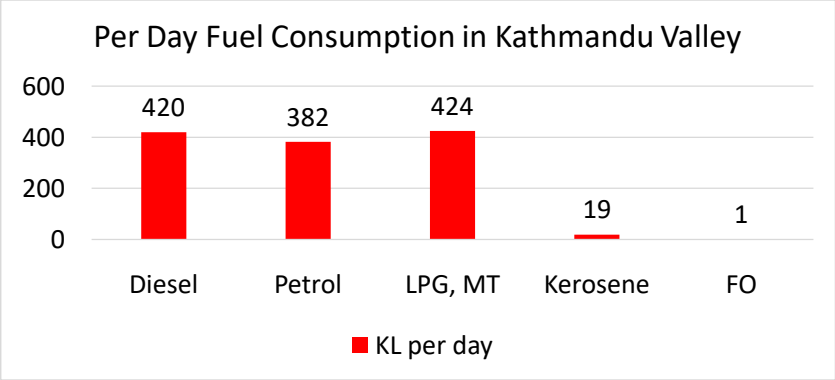
Fiscal Year	Petrol(KL)	Diesel(KL)	Petrol(KL)	A.T.F.(KL)	L.D.O.(KL)	Furnace Oil (KL)	Total Excluding LPG	LPG(MT)
2015/16*	88423	254103	5870	33239	-	-	381635	73440
2014/15	283567	901393	18628	139404	-	-	1342992	258299
2013/14	251451	811100	19064	123527	-	-	1205142	232660
2012/13	221676	716747	24721	115786	258	2450	1081638	207038
2011/12	199749	648513	41808	108908	0	435	999413	181411
2010/11	187641	655128	49495	101314	227	1415	995220	159286
2009/10	162275	612505	55788	82631	238	2589	916026	141171
2008/09	124169	446468	70089	68935	377	2171	712209	115813
2007/08	100842	302706	155216	68938	306	2919	630927	96837
2006/07	101912	306687	197850	63778	179	4558	674964	93562
2005/06	80989	294329	226637	64335	290	3695	670275	81005
Total	**1802694**	**5949679**	**865166**	**970795**	**1875**	**20232**	9610441	**1640522**

Source: Nepal Oil Corporation **Of First Eight Months*



Source: Economic Survey, 2015/16

Figure 3.3: Import of Vehicular Fuel (Gasoline and Diesel)



3.1.2 Road Infrastructure

The road network in Kathmandu Valley is classified into two groups depending on the jurisdiction of administration body of DOR and local governments as shown below in Table 3.1.

Table 3.1 Road Networks of Kathmandu Valley

Jurisdiction		Kathmandu District	Bhaktapur District	Lalitpur District	Total	Remarks
Department of Road (DOR)	Highways	39.9	14.1	18.0	72.0	H02, H03, H16
	Feeder road (Primary)	136.0	70.5	112.6	319.0	14 feeder roads
	Feeder Road Secondary	45.1	27.0	0.0	72.1	59 urban roads
	Strategic Urban Road	59.6	4.9	27.2	91.7	

Jurisdiction		Kathmandu District	Bhaktapur District	Lalitpur District	Total	Remarks
	Total	280.5	116.5	157.8	554.8	
Districts/ Municipalities	District Road	400.4	36.0	90.6	527.0	
	Urban Road	269.6	116.0	127.3	512.9	
	Total	670.0	152.0	217.9	1039.9	
Total		**950.5**	**268.5**	**357.7**	**1594.7**	

Source: Final Report on Data Collection Survey on Traffic Improvement in Kathmandu Valley, DOR/MOIDT

The Kathmandu Valley is served with a ring road and radial pattern of road network and the expansion of urban areas have proceeded along the major (or primary) feeder roads radiating from the Ring Road. Feeder road is classified into primary (or major) and secondary (or minor). The former generally leads from the national highway to the district headquarters and the latter connects the primary feeder road with major towns and villages. The road network system in Kathmandu Valley is shown in Figure 3.3

As per the statistics of DOR, all the national highways and strategic urban roads except for some sections of the urban road in Lalitpur District are paved, however, the feeder roads including primary and secondary are only 60% paved, and earthen road still exist in Kathmandu and Lalitpur districts.

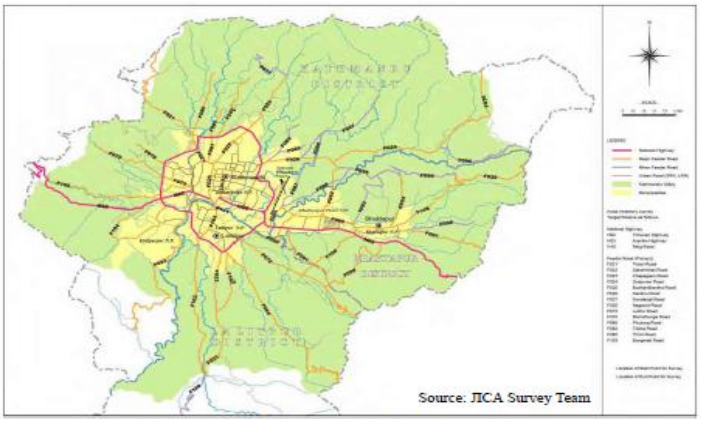


Figure 3.3: Road Network System in Kathmandu Valley

At present expansion and maintenance work is undergoing in the valley which is consider the major cause of high dust in the valley particularly in the roadsides. Tribuvan Highway (H02) (Tripureswor to Kalanki and Kalanki to Nag Dhunga) is in expansion which is the main road for vehicles to enter in the city. This is ongoing for almost 3 years and major concern for traffic congestion and dust pollution. Similarly,Arniko Highway (H03) (Maitighar to Suryabinayak) is in fairly good condition but highly dusty as well. The H16 (Ring Road) from Koteshwor to Kalankiis in expansion and some works of expansion with dumping of soil and gravel is going in other section of ring road. These days because of the excavation works of Melamchi Water Supply project major roads in valley are excavated in the centre and highly dusty and reason for congestion in the valley.

3.1.3 Traffic Congestion

The "Final report on Data Collection Survey on Traffic Improvement in Kathmandu Valley, 2011" has the following findings on the future traffic demand in the Kathmandu Valley:

- Total trips in the valley was forecasted to be 5,456 thousand/day in 2022 by 1.59 times of the present (2011).
- Intra-central trips by 1.59 times, inter-trips between the central and suburbs by 1.62 times were relatively higher than intra-suburbs.
- Based on the vehicle ownership estimation, the share of both motorcycle and car will increase continuously in the long run.
- It is fairly said that if nothing will be done for the future, ten years later every activity will be restricted due to severe traffic congestion, particularly along the central area inside the Ring Road.
- On the other hand, if ongoing projects like the Ring Road expansion are completed, it is certain that the level of mobility in 2022 will sustain the same existing level.

Based on the above future traffic demand forecast, the same study has identified following important points about the traffic demand and road network system:

- Network system of the Kathmandu Valley may withstand the traffic demand by improving the existing network system such as installation of flyover, construction of inner ring road, and widening of existing road until 2022.
- After 2022, service level of road network will decline rapidly and introduction of new transport system/land use system will be inevitable to sustain the present mobility and urban activity.
- Therefore, ten years before 2022 is the period for the introduction of new system including the establishment of implementation plan, implementation of pilot projects, and reinforcement of relevant institutions.

Six years have already been passed and the condition of the roads and traffic system is further deteriorated over the years. Emissions from tailpipe of the vehicle are dependent on average speed of vehicles and resuspension of dust on the condition of vehicles. Therefore, the traffic management and road network system will be a major concern for coming years and it will continue to be a major source of air pollution in the valley.

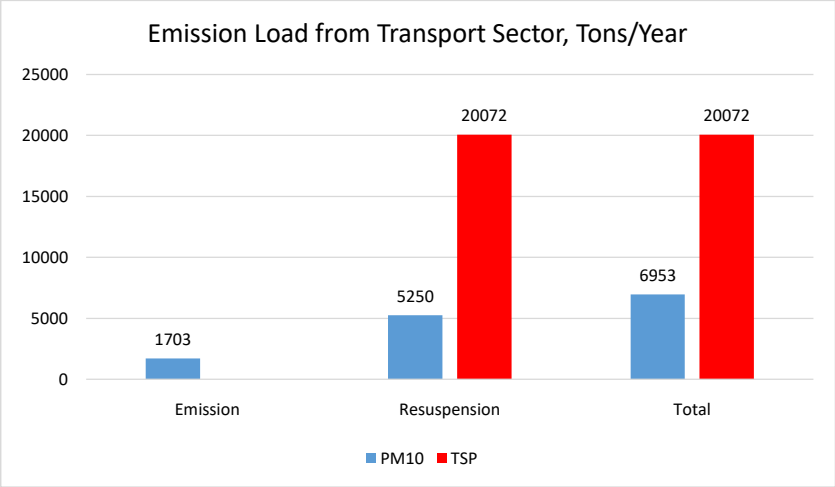
3.2.4 Emission Load from Transport Sector

The contribution of transport sector both in terms of emission from the vehicle and resuspension of dust particles from the roads is presented in Table 3.2.

Table 3.2: Emissions Load from Transport Sector

Type of Vehicles	**Emissions, PM10 (tons/year)**		**Resuspension of Dust (tons/year)**	
	Diesel	**Petrol**	**TSP**	**PM10**
Public Transport	742	-	2192	570
Goods Transport	770		1430	372
Private Cars/Van/Jeep	72	3	3510	944

Motor Cycles		116	12939	3364
Total	**1584**	**119**	**20072**	**5250**



3.2 Industry Sector

3.2.1 Brick Manufacturing Sector

Brick is one of the main construction materials in Nepal and in the valley. In Kathmandu Valley, there are 110 different types of brick kiln industries in operation currently. Among them 15 are in Kathmandu, 32 inLalitpurand 63 in Bhaktapur district. The industry is seasonal and operates for about 6-7 months from November to May except for large mechanized kilns with shades for storing bricks.About 30,000 people are employed in the sector. Brick Kiln with technology type and capacities are presented in Table 3.3.

Table 1.3 Existing brick kiln technologies

Kiln Type	Number	Percentage of Total Kilns,(%)	Brick Production (million bricks)	Percentage of total production (%)
FBTK	107	97.3	612	92.7
VSBK	1	0.9	8	1.2
Hoffmann	2	1.8	40	6.1
Total	**110**	**100**	**660**	**100**

Source: FNBI

As per the above table, the total annual production capacity of all the brick kilns in the valley is 660 million bricks. The demand of bricks in the valley is far more than this capacity and bricks are brought from outside in the valley. The main source of energy is coal and some kilns also use other fuel such as saw dust, lapsi seed, baggasse, rice husk and agriculture residue. Annual consumption of coal in brick kilns is 56100 tons and other fuel around 330 tons. As the industries in the valley can't meet the demands of bricks in valley, bricks are also brought from outside valley. The EPA and EPR require that a brick industry before its establishment needs to undergo IEE/EIA on two grounds

as set out in annex-1 and annex-4. That includes distance from the forest boundary and number of bricks to be produced. The traditional Moving Bull Trench Kiln technology has been banned in the Katmandu valley, the only alternative is to adopt the new technologies. In addition to the IEE/EIA requirement, the brick industries have to comply with the emission standard (Table 3.4)

Table 3.4 Emission Standards and Chimney Height for Brick Kilns in Nepal

S.N.	Types of Kiln	Suspended Particulate Matter (Maximum Limit)	Height of Chimney (Minimum Limit)
1	Bull's Trench Kiln Forced Draft	600 mg/Nm^3	17 meter
2	Bull's Trench Kiln, Natural Draught (Fixed Chimney)	700 mg/Nm^3	30 meter
3	Vertical Shaft Brick Kiln	400 mg/Nm^3	15 meter

Note:

1. Value of suspended particulate matter shall be calculated considering reference oxygen concentration as 10%
2. Chimney height shall be measured from ground level.

In addition to the standard, the brick kilns also require to fulfill the following requirements:

Minimum Land area requirement:

- For VSBK: 100 ft. radius (Approximately 14 ropani)
- For natural draught FBTK / forced draught FBTK: 200 ft. radius (Approximately 28 ropani)

Minimum Distance from the forest:

- For VSBK: 5 km.
- For natural draught FBTK/ forced draught FBTK: 5 km.
- Minimum Distance from nearby dense population:

- For VSBK: 500 m.
- For natural draught FBTK/ forced draught FBTK: 1 km.

According to the above land requirement the VSVK requires about 14 ropani of land and FBTK approximately 28 ropani for industry registration. In actual practice it is found that industries are using more than 100 ropani of land in lease during the season.

Air Pollution Load of the Sector

Brick industries are heavily polluting industries and one of the main sources of air pollution in Kathmandu Valley. Not only the emission, the resuspension of dust due to excavation and material handling activities generate significant amount of dust in the valley. Emission factors used for the estimation of emission load from the sector is provided in Table 3.5. The data was derived by actual monitoring from VSVK and FBTK, and Hofman technology used from USEPA. The average of three values for FBTK is used to estimate the actual load. In order to estimate the resuspension dust of excavation and material handling activities, the emission factor from USEPA other

construction activities is taken (TSP-3.3kg/m^2-year, PM10-1 kg/m^2-year). As the industries are run only for 6 months, it is divided by 2. The total air pollution load of the sector is presented in Table 3.6

Table 3.5 Mass emission load of the specific Kilns (kg of SPM/1000 fired bricks)

Type	**Mass emission load**
VSBK	0.33
FBTK Forced draught, Zig Zag Stacking	0.87
FBTK Forced draught, Straight Line Stacking	1.82
FBTK Forced draught, Straight Line Stacking	2.51
Hoffman Kilns	1.63

(Source: Stack and energy monitoring of brick kilns in KathmanduValley – 2005)
(IEM Project report reference No. : [ES – 1/48/005]

Table 3.6 Emission load and resuspension of dust in different kilns

	Emissions Load			**Resuspension of Dust**				
Technology	Annual Production (million)	EF (kg/1000)	PM (tons)	Area (meter square)	EF (TSP-kg/m2)	PM10 (1.0 kg/m2-year)	TSP (tons)	PM10 (tons)
VSBK	8	0.33	2.64	7084	3.3	1.0	12	3.5
FBTK	612	1.73	1060.8	1515976	3.3	1.0	2501	798
Hoffman	40	1.63	65.2	101200	3.3	1.0	177	50.6
			1128.64				**2680**	**812**

In addition to the air pollution problem, brick industries require large quantity of water which most industries get from ground water leading to depletion of aquifer and lowering water table. They use the agriculture land leading to loss of top soil.

3.2.2 Industries with Boilers

More than 500 boilers are currently operating in Nepal (DoE, 2017). Among them, there are all total 90 boilers in Kathmandu valley, which have average capacity of 1.2 tons per hour. Further, the average operating days per year is 300 days. In Kathmandu valley, the average operating hour ofboiler per day is 12 hours(Labour office, Kathmandu, 2017). An Industry that utilizes boilers in Kathmandu Valley is wool dyeing industries, dairy, beverage, hotelsand plywood. Most industries in Nepal predominantly use rice husk and diesel and some use bagasse, furnace oil, kerosene, coal, wooden chips as fuel in boilers to meet their steam and hot water requirements. In Kathmandu Valley, the boilers with different fuel uses are presented in Figure 3.4.

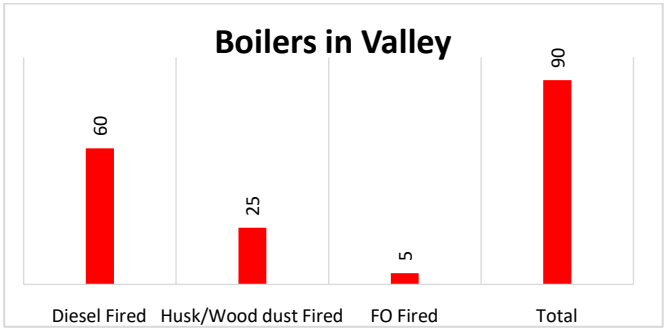


Figure 3.4: Different types of boilers used in Kathmandu Valley

Emission Standards and Compliance Status

Government of Nepal Ministry of Population and Environment (MoPE, 2012) has published the "Standard on Emission for Industrial Boiler) and while monitoring the industries it is found that industries are in compliance with the standard (Table 3.7). It is found that diesel fired boilers are cleaner than the woodchips/dust fired or Furnace oil boilers.

Table 3.7: Boilers Types and Compliance Status with Standard

SN	Boilers	Capacity (tons/hrs)	PM (mg/Nm^3)	Standards PM (mg/Nm^3)
1	Diesel Fired Boiler 1	Less than 2	126.3	1200
2	Diesel Fired Boiler 2	2.5	118.05	800
3	Diesel Fired Boiler 3	Less than 2	187.9	1200
4	FO Fired Boiler	Less than 2	570	1200
5	Wood Chips/dust Fired	Less than 2	890	1200

Emissions from Boilers

The total emissions from industrial boilers are calculated on the basis of the fuel used for the purpose like fuelwood, furnace oil, diesel or agricultural residue.The annual emissions for all boiler types in the year 2016 is calculated to be 56.88 tons of PM. The boilers number with type, fuel consumption, and the emission factors are presented in the 3.8. Fuelwood/husk fired boilers are the most polluting one as compared to diesel and furnace oil fired.

Table 3.8: Emission Load from Industrial Boilers

Boilers	Numbers	Average Capacity (tons/hr)	Annual operating days	Daily operating hours	Annual Fuel used (MT)	EF (kg/unit)	PM (tons)
Diesel fired	60	1.2	300	12	6480	0.24	1.55
FO Fired	5	1.2	300	12	540	0.61	0.33
FW/husk fired	25	1.2	300	12	3600	15.3	55.00
					Total		**56.88**

3.2.3 Other industries

According to DOCSI, there are almost 15,000 cottage and small scale industries with renewed registration inside the valley alone. Many such industries use coal, wood, rice husk, diesel, kerosene as fuel in the process. There is no estimation of such fuel consumed by these industries; however, they are using uncontrolled methods in the process, and are contributing significantly to the particulate pollutants in the ambient air.A simple assumption is done- a ton of diesel per day, 10 ton (one truck) of coal per day, 10 ton of fuelwood per day, 1 ton of kerosene per day, and 1 ton of rice husk per day is made to estimate the pollution load (Table 3.9).

Table 3.9 Estimating of PM load from other industries

Fuel Type	Annual Quantity (tons)	EF (kg/unit)	PM (tons/year)
Diesel	365	0.24	0.09
Coal	3650	20	73.00
Kerosene	365	0.61	0.22
Fuelwood	3650	15.3	55.80
Rice husk	365	15.3	5.58
			134.19

3.2.4 Industrial Pollution Load

The contribution of the industry sector to the air pollution in the valley is presented in Table 3.10.

Table 3.10 Industrial Pollution Load

Industries	***SPM (tons/year)***	***PM10 (tons/year)***
Brick Kilns	2680	1940.64
Industries with boilers		56.88
Stone Crushers		NA
Other industries		***134.19***

3.3 Waste Management

Refuse Burning

The population in Kathmandu Valley is increasing rapidly. The estimated population of Kathmandu Valley is approximately 3.5 million for the year 2016. And the average solid waste generation per capita per day is 0.50 kg/capita/day and as such total waste generated every day is 1750 tons. Considering waste collection efficiency which is not up to the international best practices, it can be assumed that 5 to 10% of waste is burned openly. Using the emission factor used in Delhi of 8kg/ton of waste, a total of 255 tons to 510 tons of PM is emitted in the valley.Alarming aspect of this practice is that in many places the plastics are mixed and burned which can generate dioxin and furan, the known carcinogen.

Hospital Waste Incineration and Burning:

In Kathmandu valley there are 42 hospitals which have incineration facilities and other hospitals and health centers do not have incinerators. It is estimated that about 28.4 tons wastes is generated by hospitals in the valley every day and of which 59% is segregated and send to municipality, the rest is categorized as hazardous waste. This hazardous waste is either incinerated or burned openly illegally. In the month of May 2017, stack monitoring of three hospitals were done and none of the incinerators are in compliance with the prescribed standard (Figure 3.5).

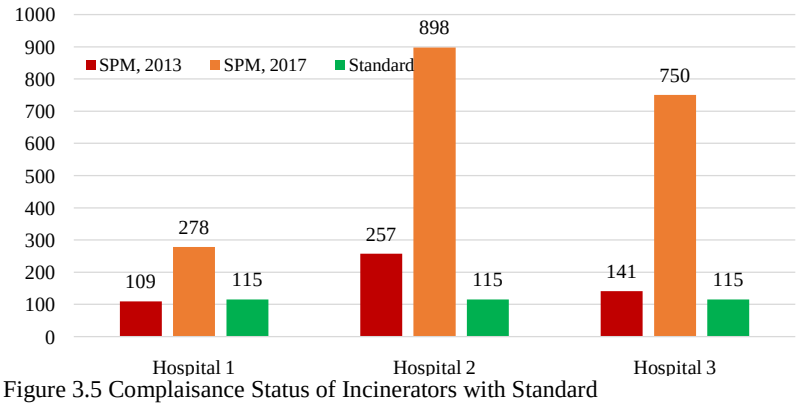


Figure 3.5 Complaisance Status of Incinerators with Standard

In many hospitals there is still lack of installation of incinerator and there are no private or municipal facilities for treatment of hazardous hospital wastes in an environmentally sound manner. Most of the incinerators are operated in worst condition without installing SPM controlling devices which has increased SPM concentration. There are toxic air pollutants like dioxin, furans, mercury and lead released by incinerator which is highly risky to patients and staffs of hospitals and people living around the hospitals. Although there is standard for these pollutants, there is no monitoring capacity in the country. Few hospitals are found well managed and using non burned technology such as autoclaving. Most of the incinerators are operated at night time to avoid public complaints.

If 11.6 tons of toxic wastes is incinerated in an uncontrolled manner or burned opening, this not only generates 9.73 tons of PM (EF- 2.3 kg/ton) annually, it also emits significant quantity of carcinogens in the populated area risking the life of many from institutions established to cure the patients.

3.4 Domestic Sources

Population of Kathmandu Valley is now reached to around 3.5 million people thus increasing the demand for fuel for cooking purposes. According to NOC, every day about 424 tons of LPG and 19 tons of kerosene aredistributed in Kathmandu Valley. About 50% of kerosene is assumed to be used for cooking purposes. There is no specific figure of fuel wood consumption in the valley. Per capita wood consumption is around 180-200 kg/year if used as domestic cooking fuel source. And assuming still 10% of valley population use fire wood as source of energy for domestic cooking and other purposes, the annual consumption of fire wood in valley is approximately 70,000 tons. About 350 tons of coal is coming to valley daily, and majority of it is used in brick industries and industries with furnaces. Assuming only 10 tons is used for commercial cooking purposes in the valley; it is used 3650 tons annually. The emission factors used for domestic purposes for both kerosene and LPG and fuel wood is taken from Delhi.

Table 3.12 : Contribution of Particulate Pollutants from Domestic Cooking

Domestic CookingFuel	***Annual Consumption (tons)***	***EF (kg/Ton)***	***PM10 (tons/year)***
Kerosene	3467	0.61	2.11
LPG	154760	0.514	79.5
Fuel Wood	70000	15.3	1071

Coal (commercial cooking)	3650	20	73
Total			**1225.61**

3.5 Agriculture Sector

The total area of three districts of KathmanduValley is 899 square kilometers (222148 acres). It is estimated that around 40 % of the total area still the agriculture land, then using emission factor used by US EPA, AP 42 (emission factor in 4 pounds per acre) (0.001818 tons/acre/year), the fugitive emission from agricultural activities for PM10 is 161 tons per year.

3.6 Construction Activities

Kathmandu is also in the process of reconstruction after the earthquake and as the mega city, there are construction activities going on for residential houses, apartments, commercial and institutional buildings, and road constructions. These activities are sources of dust pollution as well as smaller particles with use of equipments. The estimation of pollution load for these activities is provided in Table 3.13

Table 3.13 Emission Load from Construction Activities in Valley

Description of Activities	**Area (Square Meter)**	**TSP (kg/m2-year)**	**PM10 (kg/m2-year)**	**TSP (tons/year)**	**PM10 (tons /year)**
Residential buildings	13,875,000	0.29	0.086	4,023	1193
Apartments	90,000	1.0	0.3	900	270
Other than residential and apartments	170,000	3.3	1	561	170
Road construction	45,60,000	7.7	2.3	35,112	10,488
Total	**14,405,000**			**40,596**	**12,121**

3.7 Power Generation (Diesel Generators)

About 8000 DG sets are in use in Kathmandu Valley (Table 3.14) which was estimated to supply about 375 MW out of 1095 MW demand in 2013-14. If average running hours per day is 12 then 1607 KL of diesel is consumed during the peak load shedding time. These days it is assumed DG sets run one hour in average thus the daily diesel consumption reduced to 134KL. These will generate about 12 tons of PM annually (EF-0.24 kg/KL).

Table 3.14 Distribution of DG sets in Valley

S.N.	**Distribution of DG/Sector**	**Coverage %**	**No. of DG**
1	Commercial Sector	77	6160
2	Hospital sector	6	480
3	Government Offices, NGO's & INGOs	6	480
4	Manufacturing Industries	10	800
5	Others	1	80

Total	**100**	**8000**

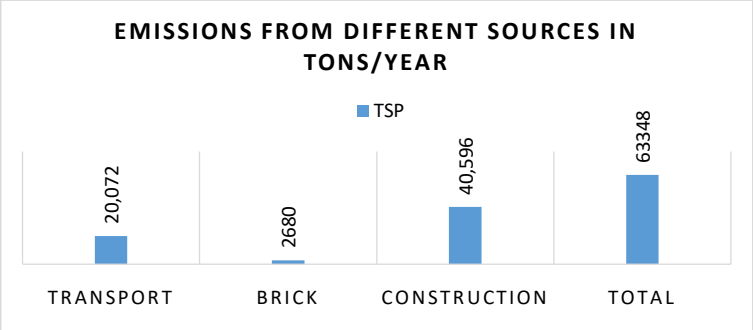
Source: On July 28, 2015 Himalayan Times

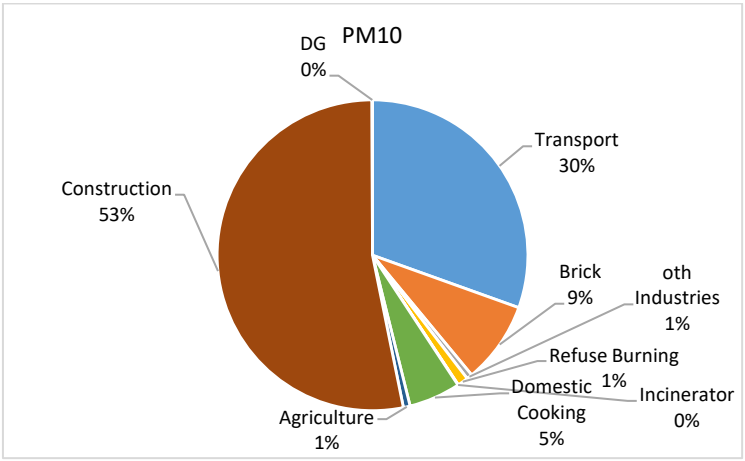
3.7 Total Emission Load From Different Sources

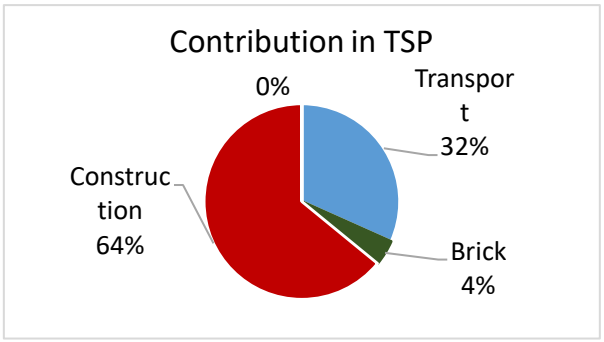
With the above detailed analysis of different sources of particulate pollutants in Kathmandu Valley, the contributions of different sectors are summed up in Table 3.15.

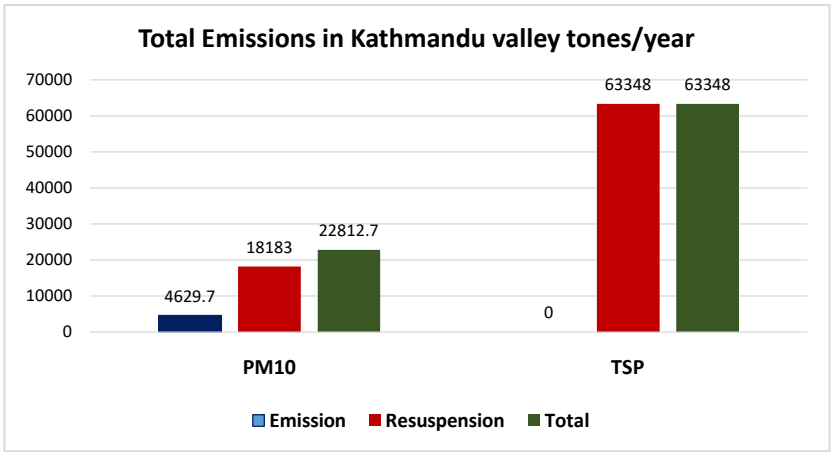
Table 3.15 Total Emission from Different Sources in Tones per year

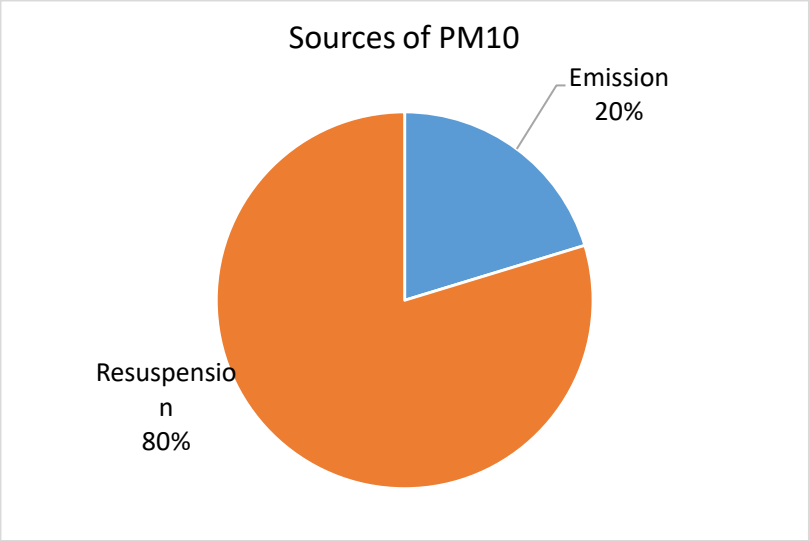
	Emission	Resuspension		Total PM10	PM10, %	TSP, %
	PM10	TSP	PM10			
Transport Sector	1703	20,072	5,250	6,953	30	32
Brick	1129	2680	812	1941	9	4
Other Industries	134			134	0.6	
Refuse Burning	255			255	1.1	
Incinerator	9.7			9.7	0.004	
Domestic Cooking	1226			1226	5.4	
Agriculture	161			161	0.7	
Construction	0	40,596	12,121	12121	53.1	64
DG	12			12	0.096	
Total	**4629.7**	**63,348**	**18,183**	**22,812.7**	**100.**	**100**




PM10
DG
0%
Transport
30%
Construction
53%
Brick
9%
oth
Industries
1%
Refuse Burning
1%
Domestic
Cooking
5%
Incinerator
0%
Agriculture
1%


Contribution in TSP
0%
Transport
32%
Construction
64%
Brick
4%


Total Emissions in Kathmandu valley tones/year
70000
60000
50000
40000
30000
20000
10000
0
4629.7
18183
22812.7
0
63348
63348
PM10
TSP
Emission
Resuspension
Total


Sources of PM10
Emission
20%
Resuspensio
n
80%

Chapter Four

Review of Relevant National Policies/Strategies/Legislations and Administrative Recommendations:

4.1 Environmental Policy and Legislative Framework

Environmental Act 1996 and Regulation 1997

Environment Act 1996 and the Regulation 1997 are the umbrella law on the environment in the country. Main provisions that relate to prevent and control air pollution include:

- Major projects need to go through the process of environmental assessment and comply with the environmental management plan and mandate to MOPE to monitoring during the implementation
- Creating pollution is the punishable act
- Provides authority to MOPE to promulgate standards and ensure their compliance
- Provision of Environmental Protection Fund for utilization in pollution prevention and control activities
- Use of economic incentives and disincentives to prevent and control pollution
- Polluters to have pollution control certificate (concerned authorities to issue within 6 months of this acts in place, and hence not in use yet)

As environmental legislations are being reviewed and modified regularly in many countries, there is the need to review and make them more clear and easy to implement.

National Climate Change Policy 2011

Government of Nepal on January 22, 2011 introduced the National Climate Change Policy which envisions a country spared from the adverse impacts of climate change, by considering climate justice, through the pursuit of environmental conservation, human development, and sustainable development--all contributing toward a prosperous society.

This policy has set the target to have the National Low Carbon Development Strategy by 2014 and also a national strategy on carbon trade to benefit from CDM by 2012. Establishment of climate change center, climate resilient infrastructures, and focus on public awareness are other areas of priority. This policy has set seven different objectives focusing on institutional strengthening, climate change mitigation and adaption, promotion of use of clean energy, strengthening the capacities of local communities, follow the low carbon development path, institutional capacity on impact assessment, maximizing the benefits from climate finance. In order to achieve the objectives, policies for each objective are defined and altogether 61 different policies are there.This policy proposes establishing a separate "Climate Change Fund" for implementing programmes.

National Low Carbon Economic Development Strategy (Draft)

As per the commitment made in the National Climate Change Policy, this strategy should have been finalized by 2014 but it is still in the draft stage. This is developed to guide the country to follow the low carbon development path with following goals:

- To decrease the dependence on fossil fuels by the optimal development of hydropower and other renewable energies, and build energy capacity.

- To develop climate change resilient infrastructure through the development, use and promotion of the technologies that emit low carbon.
- To reduce poverty through the growth of national production and income by attracting fund for rapid low carbon economic development.

As this strategy is to promote the low carbon development, the implementation of this will directly help to reduce the use of fossil fuel in the valley. The key strategies that will help to reduce air pollutants are:

- Hydropower and renewable energy development (4000 MW by 2020 and 12000 MW by 2030) and 2100 MW of solar energy by 2030
- Maximum focus on demand side management (energy efficiency, energy code, energy performance standards, use of economic instruments)
- Moving towards environmentally sustainable transport system
- Utilizing waste as resource
- Urban plantation

National Pollution Control Strategy and Action Plan (Draft)

This NPCSAP has set the vision of pollution free clean and healthy environment and in order to move towards this vision has considered two strategic pillars- pollution prevention and pollution control.

The pollution prevention strategy focuses on:

- Strengthening the institutional mechanism
- Mainstreaming pollution prevention measures into all development efforts
- Minimization/Reduction at the source
- Raising public awareness

And the pollution control strategy focuses on:

- Ensuring compliance to legal provisions
- Comprehensive waste (pollutants) management
- Enhancing accountability (through legal measures)
- Making polluters pay
- Addressing trans-boundary pollution issues
- Enhancing government's preparedness to respond environmental accidents

As this the strategy with action plan, the action plan proposed with respect to air pollution prevention and control are summed up here:

- ✓ Redefine emission standards for vehicle and industries based on baseline assessment of monitoring parameters
- ✓ Update motor vehicle inspection and emission testing system (MVIETS)
- ✓ Activate and operationalise VFTQC
- ✓ Strengthen vehicle emission enforcement capabilities with gradual improvement in implementation of MVIETS for all vehicles
- ✓ Strengthen traffic control office and traffic engineering capabilities to reduce traffic congestion (including the road discipline programs)
- ✓ Promote mass public transport and put restriction on entry of non-destined commercial vehicles inside core urban areas
- ✓ Establish the accredited organization/institution for the inspection of the vehicle exhaust emissions and implement strictly the green sticker provisions

- ✓ Monitor gasoline sale to ensure that it is not adultered; and has low emissions of benzene
- ✓ Develop and implement a policy to discourage to ply the EURO1, EURO 2 vehicles and encourage importing only the EURO 3 and 4 standard vehicles.
- ✓ Provide the emission test equipment to private motor workshops to ensure that the vehicle that goes under the maintenance have thoroughly done maintenance and have passed the emission test.
- ✓ Introduce metro, trolley buses and low emission vehicles
- ✓ Conduct regular clean-up activity of the road and roadside areas and prohibit littering habit of people
- ✓ Capacitate the private sector technical human resources in emission testing
- ✓ Introduce age limit regulations based on emission testing results and comply with regulations
- ✓ Designate appropriate zone (Land zoning) for placement of the industries and extraction of resources for the industries (for example excavation of soil resource for brick industries)
- ✓ Prepare the Air pollution Monitoring guidelines
- ✓ Monitor to ensure that industries have installed pollution control, smoke and dust control and/or gas control devices
- ✓ Initiate and "Pilot Green Industrial Fund" to promote innovative green industrial technologies that can out-perform conventional methods (emission reduction devices, fuel saving devices and conversions from conventional to alternative fueled machines)
- ✓ Conduct studies on health impact of air pollution in urban areas by providing research grants
- ✓ Make clear legislative provision to close and/or relocate heavily polluting industries (based on emission monitoring results) from settlement areas or protected and environmentally sensitive areas, implement it and comply with it
- ✓ Strictly enforce "polluters pay principle" and fines for violations and clarify obligations to submit emission monitoring reports

4.2 Transport Sector Policies and Legislations

National Transport Policy 2001:

- Aims to make the transport sector environment friendly.
- Construction, improvement and management of the means of transport in compliance with the requirement of traffic and environmental safety.
- Expansion of the solar power and electricity driven transport means throughout the country.
- Special attention to be provided in improving 'the comfort, reliability, safety, frequency, availability and affordability of public transport" to reduce the harmful emissions from mobile sources.
- Provisions of the economic instruments in the form of custom and tax incentives to promote private sector involvement in the construction maintenance and rehabilitation of transport infrastructure and to encourage nonpolluting vehicles.

Transport Management Act 2049 and Vehicles and Transport Management Rules 2054

- Categorizes the vehicles (big, medium, small, public, tourism, private, government, corporation, diplomatic) and use is mandated to be as per the registration
- Mandatory requirement for registration with proof of fitness to run
- Authority to prescribe standards for vehicles worthiness and right to reject in noncompliance
- Restriction on change of vehicles even fuel switch without prior permission
- Route permission for public transport with requirement of fitness certificate
- No overload beyond the registered capacity of the public transport
- Restriction on vehicle speed and also on load of the vehicle as per the road status

National Sustainable Transport Strategy (NSTS) (2015-2040) (Draft):

This draft NSTS has the vision of "developing a transport system that is efficient, accessible, people-centric, affordable, reliable, safe, inclusive, environmental friendly, and climate and disaster resilient". This vision is based on the principles of efficient, accessible, people-centric, affordable, reliable, safe, inclusive, environment-friendly and climate and disaster resilient. It has set a total of 19 objectives into economic, environmental and social dimensions with indicative targets for each objectives (Table 4.1). Once approved by the government it will be the latest strategy of the government in transport sector, the recommended strategic actions under 9 different strategies are summed up in Table 4.2.

Table 4.1: Objectives and Targets of National Sustainable Transport Strategy (2015-2040):

Economic Dimensions	***Environmental Dimensions***	***Social Dimensions***
1. Efficiency in investment and service operation ✓ Reasonable IRR and profitability ✓ Operating cost per vehicle km ✓ Energy consumption per pass-km 2. Efficient and timely maintenance of infrastructure and facilities ✓ Pothole free roads ✓ Acceptable International Roughness Index (IRI) 3. Improved accessibility □ ✓ Minimize time to road head (ICT, RT); ✓ % Coverage of public transport (with 15 minute walk) (UT) 4. Secure higher mobility ✓ Average travel speed in city area (30 km/hr) (UT)	8. Ensuring sustainability in the use of natural resources and nature conservation ✓ Minimize use of arable land for infrastructure ✓ Minimize impacts on ecological resources (ICT, RT) 9. Maintain the standard of vehicle or engine condition ✓ Limit on vehicle age (years); Average age of vehicle ✓ Emission compliance rate 10. Minimize local pollution and noise effects (UT) ✓ Minimize car/motor cycle ownership (#/population) ✓ Mode share of public transport (> 60 %) 11. Promote electric vehicles ✓ Percentage of electric	15. Improve transport safety and security ✓ Reduced traffic accidents (fatalities per vehicle, fatalities per vehicle-km) ✓ Reduced incidence of travel related crimes 16. Ensure inclusiveness of transport system ✓ % of public transport coverage; % of barrier-free vehicles 17. Ensure gender equity in transport services ✓ % of all-women public transport vehicles; % seats for women 18. Minimize social

Economic Dimensions	*Environmental Dimensions*	*Social Dimensions*
✓ Average travel speed for ICT (general highway 50 km/hr; Exp ways 80 km/hr; railway 160 km/hr) 5. Ensuring affordable transport services ✓ ICT/RT- fare per Km as % of per capita income ✓ UT- daily commuting cost as % of per capita income 6. Provision of reliable transport services ✓ Provision of schedule services (% of delay) 7. Leveraging transport for poverty reduction ✓ Degree of labor intensive technology ✓ % of investment in backward areas	vehicles in total fleet 12. Minimize CO2 emissions from transport ✓ Per capita CO2 from transport sector ✓ Average CO2 emission per pass-km (g CO2) 13. Increase climate and disaster resiliency of transport infrastructure ✓ Revising design standards and codes ✓ Reduced incidence of infrastructure damage by climate related disasters 14. Greening the freight transport ✓ Develop database on freight transport ✓ Higher standard of truck engines (Euro IV) ✓ Efficient operation (fuel economy) ✓ Modal shift to rail/water	impacts of transport development ✓ Minimize degree of community separation due to transport routes 19. Integrate transport and public health ✓ Minimize local pollution ✓ Share of NMT modes in total trips

Table 4.2: Strategic Actions of National Sustainable Transport Strategy (2015-2040)

Investment for essential, people friendly and sustainable transport infrastructure
✓ Expand road network in Kathmandu Valley and other major cities ✓ Introduce advance and innovative construction/maintenance methods for urban roads ✓ Acquire adequate right-of-way (RoW) for strategic urban roads in secondary and tertiary cities ✓ Designate the road hierarchy and complete missing links in Kathmandu ✓ Improvement of major intersection in Kathmandu valley and other major cities (including provision of flyovers) ✓ Improvement of traffic management system in Kathmandu valley and other major cities ✓ Provisions of pedestrian facilities, such as overhead bridges ✓ Planning and implementation of outer ring-road and other suburban arterial roads in Kathmandu valley ✓ Prepare a Master Plan for mass transit in Kathmandu (high capacity bus, BRT, LRT, MRT) ✓ Improve the condition of road-based public transport with viable options, such as introduction of high-capacity buses, provision of bus lane or Bus Rapid Transit (BRT) system. ✓ Make use of value-capture mechanism to fund urban transport infrastructure investment and integrate transport and land development. ✓ Invest for pedestrian and Non Motorized Transport (NMT) infrastructure in Kathmandu and other cities

- ✓ Make provisions for bus terminals, bus stops, taxi stands and bicycle stands and transfer facilities
- ✓ Make provision of parking facilities in Kathmandu and other major cities
- ✓ Undertake road network planning in secondary/tertiary cities

Planning and development of integrated transport system

- ✓ Coordinated planning of transport network with other sectoral plans, such as industrial zones, hydropower development, eco-tourism, agro-industries and so on.
- ✓ Achieve integration between national transport network and regional development plan
- ✓ Match transport hierarchy with city hierarchy
- ✓ Coordinate railway development with regional development and local town development plans Physical integration with good connectivity of highways, railways and airports with the provisions of intermodal (transfer) facilities
- ✓ Coordinate the development of road-side service station with the function of market for local agricultural and other productions
- ✓ Balancing social cost and benefits of different intercity modes through subsidies and taxes Coordinate land-use and transport development
- ✓ Promote transit oriented development (TOD) in big and small cities
- ✓ Promote high-density and compact city development (minimize travel)
- ✓ Plan for future Mass Rapid Transit (MRT) routes and locate the high-density housing (such as apartments) along the MRT routes
- ✓ Make adequate provision of transfer facilities (connecting different modes)
- ✓ Make provision of parking for introducing park-and-ride system
- ✓ Enforce integrated fare system (eg distance-based) for public transport
- ✓ Seek balance between the cost of private mode and public transport fare
- ✓ Recognize walk and NMT modes as the means of improving public health

Introduction of technology for efficiency and sustainability

- ✓ Improved standard for vehicle energy efficiency
- ✓ Upgraded emission standards
- ✓ Use of alternative and low-emission fuels
- ✓ Electrification of transport vehicles
- ✓ Introduction of electric rickshaw in small/medium cities
- ✓ Exploring possible use of Intelligent Transport System (ITS) for enhancing road safety and transport service improvement, and designing new infrastructure considering possible use of ITS in future.
- ✓ Consideration for possible use of high-speed rail (HSR) in future for the proposed East-West railways routes (civil structure to be designed for HSR)
- ✓ Introduction of trolley buses or electric buses in Kathmandu
- ✓ Introduction of bus lane or BRT routes where the existing road width permits.
- ✓ Provision of high-quality buses (with bus info system, WiFi)
- ✓ Barrier free public transport vehicles (eg., low floor buses)
- ✓ Use of green road technology and bio-engineering to minimize ecological impacts and landslide hazards due to construction of rural roads

Priority for improving public transport and non-motorized transport

- ✓ Taxing private modes (vehicle tax and fuel tax) and provide subsidy to public transport from the collected revenue
- ✓ Improve service level of public transport (speed, vehicles standard, reliability, safety)

- ✓ Planning for bus lane in newly constructed intercity expressway routes
- ✓ Pedestrian way and dedicated bicycle lanes along national highway sections passing through the settlement areas.
- ✓ Make provision of bus lane during peak hour
- ✓ Setting standards for pedestrian way and NMT lanes in urban areas
- ✓ Study for possible restriction of motorcycles and cars (during peak hour) on the busiest routes in Kathmandu valley
- ✓ Provision of public transport (electric vehicles) and NMT facilities in cities/towns that are popular tourist destination

Travel demand management (TDM)

- ✓ Plan for regional economic zones and transport connectivity to minimize intercity travel and for better economic integration among the regions.
- ✓ Planned city development along national transport corridors giving priority for making use of public transport (intercity) more efficient and convenient (such as with provisions of bus terminal, access/egress modes).
- ✓ Reduce travel demand by
    - Land-use and transport coordination
    - Pricing transport to reflect real social cost
- ✓ Arrange staggered working/school hours
- ✓ Promote tele-commuting
- ✓ Promote modal shift (from private to public)
    - Raising public awareness on the benefits of public transport
    - Imposing higher cost on private modes ('push' factor)
    - Making public transport attractive ('pull' factor)
- ✓ Plan and implement urban development schemes under Transit Oriented Development (TOD) in Kathmandu valley and other sub-metropolitan cities.
- ✓ Early planning intervention to ensure land-use and transport coordination in newly (recently) declared municipalities or newly extended areas of existing municipalities or metro (and sub-metro) cities.

Environmental and social safeguards

- ✓ Reviewing guidelines for environmental and social assessment
- ✓ Provision of considering positive environmental benefits of railways in EIA guidelines
- ✓ Strengthening vehicle testing and green sticker system.
- ✓ Monitoring of vehicle/engine condition for compliance
- ✓ Regulation on aging vehicles
    - Implement the policy decision of phasing out 20 years old vehicles
    - Prepare guidelines for limiting vehicles ages by the kind of vehicles (such as private, taxis, buses, minibuses, freight vehicles, vehicles for urban, intercity and rural; vehicles for terai and hill areas)
- ✓ Provision of safety audit for infrastructure and vehicles
- ✓ Checking drivers' health and other condition
- ✓ Stringent conditions for issuing driving licenses for public transport vehicles
- ✓ Provision of service lanes on national highways
- ✓ Provision of over/under pass on national highway and railways
- ✓ Up scaling vehicle emissions standards in Kathmandu valley
- ✓ Strict monitoring of compliance of vehicle emission standard
- ✓ Upgrading engineering and environmental standards of rural roads

Adopt the concept of green freight
✓ Coordinate production and consumption places (minimalize transport distance) ✓ Minimize empty-running of trucks ✓ Improve engine efficiency (fuel economy) ✓ Improve operational efficiency of truck transport ✓ Modal shift to railway/water transport ✓ Provision of container port (dry port) ✓ Urban freight transport • Provision of appropriately located freight station • Design of efficient distribution logistics • Clean vehicles
Building climate and disaster resilient transport system
✓ Awareness raising among key stakeholders ✓ Developing and mainstreaming project screening guidelines ✓ Adopt design standards to adapt climate change and other hazards ✓ Provision of network redundancy in transport planning ✓ Classification of road system based on the degree of vulnerability ✓ Adopting hierarchical design standards based on the strategic importance of a particular route of link ✓ Adopt higher design standard for strategic roads (eg access to hospital etc)
Enhance institutional capacity and undertake reform
✓ Building capacity of government institutions (central and local level governments) ✓ Upgrade technical capacity of private firms involved in infrastructure design and construction (consultants and contractors) ✓ Start courses on railway planning, engineering, and management in public engineering campus ✓ Establish railway training institute ✓ Building capacity for transport policy research • Establish in-house think-tank within government agencies • Establish long-run collaboration for transport policy research with some research center of public university ✓ Maintain data-base of basic transport data ✓ Restructure transport regulatory institutions and reform regulatory provisions for transport services. ✓ Establish linkage/partnership/collaboration with concern agencies /institutions/stakeholders national and international levels. ✓ Improve/enforce regulation for axle loads of heavy vehicles plying on the national highways ✓ Regulate use of motorcycle on some busiest routes (as a pilot project) ✓ Conduct periodic personal trip survey for Kathmandu valley ✓ Design public transport routes and franchising policy based on scientific analysis

4.3 Industry Sector Policies and Legislations

Industrial Policy 2011

- This policy identifies insufficient energy availability, weak industrial infrastructures, low productivity, and absence of technology acquire capacity as some of the barriers for industrial growth
- Vision of enhanced productivity and sustainability to achieve the goal of sustainable industrial development
- Aims to create a conducive environment for private, public and collaborative sector to participate and contribute in the national goal of poverty reduction
- Aims to establish the industry sector as one of the most reliable and dependable sector by promoting the use of modern technology and environment friendly production processes
- Provide financial and technical support to proactive industries on adopting environment friendly and energy saving technologies
- Initiate special programs to establish green industries and make the existing industries pollution free and zero carbon.
- The policy also has made the provision of special facilities like no royalty for energy produced by industry for its own use and also provision to sell through national grid at market price

Foreign Direct Investment Policy 2015

- In the context of promoting private sector investment in the cleaner technologies and cleaner industries through the market mechanism like Clean Development Mechanism or Sustainable Development Mechanism (Paris Agreement), this policy is important.
- Private investment and also the technology transfer require permission from the government as per this policy.
- Long-term goal of this policy is to attract the foreign investment on nationally prioritized sector.
- The objectives include not only to attract the foreign money but also equally prioritizes the investment on modern technology, management skill, and high technical skills to ensure the productive and competitive industrial growth.

Industrial Enterprises Act 2073:

- Provides responsibility to owners to ensure that the industry takes full care to control the adverse impact on environment
- Provision of license for industries that require to go through EIA and IEE procedures
- Industrial Promotion Board has the authority to restrict registration of industries in urban areas including Kathmandu Valley
- IPB had made the following decisions regarding the industries in the valley:

4.4 Energy Sector Policies and Legislations

Hydropower Development Policy 2001

- Quite old comparatively and do not even mention the word climate change
- On hydropower development, a clean source of energy, encompasses the objectives of the climate change
- Aims to develop hydropower as an exportable commodity

- Pursue investment friendly, clear, simple and transparent procedures so as to promote private sector participation in the development of hydropower, also taking into account internal consumption and export possibility of hydropower". Favors public private partnership in the development of hydropower sector in the country
- Promotes river basin approaches for watershed management

Rural Energy Policy 2006:

- In this policy rural energy is known as renewable energy
- Overall goal of this policy is to contribute to rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in the rural areas.
- Sets sector specific working policies on -micro and small hydro power; biogas; fuel-wood, charcoal, briquette, biomass energy, and biomass gasification; solar energy technology; wind energy technology; improved cook stove technology; improved water mill technology; and rural electrification
- Specific strategy on subsidy for renewable energy promotion

Renewable Energy Subsidy Policy 2016:

Introduced for the implementation of REP 2006:

- Provides the subsidies for different renewable energy technologies and defines the procedures for distribution of subsidies to the recipients.
- Involves the qualified private sector institutions in the distribution of subsidies also.
- A latest policy of the GON to promote renewable technologies with the use of economic instruments.

4.5 Summary of Recommendations of Various Committees

The challenge of dealing with increasing air pollution in the Kathmandu Valley has been recognized by the Ministry of Population and Environment in mid-nineties and over the years many committees it different levels has been constituted to recommend the actions in dealing the air pollution problem.

- Task Force on Air Pollution Control in Kathmandu Valley, 2073
- High Level Committee on Probing and Solving the Issues on 20 year Old Vehicles (MOPE), 2058
- Committee on Implementation of the Order of Supreme Court on Phase Out of 20 Year Old Vehicles (MOLTM) 2058/59
- Committee on Review of Vehicle Emission Standard and Monitoring Mechanism (MOPE)2060
- Technical Committee on the Relocation of Brick Industries from Kathmandu Valley (MOICS) 2060

4.5.1 Task Force on Air Pollution Control in Kathmandu Valley, 2073

This Task Force was constituted under the chairmanship of the Director General of Department of Environment with members from concerned ministries/departments and experts in the field. This TF was formed to recommend the immediate and short-term actions to deal with the alarming air pollution observed in the valley. The recommendations made by this TF are presented in Table 4.3

Table 4.3: Recommendations of Task Force on Air Pollution Control in Kathmandu Valley

Ban on Refuse Burning		
Activities	Roles and Responsibilities	Time Frame
Make waste collection system effective and restrict dumping of wastes at public places	Municipalities	Immediate
Strict ban on open burning of the wastes	Municipalities	Immediate
Proper management of health based wastes	DOH, health institutions, hospitals	Immediate
Expand electric cremation facilities at Pashupati and Teku	Pashupati Area Development Fund, and KMC	Next Fiscal Year
Control of Resuspension of Dusts from Roads in Valley		
Fix time table for refilling the excavated roads and blacktopping of roads	DOR and Muncipalities	Immediate
Arrangement of water spraying in the excavated roads	DOR and Contractors	Immediate
Monitoring to ensure the compliance of above recommendations	DOE	Immediate
Use alternative route in the excavated roads to the possible extent	Traffic Police	Immediate
Ensure quality of blacktopped roads and drainages	DOR and municipalities	Immediate
Control of vehicular exhaust emission		
Make the green sticker system effective throughout the Kathmandu Valley for all types of vehicles. Involve capable private sector workshop in the testing and DOTM in monitoring	DOTM, DOE, and Traffic Police	Immediate and next fiscal year
Introduce the on-road monitoring of vehicles and restrict the movement of non-comply ones.	Traffic Police	Immediate, and new equipments next FY
Reward citizens complaining the polluting vehicles and make use of mobile apps for this.	DOTM and Traffic Police	Immediate
Increase tax on private diesel vehicles,	MOF and DOTM	Next FY
Introduce EURO IV mass emission standard and fuel standard; and fix timetable for updating of the standards	MOPE, DOTM, NOC	Next FY
Monitor the load of the vehicles and take actions for those overloaded goods vehicles	Traffic Police	Immediate
Promotion of electric and hybrid vehicles		
Zero custom to electric vehicles, spare parts, and equipments. Economic incentives to hybrid vehicles	MOF	Next FY
Politician and high ranking government officials to use electric cars to create awareness	MOF	Next FY
Establish charging networks at highways to facilitate the movement of electric cars	MOF, NEA and Private Sector	Next FY
Legal arrangement to convert diesel and petrol vehicles into electric vehicles	DOTM	Immediate
Effective traffic management		
enforcement of traffic rules for easy movement of vehicles	Traffic Police	Immediate
Fix the public bus stops and enforce strictly	Traffic Police	Immediate
Make effective parking system and increase fees significantly	Municipalities	Immediate
Implement the fix time table for office/school	Traffic Police	Immediate

vehicles		
Install more traffic lights and repair the non-function traffic lights	DOR, Municipalities, Traffic Police	Immediate
Fix time table for goods vehicle to enter city areas	Traffic Police	Immediate
Make bus and truck terminal at appropriate places	DOTM and municipalities	Next FY
Improve public transport system		
Implement route reorientation plan developed by the Kathmandu Sustainable Urban Transport Project	DOTM	Immediate
Conduct the detailed feasibility study of pollution free mass transit system and establish bus rapid transit and bus lanes	KSUTP	Immediate
Develop integrated bus transport system with routes, bus stops, transit points, ticket counters and monthly ticket passes	DOTM and Public bus owners	Next FY
Incentives to pollution free public transport	MOF	Next FY
Promote walking and cycling		
Make walking safe and comfortable	DOR	Immediate
Make separate cycle lane in possible roads	DOR, Municipalities	Immediate
Make master plan for walking and cycling routes in whole valley	KVDA	Immediate
Make inner city of valley and other appropriate areas only cycling and walking areas	Municipalities and Traffic Policy	Immediate
Develop and implement guidelines and standards for design of urban roads	KVDA, DOR, Municipalities	Immediate
Minimize Emissions/Dusts from Brick-Kilns and Other Industries in Valley		
Use of Zig-zag firing technology or technology more efficient than this.	MOI, FBIN	Next FY
Review and upgrade the emission standard for Brik Kilns	MOPE	Immediate
Regular monitoring of emissions from brick kilns and boilers	DOE	Next FY
Encourage roofs to run industries in rainy season	MOI	Immediate
Restrict the running of Brick Kilns during January and February	MOI	Next FY
Promote alternatives to bricks and use them in government buildings	MOI	Immediate
Trainings to industries on cleaner production	MOI and Private Sector	Immediate
Promote Greenery in the Urban Areas		
Measure Green area in valley and prepare action plan for expansion and conservation	Kathmandu Valley Development Authority, Municipalities	Immediate
Plantation at roadside with proper care	DOR and Municipalities	Immediate
Develop and run public parks inside the city	Municipalities	Immediate
Convert into public parts the areas occupied by security agencies	MOD, MOH, KVDA	Immediate
Promote in-house greenery by promoting growing vegetables and gardens	Municipalities, MOAD	Immediate
Air Quality Monitoring and R&D		
Expand the network of AQM and dissipate the results to general public	DOE	Immediate
Impact assessment on human health in cooperation with hospitals	DOE and NHRC	Immediate

Analysis of government policies and its impact on the quality of air, human health and economy	MOPE and MOH	Immediate
Effective Coordination or Good Governance for Air Quality Management		
Reactivate Environment Protection Council	MOPE	Immediate
Develop guideline and proposal for utilization of pollution fee	MOPE	Current FY
Develop detailed action plan on improvement of air quality management of Kathmandu Valley	DOE	Immediate
Institutional strengthening of the DOE with clear legal mandate and financial and human resources	MOPE	Immediate
Institutional strengthening of the DOTM with clear legal mandate and financial and human resources	MOIDT	Immediate
Institutional strengthening of the Traffic Police with clear legal mandate and financial and human resources	MOH	Immediate
Nepal to become member of CCAC to benefit from its knowledge networks	MOPE	Immediate
Establish the Kathmandu Valley Transport Management Authority	MOIDT	Next FY
Public Awareness		
Develop action plans for public awareness	MOPE, MOH	Immediate
Publication and distribution of awareness materials including public notices;	DOE, DOH, Municipality, Information Centre	Immediate
Training to health professionals on air pollution and its impact on human health;	MOH	Immediate
Training to teachers and students on air pollution and its impacts;	MOE	Immediate
Mobilize mass communication media on public awareness	MOIC	Immediate

4.5.2 High Level Committee on Probing and Solving the Issues on 20-year-Old Vehicles (MOPE), 2058

Aneight-member high level committee formed under the chairmanship of member of National Planning Commission with secretaries from six ministries as member and joint secretary of MOPE as member secretary specifically to deal with the strong opposition of transport entrepreneurs on the decision ofbanning 1980s model either diesel or petrol-operated vehicles from plying on the streets of Kathmandu valley, a ban on the operation of the two-stroke-engine either petrol or gas operated three-wheeled vehicles effective from 2058-8-1.

Vehicle Retirement

Two stroke engine vehicles are responsible for particulate pollutants because of the mixing of lubricant in the engine and looking into the carrying capacity of the roads of Kathmandu Valley, following alternative measures are recommended:

- Government to scrape such vehicles (two stroke three wheelers) and compensate the vehicle owner (70 million rupees required for this based on 12 times of price of Rs 8/kg of scrape value)

- Tax rebate of 15% if two stroke three wheelers are replaced with EURO-I or EURO-II four stroke three wheelers by similar numbers (vehicle owners to get benefit of Rs 80 million in tax rebate)
- Facility to import individually or jointly of EURO-I or EURO-II standard microbus with seating capacity of 10-14 seats with 20% tax rebate against four such vehicles to be phased out (vehicle owner to get benefit of Rs 120 million in tax rebate)

Vehicle retirement program to be based upon the compliance of the vehicle with in-use emission standard and not on the age of the vehicle, and for this the following recommendations are made:

- Emission checking programs to the affected vehicles other than two stroke three wheelers to be established within 15 days and 15 days time to be given for repair and maintenance of vehicles not within the standard. Further 35 days time to repair and maintenance to bring within standard and if could not come, then phase out such vehicles.
- 2056-7-25 notification to be amended with provision of replacing the 20 years old vehicles not complying with standard only by EURO-I or EURO-II standard within certain time period.

Pollution Control Devices

- MOPE to investigate the feasibility of introducing pollution control devices like Catalytic Converter, Exhaust Gas Recirculation, Fuel Ingestion System into old vehicles to reduce pollution level.

Clean Fuel and Clean Vehicles

- Arrangement to be made to import fuel quality demanded by EURO-I or EURO-II standard vehicles for their optimum benefit in environmental ground and monitoring of fuel quality to be initiated by the designated authority NBSM.

- Explore of possibility of donor support in the strengthening of vehicle monitoring system, establishment of battery recycling plant, and expansion of trolley and tram as mass transport system.

- Promote clean electric vehicles through providing preferences in routes, developing infrastructure for battery recycling, promoting clean mass transport system in the valley and expand it in other cities

- Enforcement of load capacity standard on vehicles to prevent emission due to overload and also enforce the standard strictly on appearance, security, passenger facilities to avoid traffic congestion and reduce pollution. And also restriction on running of vehicles in other cities in the valley and vehicles permitted in long routes.

Traffic Management

- Preference for big vehicles in main roads and other small vehicles and three wheelers in link roads

- Alternate day permission for running of private vehicles as per odd and even number of vehicles in the first phase
- Compulsory arrangement for running in the left side of road for slow moving vehicles
- Expansion of road width, proper sewage management and improvement in quality of such facilities
- Arrangement for alternate passage like sky-over, sub-way, etc
- Smokeless vehicles only provision in tourist and cultural sensitive places
- Proper facilities and effective management of public transport stop over at roadside
- Complete ban on running small shops at footpath and piling of construction materials
- Repair and maintenance of water supply, telephone, sewage, electricity on roads to be done only in night time
- Municipalities to allocate space for establishment of standard workshop and discourage the workshops established at roadsides inside the city

Other Sources of Pollution

Particulate pollution is of serious concern and for the prevention and control effective programs are required focusing on major sources, particularly in the following sector:

- Vehicles
- Industries (traditional brick kilns and cement industries)
- Road quality improvement
- Solid waste management
- Fuel quality

Policy Shift

- "Polluters Pay" principle should be the long-term strategy of Environmental Policies and for this MOPE should take initiative.
- Private auto workshops to be accredited and entrusted with vehicle emission testing roles and responsibilities and government authorities to monitor such workshops

4.5.3 Committee on Implementation of the Order of Supreme Court on Phase Out of 20-Year-Old Vehicles (MOLTM) 2058/59

A writ was filed in the Supreme Court against the government's asking to enforce the decision of 2057-7-25 on phasing out of the 20 year old vehicles. Supreme Court directed government to implement the decision made with the objective of reducing the pollution level in the valley and Ministry of Labor and Transport Management formed a high level committee under the chairmanship of secretary of Ministry of Labor and Transport Management with following members:

- Director general of Department of Transport Management,
- Joint secretary of Ministry of Environment, Science and Technology,
- Joint secretary of Ministry of Finance,
- Chairmen of two different organizations of Transport Entrepreneurs Associations,
- Chairman of Consumer Forum,
- Director- technical, Department of Transport Management

- SSP from KathmanduValley Traffic Police

Recommendations of the Committee:

- Requesting Ministry of Finance for waiving off the import duty up to 50% on the import of the vehicles replacing the older vehicles.
- The vehicles in question will be allowed to ply in the roads of Kathmandu for another year. However they will have to go off road if these vehicles are found not complying (can't come back even after repair and later complying the standards) on any on the road monitoring or routine monitoring.
- Government should fix the lump sum compensation for scrapping these vehicles
- Another subcommittee to be constituted to make necessary arrangement for the implementation of these decision

4.5.4 Committee on Review of Vehicle Emission Standard and Monitoring Mechanism (MOPE) 2060

Then Ministry of Population and Environment, realizing the need to review the vehicle emission standards in the changed context and to ensure the compliance of such standards, had constituted a technical committee under the chairmanship of joint secretary with representatives from Department of Transport Management, Kathmandu Valley Traffic Police, Institute of Engineering, Nepal Automobile Dealers Association, Transport Entrepreneurs Associations, NGO, and ESPS/MOPE. This committee had made the following recommendation to the ministry.

1. I/M programs should be designed as 'decentralized system' in which the inspection and maintenance activities are separated. It is advised that the inspection part should be entrusted with the private parties and a referral agency be established under the government umbrella which should also look after the roadworthiness aspect. Such referral workshop should preferably under the aegis of Department of Transport Management. Alternatively, Institute of Engineering, Automobile Department, Thapathali can be entrusted for this activity. The number of inspection stations should be designed after paying due consideration to likely size of vehicle fleet for inspection, location, manpower availability, financial requirement and so on. It is also advised that at least one station should have facilities to carry out 'loaded test'. During the bidding process, the cost for proposed testing, that is to be levied to the motorists should be obtained and fixed accordingly.

   In the beginning, or during transition period, private sector should share the workload with DOTM and KVTPO. However, during this phase the fee charged by these government agencies should be at par with private sector and which should be based on the 'actual cost' basis.

2. The maintenance part of I/M should be left to private workshops. However, the authorized vehicle dealers should be made accountable to ensure that the vehicles they supply in the market meet emission standards for new as well as in-use vehicles, so long they are repaired at their workshops. This is to suggest that they need to have pollution monitoring devices at their disposal and their staffs are well trained for the maintenance of pollution control devices fitted in the vehicle. Furthermore, the authorized dealers must maintain the requisite repair/maintenance machineries that are recommended by vehicle manufacturers.

This is to suggest that there is need to regulate the vehicle importers/dealers. Government, while approving the agency for vehicle dealership should set such criteria and regulate this market.

3. To ensure that pollution control devices fitted in the vehicle, and conforming to NVMES 2056, meet the set emission standard for at least 80,000 km, vehicle importer should identify the 3% of total imported vehicles in, which are likely to be well maintained. Subsequently, the emissions of these vehicles should be monitored on regular basis (surprise checks as well) and the data maintained. If the average emissions of such vehicles do not meet the set standard for 80,000 Km the dealer should recall all the vehicles of that particular model and get them repaired under warranty cover.

4. The following enforcement mechanisms are suggested to ensure motorists' participation in the program.

    - For vehicles that intend to ply in the valley must get green stickers. Therefore, it is essential that testing facilities should be located at least one near to Thankot, in the west and another close to Bhaktapur in the east.

    - Vehicles that fail in two tests in one calendar year should be subjected to 'loaded test' in chassis dynamometer. Initially, such provision should be limited to heavy-duty diesel vehicles and commercial fleet such as taxis and buses/mini buses/pick-ups plying in the urban area. Once the program runs successfully, such tests should be extended to other categories of vehicles as well.

    - A team should be constituted to carry out roadside inspection. Preferably, such team should have representative from MOPE, DOTM, KVTPO, and municipality. Once the program is well developed concerned municipality should be entrusted for regular inspection as well as roadside checking.

    - The following penalty mechanism should be in place if a vehicle fails the inspection test.

        - Registration book should be confiscated once the vehicle fails the test. It should be returned only after the vehicle passes the test after it is subject to repair.
        - Vehicles that fail the test should not be allowed to ply in the streets of Kathmandu. However, they should be allowed to go to the workshop for repair.
        - Vehicle administration activities such as registration, renewal, ownership transfer etc., within the valley, should be done only after getting the green stickers.

5. If a vehicle that holds green sticker fails in roadside emissions test, they should be subject to following additional penalties, in addition to that specified in the preceding paragraphs:

- A monetary fine Rs. 500/-, if the emissions level is higher than set standard by up to 10%.

- A monetary fine Rs. 1,000/-, if the emissions level is higher by 10.1-25% of set standard.

- A monetary fine Rs. 2,000/-, if the emissions level is higher by more than 25.1-50% of set standard.

- If the emissions level is more than 50.1% of set in-use emission standard, the driving license of the driver should be confiscated, vehicle should be prohibited from plying in the road, and the vehicle should be subjected to 'loaded test, after repair.

6. The insurance premium of the vehicles should be linked to emission test result. For a vehicle that meets emission standard should get some rebate in premium.

7. Vehicle database needs to be created to monitor the emission history of the vehicle. Computer networking is required between the testing stations and the concerned government agencies such as MOPE, DOTM, Municipality, and KVTPO.

8. TV/Radio advertisement or jingles should be devised so as to create the awareness amongst the motorists and the general public that proper maintenance not only reduces the pollution but also improves the fuel economy and enhance the life of the vehicles.

9. While performing the test for emissions, the test controller should fill in the printout as well as the green sticker with license plate number, date, and put signature on both. The motorist should show the green sticker on the front windscreen while the printout must be together with the registration book (blue book). This measure should held the person accountable.

10. In order to train the workshop technicians and mechanics, the activities of VAPP should be expanded and diversified to prepare the workshops to repair Euro II vehicles as well. Alternatively, Thapathali Engineering Campus can be used for the purpose.

11. Agencies such as SOMEN or Thapathali Engineering Campus should be entrusted as independent certifying agency for workshops, technicians, and spare parts.

12. The guiding principles for certification of inspection stations, should be as follows:

    - Must have necessary equipments to carry out the 'idle' test for petrol vehicles and 'free acceleration' testing of diesel vehicles. That is, they must have at least one set of four-gas analyser and an opacity meter. (For testing centre that is willing to provide 'loaded test' should have complete sets of dynamometer testing facilities for light and heavy-duty vehicles).

- Must have at least two skilled motor mechanics with at least three years' formal training in a technical college and two years practical experience in a workshop. They must also be certified as 'Motor Vehicle Emission Technician' by training agencies such as VAPP or any such recognised institutions.

- Must have own land and shed. The requisite land can be determined after analyzing the likely volume of vehicles that need to be tested at any one point in time. It could also vary depending upon the location. However, the minimum land requirement is estimated to be 2-3 Ropani with good access road.

13. The recognized inspection centers should be periodically evaluated in terms of their performance and quality service. The likely indicators could be:

    - Number of vehicles inspected, pass, and fail data.
    - Roadside tests data of vehicles, pass, fail
    - Failure margin of roadside testing
    - Time required to get the testing

    Based on the performance audit, appropriate reward and mechanism should be devised. Evaluation team should consist of representatives from government as well as independent agencies.

4.5.5 Technical Committee on the Relocation of Brick Industries from Kathmandu Valley (MOICS) 2060

MOICS (IPB) constituted a Technical Committee under chairmanship of the Joint Secretary, Technical and Environment Division of MOICS on 2060/6/6 to address the public complaints coming up from time to time regarding the air pollution due to brick industries. The conclusion and recommendation of the committee are reproduced here as they are relevant today also.

Conclusions

After detailed evaluation on the status of the brick industries in Kathmandu Valley on legal ground, technical ground, demand and supply situation, environmental concern, and socio-economic impact, the committee has reached on the following conclusion:

- The study showed that relocation of brick industries from Kathmandu Valley to any other places would require plain land area of about 14,000 ropanis. The neighboring sites, which could be useful for making bricks, are Dhading, Nuwakot, Kavre and the districts in Terai.

- In Terai region, required land is available and pollution problem may not arise because of better dispersion. The relocation of brick industries to Terai region will increase the price of brick in KathmanduValley because of higher transportation cost.

- The land required for relocation of the industries to Dhading and in Nuwakot may not be suitable due to their topographic structure. Plain lands in those districts are very less and they have terraced type of topography.

- In Kavre, the possible areas are Banepa, Dhulikhel, and Panauti. However, if the brick industries are relocated in these areas only the pollution problem will be shifted to these areas, as its topography is similar to KathmanduValley. Since suitable area of those sites is less than KathmanduValley it is envisaged that the problem of air pollution in those areas will be more than that in KathmanduValley.

- In present state, the highway linking Kavre and KathmanduValley is narrow and busy. The transportation of bricks from those areas will cause heavy traffic in the Arniko highway and there will be added pollution on the way. Increased transportation cost of brick from those sites to KathmanduValley will drastically increase the cost of bricks.

- If the industries are relocated from KathmanduValley it will aggravate the existing heavy traffic load in the highways. In average, 1500 trucks will move everyday to and from KathmanduValley which is the biggest market of bricks in the kingdom. The movement of trucks will cause air pollution on the roadside and in the valley. More traffic load on highways will cause more jam, more pollution, more accidents etc.

- However, the details studies on environmental, socio-economic aspects have to be carried out for those sites. Due to resource and time constraint the team did not do the detail study of those sites.

Recommendations:

- Air emission standard for the brick industries should be formulated, made mandatory and closely monitored. The brick industries in operation must have sampling port, platform and ladder so that the emission from the chimney can be closely monitored.

- Traditional brick making process should be banned and new technologies such as VSBK, which emits less air pollution, should be promoted and encouraged.

- The brick industries should be clustered in some places in the eastern/northern part of valley considering the normal wind direction (west-east). Clusterization will also facilitate compliance monitoring system as well as providing facilities to the labors and the industries as well. This will also help saving prime land and maintain landscape of the valley. Detail study for the industrial zoning is recommended.

- Alternative option of relocation is to promote industry to be established in consortium. This will help reduce the pollution and cost as well.

- Alternative construction materials to bricks should be identified and promoted.

- EPA and EPR should be amended to the implement level.

- Most of the existing manpower has not been adequately trained to discharge counseling services of two technologies, namely FBTK and VSBK, it is therefore massive training should be programmed.

- Distance from the forest boundary should be relaxed from 5 Km to 1 Km and forest boundary should be defined. A type of forest from which the distance is measured should be clearly mentioned.

4.6 Summery of Recommendations of Stakeholders Consultation Meetings

In the process of developing this action plan, a number of consultation meetings with key stakeholders were organized, and the summery of recommendations made are presented in Table 4.4.

Table 4.4: Summery of Recommendations of Stakeholders Consultation Meeting

Stakeholder	***Recommendations***
Industry Sector (boilers)	• Solid fired boilers should be replaced with liquid fire boilers and government should make a provision for custom duty free for such boilers. • Euro IV deiseal should be used by all boilers. • Latest technology based Fluidized Bed 3 pass boiler with multi cyclone should only allow to install in case of solid fired boilers. • Department of Environment should request to the Department of Industry for facilitation of soft loan for purchasing and installation of pollution controlling devices and replacement of high polluting boilers with low pollution generating boilers. • Self-Monitoring of boilers emissions and submission of emission reports to the Department of Environment in every 6 monthsmandatorily. • Review the existing boiler emission standards. • Capacity enhancement of Ministry of Population and Environment and Department of Environment for strictly monitoring and compliance of standards.

BOX1: Major Policy Initiatives Targeting Vehicular Emissions:

1991: Banned diesel three wheelers registration.
1994: Emission standards for in-use vehicles
1999: Banned three wheelers operated by diesel
1999: Subsidies for electric vehicles.
2000: Nepal Vehicle Mass Emission Standard EURO I.
2000: Stopped two stroke registration
2001: Announced the ban of 20 years old vehicle, but not implemented.
2001: National Transport Policy
2003: National Ambient Air Quality Standards
2004: Two stroke three wheelers banned from operation
2009: National indoor air quality standard and implementation guideline
2012: EURO III standard
2017: Phase out of 20 years old public transport and goods vehicles
2017: Import of EURO IV fuel quality

Industry Sector (Brick Kilns)	• Government has banned in using rubber items and tyres as fuel in brick kilns however, such items are still used in brick kilns during night time. These brick kiln where illegal use of rubber as fuel is posing threat to environment and public health of Kathmandu Valley. Therefore, government should make regular surveillance visit where brick kilns are violating the ban. Furthermore, imprisonment on charges of using rubber should be enforced by law. • Brick Kiln industries are mostly depending on coal as fuel therefore government should encourage adopting energy efficient and clean alternative fuel instead of imported coal. • Government should fix standard of coal that is imported from India. Coal with high GCV values and less ash and sulphur contain should be imported. • Large scale brick producing kilns with cleaner technologies should be introduced. • The temperature measurement instruments such as thermocouple, pressure meter and temperature indication should be used in brick kiln instead of worker's own judgment so that coal can be added when necessary that will ultimately reduce coal consumption. Additionally, workers do negligence during night time so use of new equipment is very necessary. • All the brick kiln owner are ready to welcome new technology such as Hybrid Huffman and Tunnel, Zig Zack if 40% fuel is consumed as internal fuel which really reduce the fuel consumption. However, govern has no clear policy and standard and also due to unstable political situation in Nepal, the recommendation developed is difficult to be implemented as said by stakeholders. • The brick kiln industry owners are ready to adopt particular and specific technology instead of several other technologies as prescribed by government. Therefore, government needs to enforce one specific technology. • Regular training to worker should be conducted. • Promotion should be done instead of compulsion. • Supervision should be done by environment officer and coordination of officer with stakeholder is must.
Health Sector	• Discourage to use common type of inclinators in all hospitals and municipalities. • Promotion of integrated waste management system. • Self-Monitoring of waste management practices and submit the report to the Department of Environment in every 6 months mandatorily. • All pollution controlled devices applied large scale of waste to energy based incinerator should only allow to install in Kathmandu valley. • All hospitals should segregate their waste. Generate the biogas from all biodegradable waste and sold out sellable noninfectious waste. • Infectious waste should be autoclaved and make infection free then

	only sold out or managed. • After 5 years' operation of any kinds of incinerator should be complete banned by law. • Open burning of hospital waste and municipal waste should be banned and make punishable by law. • Refuse burning by any persons/organizations should be banned and make punishable by law.
Civil Society and Expert	• Kathmandu Valley is more vulnerable compared to other region of Nepal due to its unique topography. Appropriate location is necessary to be selected to establish new brick kiln industry in the valley. • Brick Kiln industries should be encouraged to adopt existing economically viable technology rather than new technology. • Regular study on air pollution impact on local area and transboundary effect is necessary to carry out. • Merging together around ten industries and shifting to the location where there is less impact on environment and human health is necessary. • For the operation of new industry, government should make IEE and EIA mandatory which should be approved by Department of Environment (DoE) and there should be coordination of every industry with DoE. • In case of non-compliance with air pollution standards, the industry should not get renews. The industry should be renewed upon proof of compliance with emission. • Despite all the pollution, almost all brick industries meet the national standard therefore; amendment of national standards should be done.

Chapter Five

An Integrated Urban Air Quality Management Framework

The "Action Plan on Air Quality Management of Kathmandu Valley"is based on an integrated management framework approach to achieve the objectives and targets set in this action plan. The components of this integrated framework are presented graphically in Figure 5.1 and each component is briefly discussed in the following headings for their importance and need prior to presenting the strategy on each component and the action plans.

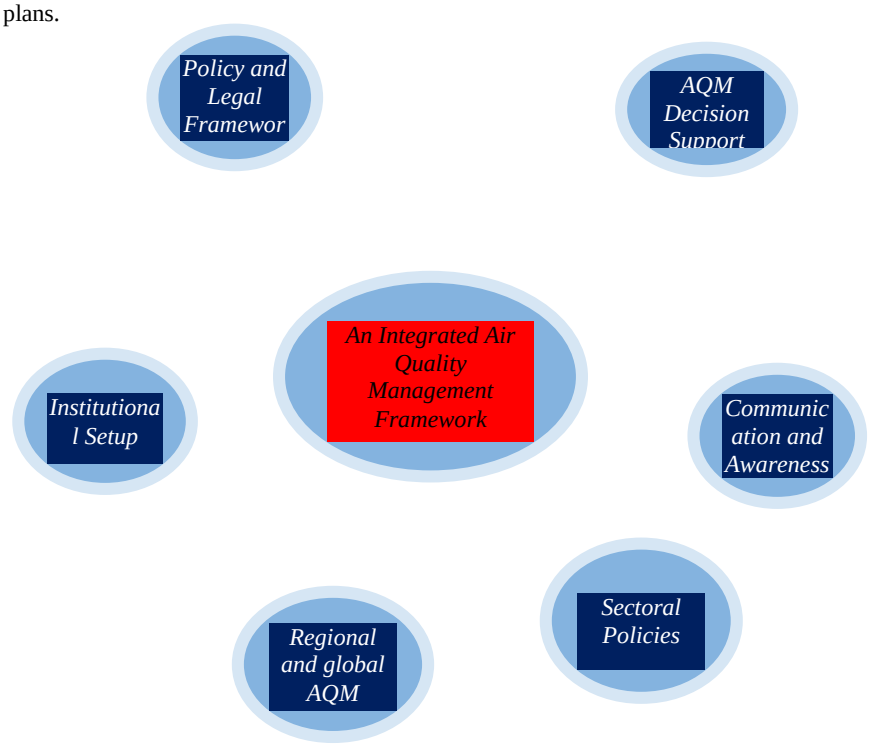


Figure 5.1: An Integrated Air Quality Management Framework

5.1 Air Quality Management Decision Support System

In order to achieve the air quality objectives, first there should be a AQM decision support system in place that provides information on:

- the status of air quality with concentration of pollutants of concerns in the urban air with different averaging time in the different locality of the city
- the details on different sources (mobile, area or stationary) for different pollutants of concern including secondary pollutants and their dispersion in the local meteorological conditions
- the impacts of pollution on human health, local environment and economy, and
- a system on setting air quality standards for pollutants of concern for time bound targets with different averaging time and QA/QC system

With such a system in place (presented in Figure 5.2), institutional arrangement made for the implementation of the air quality strategy can only develop pragmatic clean air implementation plan with priorities and regularly evaluate their effectiveness and set new targets with added actions for continual improvement of the air quality. The importance or the need of each of the above mentioned system is briefly discussed to support the national strategies on AQM decision support system.

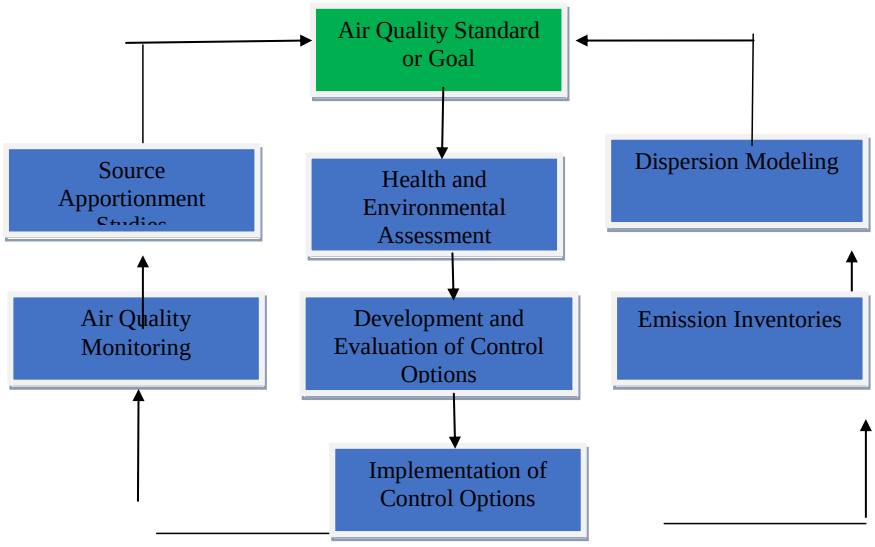


Figure 5.2: Air Quality Management Decision Support System

5.1.1 Air Quality Monitoring System

Air Quality Monitoring System is developed to regularly monitor the concentration of different air pollutants to achieve the following objectives:

- Judge compliance with air quality objectives

- Determine trends in pollutant concentrations
- Identify source contributions to air pollution
- Development and evaluation of control strategies
- Development of air quality data for public information needs
- Exposure and health effects evaluation and research
- Atmospheric process characterization and verification of dispersion models

Campaign air quality monitoring in Kathmandu Valley was done in the 1990s but the system for continuous monitoring of air quality in Kathmandu Valley was established in 2002 with DANIDA support. This system run successfully for few years even after the project was completed in 2005.Ministry of Population and Environment has recently established two more stations in the Valley and has plan to expand the monitoring networks.

5.1.2 Emission Inventories

Different sources contribute different pollutants and add to the air. They can be stationary sources (e.g. power plants, cement kilns, etc), area sources (cluster of industries or facilities-e.g. brick kilns in certain area, waste management facilities, petrol pumps, etc) and mobile sources (on road mobile sources like vehicles and non-road mobile sources like aircraft). An emissions inventory is essentially a current database of emission estimates for one or more air pollutants for a defined geographic area during a defined period from different sources. Emissions inventories are:

- needed for dispersion modeling to understand the concentration of pollutants away from sources in the local meteorological conditions,
- important for assessing emission trends and developing (and evaluating) control programs

Emission Inventory (EI) development needs to be ongoing as additional sources are identified, emission factors improved, etc. EI tell us where air pollution is emitted, how much is emitted from each source, and what sources can be most effective for control strategies. There has been some initiation made to estimate the pollution load in the valley but there is the need to transform that initiation into an established Emission Inventory development and continues updating system with changes in sources due to the implementation of the initiated control measures.

5.1.3 Dispersion Modeling

An emissions inventory and historical meteorological data (surface and *upper air*) which are recorded by the meteorological departments are required to run the dispersion models. Technical skills are required to run the dispersion models and present them. Ambient air quality monitoring data will validateresults obtained from the models. These are excellent tools for assessing the potential control strategies and in assessing the trans-boundary movement of air pollutants. It is a very useful tool in identifying monitoring locations for monitoring secondary pollutants like ozone and pollution hotspots. MOPE/DOE need to work in partnership with the academic institutions.

5.1.4 Source Apportionment Studies

Source apportionment studies are generally carried out to determine the sources for particular pollutants. These studies will add to the emission inventories and dispersion modeling and local meteorological conditions to determine and validate the source for the concentration of particular pollutants of concern. No such studies been done in Kathmandu Valley so far.

5.1.5 Health, Environmental and Economic Impact Assessment

Monitoring tells us the concentration of pollutants at a particular location at a particular time. If our program is well developed, the monitoring data will be "representative" of a larger area.However, our aim is to protect public health and the environment. Therefore, we need to translate monitoring data into actual health and environmental impacts.

In order to generate the political will to prioritize setting policies and allocate resources for the implementation of clean air implementation plan, the information on impact on human health and cost associated to deal in addressing such impact is very important. The quantification of the damage cost and loss to the national economy due to air pollution is a very good tool to convince political leaders and generate public pressure to address the problem. To have this system in place, there is the need:

- Co-operation with the health sector to establish a public health surveillance system
- Exposure studies
- Health effects research
- Environmental impact assessment – vegetation, buildings (including historic and cultural monuments, etc), visibility, and loss of other resources due to air pollution
- Understanding of the epidemiological studies carried out in other countries and cities and draw references

Control programs can then be evaluated based on more direct improvements in public health and the environment rather than on reduced pollutant concentrations at monitoring locations.A coordinated approach between air quality monitoring institutions and health sector institutions is highly desired.

5.1.6 Developing and Reviewing Air Quality Standards

Ambient air quality standards are not just the numbers. It includes the pollutants, the averaging time, locations, monitoring methods, frequency of monitoring, quality assurances and control system (QA/QC), attainment calculation procedures, and the reporting methods with the use of defined air quality indexes (AQI).

AQS provide the basis for assessing the quality of the air that we breathe and is the foundation of the control programs. It is also used to assess the new sources of air pollution and through the use of AQI it can be used to alert the public about the status of air pollution.

Air quality standard is a difficult processrequiring input from technical experts and stakeholders as well as political support. WHO with detailed exposure assessment and impact on the human health recommends guideline values for countries to adopt

standards which becomes legally binding. It should be based on the current air quality, available skills, and the cost of monitoring. There should be a system of reviewing AQS on regular basis. Ministry of Population and Environment in 2003 has brought the national ambient air quality standard for Nepal.

5.1.7 Development and Evaluation of Control Options

All the systems briefly described above of AQM support system are the basis for the development of control options. Further, the above system also helps to evaluate the implementation of the control options and also their effectiveness. Development of the control options should identify the target pollutants and target sources, develop possible control options and evaluate cost benefit analysis of each option. The next step is to rank options in terms of cost effectiveness, compatibility with other sector objectives, ease of enforceability, and political feasibility. And then only the action programs are developed and approved by the highest authority to have ease of implementation.

5.1.8 Implementation of Control Options

Implementation of the control options requires compliance to the prescribed standards both for emissions and technologies, guidelines for pollution prevention and control to manufacturing and service sector facilities, and allocation of sufficient financial resources and development of capable human resources. Without compliance there is no control and therefore it will be better to have strong compliance with weak standards than weak compliance with tough standards. Challenge is to improve the technical capacity to effectively enforce control plans. Monitoring and evaluation should include air quality improvements as well as economic and social impacts and it should be reviewed on a regular basis.

5.2 Policies and Legal Framework

Air quality management stakeholders include government, industry groups, research institutes, NGOs, judiciary, health and community groups, and international organizations. A very strong national environmental policy supported by all of the government and developed in consultation with all stakeholders is very essential. An effective AQM system which demands participation of all the stakeholders, it is always desirable to move away from the "DAD" approach (Decide, Announce, and Defend) towards a participatory approach to policy development.

In order to implement the policies, the legal system (acts and regulations) need to be clear and unambiguous- with enforcement actions defendable in courts, avenues for public appeal, and mandatory reporting on Air Quality issues.

Nepal has the environmental policy and action plan, and recently Nepal has brought National Climate Change Policy and drafted the National Pollution Control Strategy and Action Plan. National Low Carbon Development Strategy is also in the draft stage. However, there is the lack of clean air regulation to deal with the challenge of air pollution.

5.3 Sectoral Policies

Integrating AQ objectives with sectoral policies can achieve multiple objectives in a more cost effective and easily enforceable way. Sectoral policies on land use, transport, energy, waste management, urban development, industrial development, commerce and trade, information and communication, all need to integrate the air quality objectives

rather the AQM regulations making to deal with them. Towards making sectoral policies to integrate the AQ objectives, the key challenges in Nepal (common in many developing countries) are lack of communication and co-ordination between ministries, unclear or duplicated responsibilities, focus on end of pipe regulation, and minimal use of economic instruments.

5.4 Regional and Global AQM

Climate change and air pollution share common sources. Electricity generation and road transport are two of the most significant sources of both air quality and climate pollutants. It will be important to develop strong linkages between air pollution control and climate change mitigation to deliver the air quality management goals in a most cost effective way. Nepal is party to UNFCCC and Kyoto Protocol and as a developing country there is ample opportunities available to benefit from the financial mechanism and technology transfer mechanism. Therefore, the development, evaluation and implementation of air quality control plans should favor options with co-benefits for local, regional and global air quality. This will help to place even greater priority on demand management and efficiency improvements in our sectoral objectives as well.As trans-boundary movement of air pollutants is one of the sources for the increased concentration of air pollutants, the integration of regional action plan on environment and climate change into national action plan can deliver regional and global benefits with added resources to implement the action programs.

5.5 Communication and Public Awareness

Delivery of air quality goals requires public engagement to encourage more sustainable behaviors in relation to, for example, transport choices, selection of household equipments, energy conservation, and how people value to local environment. Communication and awareness programs designed to educate stakeholders and the public need to focus to influence the behavioral change and also to ensure that stakeholders' views are considered in policy development to promote the acceptance of control measures. The challenges in Nepalare to have a more effective communication and information sharing system between stakeholders, development of targeted public awareness plans, improvement in institutional capacity for public relation management, and a system for the evaluation of public perception through regular surveys.

Chapter Six

Strategies and Action Plan on Air Quality Management of Kathmandu Valley

The management of ambient air quality, especially in large cities in developed and developing countries, has created a rich portfolio of experiences for implementing and executing successful programs while avoiding many of the recognized pitfalls. In order to make the action plan based on the long term strategic approach, first the strategies on the components of the integrated air quality management framework discussed in the previous chapter are derived from the national and sectoral policies/strategies and international and regional experiences and then only action plans are proposed based on that strategic approach and strategies, recommendations made by different committees formed to address the air pollution of the Kathmandu Valley, sectoral strategic actions, regional and global commitment of Nepal, and the recommendations of the stakeholders' consultation workshops.

6.1 Strategies on Ambient Urban Air Quality Management

This strategy is derived from the widely adopted integrated framework on urban air quality management with the vision that all the citizen living or visiting in urban cities of Nepal breath with clean air. The strategic components are:

- Establishment and Strengthening of Air Quality Management Decision Support System
- Strengthening the Policy and Legal Framework on Air Quality Management
- Strengthening the Policy and Legal Framework on Air Quality Management
- Establishing Linkages in Air Pollution Control and Climate Change Mitigation
- Establishing Linkages in Air Pollution Control and Climate Change Mitigation
- Integrating Regional and Global AQM into CAIP
- An Effective Communication and Information System to promote Sustainable Behaviors
- Institutional Framework for Better Coordination and Cooperation with Stakeholders
- Financing the CAIP and National Capacity Building for Implementation

The strategies on each strategic component are presented in Table 6.1.

6.2 Action Program on Ambient Air Quality Management of Kathmandu Valley

This action program on the ambient air quality management of Kathmandu Valley will aim to bring the level of air pollution in the valley to the target set in the National Ambient Air Quality Standard of Nepal within next 5 years. The detailed clean air action plans are listed in Table 6.2 to Table 6.9.

Table 6.1 A Strategic Framework for Air Quality Management in Kathmandu Valley

Strategic Components	Strategies on Strategic Components
Establishment and Strengthening of Air Quality Management Decision Support System	***Strategy on Air Quality Monitoring*** • Particulate Matter with special focus on PM10 and PM2.5 is the main pollutant to be monitored in KV continuously covering heavy traffic, residential, industrial and background stations. • Other criteria pollutants NOx, SO2, O3 and CO will also be monitored in two of the monitoring stations derived through dispersion modeling • Monitoring of toxic pollutants will be carried out by analysis of the filters of PM10/PM2.5 and the use of passive samplers in laboratories (accredited) • QA/QC system will be further strengthened in DOE, AQI will be defined and daily dissemination of AQI through mass media within a year and continued thereafter ***Strategy on Dispersion Modeling*** • National capacity development for use of emission inventories and meteorological information in running dispersion models and demarcate areas in terms of level of pollution for different pollutants (in partnership with academic institutions) • Department of Meteorology to initiate recording the meteorological parameters in different heights from ground level • GIS section at DOE will be establishedandstrengthened for regularly updating the sources of air pollution, use of emission inventory software to update the inventory, and carry out dispersion modeling and disseminate the results ***Strategy on Development of Inventories*** • Kathmandu Valley will be divided into grid of 2 km by 2km and all the sources of air pollutants will be

	documented with system of regular updating. • Use of emission factors as per the status of technology will be used to estimate the emissions of various pollutants with particular focus on PM from domestic and industrial sources • A study on traffic congestion on vehicle speed and average distance travel, status on road conditions, and categorization of vehicles (type and age, with or without pollution control devices) to choose the emission factors and estimate the vehicular emissions load including re-suspension of dusts from roads • National professional including staffs of MOPE/DOE, line agencies, and academicians will be trained in inventory development integrating with Green House Gases inventory for National Communications ***Strategy on AQS Development and Review System*** • MOPE and NBSM will coordinate to review the AQS and develop emission and technology standards for different sources • The prevailing Ambient Air Quality Standard of Nepal will be reviewed by the end of 2018 to include some hazardous toxic pollutants and thereafter in every five years • The impact of air pollution on the human health, environment and economy will be the basis for review of AQS • WHO guideline values including Interim Targets and the standards in the region will be considered while reviewing the standards and setting new targets ***Strategy on Assessment of Impact of Air Pollution on Environment, Health and Economy*** • Ministry of Health will provide special attention in establishing the public health surveillance system to determine the burden of diseases due to increased air pollution in Kathmandu Valley • Information generated from air monitoring system, and dispersion models and information on population exposure to different levels of pollution will be used to estimate the impact on health, environment and economy using models developed from studies in other similar countries

	• A national system on valuation of the damage will be developed and the results will be disseminated for creating public awareness to participate in preventive and control measures • Such studies will be regularly updated to evaluate the effectiveness of control options. • Epidemiological studies will be carried out with support from WHO and other international health research institutions to validate the results obtained from developed models ***Strategy on Development and Evaluation of Clean Air Action Plan (CAAP)*** • A High Level Committee on Air Pollution (HLCAP) under the chairmanship of the Minister of MOPE and secretaries of key ministries, mayors of local bodies will be established for the development and implementation of CAAP. • MOPE/DOE in coordination with line ministries, local bodies and other stakeholders will develop Clean Air Action Plan (CLAP) for Kathmandu Valley with particular focus on TSP, PM10 and PM2.5 and minimization of the concentration of hazardous air pollutants. • HLCAP will review the CAAP to ensure that sectoral priorities are part of the CAAP and recommend for approval by the council of ministers. • CAAP will be evaluated in every six months comparing the trend of pollution by Air Quality Monitoring System by HLCAP • CAAP will also be evaluated in every two years with the assessment of impact on the human health, environment and economy and will set additional time bound targets with actions plans to achieve the long-term targets. • CAAP will be based on the principles that "without compliance there is no control!" and "it will be better to have strong compliance with weak standards than weak compliance with tough standards" • CAAP will also focus on strengthening the technical capacity of institutions to effectively enforce control plans, and also for monitoring and evaluation of air quality improvements as well as economic

	and social impacts
Strengthening the Policy and Legal Framework on Air Quality Management	• MOPE with participation of all the government ministries, NGOs, business communities, international partners, judiciary, and academic and research institutes will develop a National Environmental Policy to have an integrated approach to deal with the environmental challenges that promotes overall improvement into environmental quality rather than transferring pollution from one medium to another one. • A separate regulation will be brought to introduce the mandatory provisions to have Strategic Environmental Assessment of Policies, Plans and Programs (PPPs) to promote the integration of environmental and air quality objectives into sectoral PPPs through detailed cost benefit analysis of different alternatives for achieving the sectoral objectives. • MOPE in consultation with stakeholders with carry out the review of the prevailing Environmental Act/Regulations and will recommend if needed, a separate Clean Air Regulation to deal with the challenge of air pollution. • MOPE in consultation with stakeholders and technical support from international organization will develop a list of financial incentives (taxes, subsides) and minimal technology standards/requirements for fuel and equipments/machineries with potential for high energy efficiency will present to High Level Committee on Air Pollution for its approval and recommendation to make it part of fiscal regulations. • Regulations will be reviewed regularly in order to promote the implementation of control options introduced through evaluation of CAIP with introduction of new emission standards as part of regulation, new economic instruments, and promotion of cleaner technologies. • MOPE in consultation with stakeholders will develop a regulation for creation and implementation of environmental protection fund to finance the CAIP. • Legal framework that will promote foreign direct investment and private sector investment in the development of physical infrastructures helping to achieve the AQ objectives
Integrating Air Quality Objectives into Sectoral Policies	***Moving towards Environmentally Sustainable Transport System by adopting:*** • *Strategies to avoid unnecessary travel and reduce trip distances (*change in vehicle km travels per person over time in metropolitan cities and national level*)* • *Strategies to shift towards more sustainable transport mode (e.g.* Non-Motorized Transport (NMT) component in transport plan; Public Transport System; Transportation Demand Management (TDM);

	Intercity Goods and Passengers Transport; etc) • *Strategies to Improve transport practices and technologies (e.g.* diversify towards electricity, hybrid and natural gases; progressive and affordable standards for fuel quality, vehicle emissions (new and in-use); I/M system; Intelligent Transport System (electronic fare system and road user charging system; transport information centers; transport control centers)) • *Cross-cutting strategies (e.g.* safety; health impacts; compliance to air quality and noise standards; climate mitigation and energy security; social equity; innovative financing mechanisms; public information and awareness; etc) ***Moving with Low Carbon Energy Path:*** • It shall be the long term strategy of Government of Nepal to move towards the renewable sources of energy including the hydropower generation to meet the national demand of electricity. • It shall be the strategy of government to procure clean energy from neighboring countries and supply to cities to immediately replace the use of fossil fuel in small generators and residential and commercial heating purposes. • Energy policy will fully recognize that the increasing energy efficiency is the quickest and least costly way of addressing energy security, environmental and economic challenges and will adopt strategies to achieve continuous improvement in energy efficiency in transport, buildings, industry, equipments and appliances, energy utilities, and lighting. • Ministry of Energy will review the legal system to make them conducive for competitive energy markets to ensure that retail energy prices reflect the full cost of energy supply and delivery including the environmental costs, and promote private investment in energy efficiency. • Ministry of Urban Development in coordination with all the stakeholders will develop building energy codes and minimum energy performance standards for buildings and make them mandatory for commercial buildings immediately and in residential buildings gradually. • It shall be the strategy of government to introduce minimum energy performance standards for equipments and appliances to be imported in Nepal and also to be produced in the country. • MoE will develop the phase out program of the inefficient lighting products and systems to promote the energy efficient lighting system through the use of economic instruments. • Government of Nepal will introduce subsidies to households in cities to install renewable sources of

	energy for heating purposes to reduce the demand of fossil fuel used in traditional heating system particularly in the winter times. • MOPE will coordinate with Ministry of Commerce and Industry to develop projects to demonstrate the energy efficiency in industries and promote transfer of energy efficient technologies in industries particularly in SMEs. • MOPE will support the line ministries and departments and private sector in designing projects in the above mentioned areas so that they attract investment through CDM. ***Utilizing Waste as Resources:*** • MOPE in consultation with municipalities shall introduce the regulations on waste management including the hazardous and hospital wastes management • Wastes are segregated at sources (households, industries, health institutions, commercial institutions, schools and colleges) and used as resources by reusing, recycling and composting and thus minimizing the transport and also avoiding the possibilities of incinerating. • Demonstration programs shall be launched to promote household level composting. • It will be mandatory for municipalities to design landfill sites with facilities with methane gas trapping and use it for power generation. • Private sector will be encouraged to invest in waste management and get benefits from provision of CDM. ***Land Use Plan and Urban Planning*** • Land use plan and urban development plan of new municipalities will go through the Strategic Environmental Assessment Procedures to integrate the objectives of air quality management as well as other sectoral strategies that promotes the objectives of air quality management.
Establishing Linkages in Air Pollution Control and Climate Change Mitigation	• MOPE shall coordinate with all the line ministries and private sector to make them aware of the provisions of financial mechanisms under the UNFCCC, Kyoto Protocol and other MEAs and facilitate in the development of projects that can benefits from Climate Change mitigation funds, particularly Green Climate Fund and attract investments in physical infrastructures development, use of renewable energy and energy efficiency improvement and generate carbon credits to benefit from the clean development

	mechanism (CDM)/Sustainable Development Mechanism (SDM). • CAAP will also include control options that promotes energy efficiency and renewable energy to get financial resources from GEF and the Green Climate Fund • CAAP will be designed and prioritized with targets of generating emission reductions to get benefit from carbon market. • It will be the strategy of Government to at least register two projects each in a year in transport sector, energy efficiency improvement in industries and commercial sectors, use of renewable energy, and use of methane from land fill sites for the carbon trading mechanism of UNFCCC.
Integrating Regional and Global AQM into CAIP	• As a member to SAARC and commitment for the implementation of Regional Action Plan on Environmental and Climate Change, MOPE will make ensure that actions plans that help to address the trans-boundary movement of air pollutants are part of CAIP and implemented with partnership with member states. • CAAP shall put greater emphasis on control options that promote climate change mitigation to attract investment in infrastructure development and technology transfer in the region.
An Effective Communication and Information System to promote Sustainable Behaviors	• Status on the ambient air quality will be disseminated through mass media and public hoarding boards to make public aware and also to generate public pressure to take actions to reduce air pollutants. • Communication and public awareness programs will be designed and launch to educate stakeholders and public to influence the behavioral change of general public and their acceptance of control options • Information system will be developed to have more effective communication and information sharing between stakeholders and also to promote the voluntary participation of NGOs, mass media, and members of civil society. • Awareness programs will be evaluated regularly through public perception surveys • MOPE as a focal point to many MEAs will coordinate with all the stakeholders to make them participate

	and get support from the MEAs to design and launch education and awareness programs.
Institutional Framework for Better Coordination and Cooperation withStakeholders	• High Level Committee on Air Pollution will be responsible for policy guidance, approval and evaluation of Clean Air Action Plan • A Technical Committee in the Department of Environment will be established with representative from key implementing departments of line ministries, local bodies and private sector to recommend the CAAP for the consideration of High Level Committee. • MOPE will coordinate with each local bodies and provide technical support to build the capacity of local bodies to ensure public participation in the implementation of the action plans.

Financing the CAAP and National Capacity Building for Implementation	• It shall be the responsibility of sectoral ministries to propose and get financial resources from the Ministry of Finance to implement the actions under the CAAP with sectoral responsibilities.
	• Ministry of Finance shall coordinate with line ministries and potential donor communities to seek financial and technical support from external sources.
	• MOPE with recommendation from HLCAP will propose to Ministry of Finance to introduce the following taxes and create mechanism to deposit money in the fund which will be used to fund certain activities of CAAP:
	  • Road maintenance tax (annual tax for each vehicle differentiated with size and type of vehicle)
	  • Pollution tax on import of fuel
	  • Taxes on brick kilns and other polluting industries
	  • Penalties on non-compliances
	  • Annual Contribution from Government budget in the environment fund
	  • Contribution from donors
	  • Small percentage of fund from the trade of carbon credits
	• Projects to be designed to get financial support from GEF and Green Climate Fund
	MOPE will develop project proposals to get financial and technical support to develop the capacity development

	action plan and implement them.

Table 6.2: Clean Air Action Plan for Kathmandu Valley- AQM Decision Support System

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Strengthening of Air Quality Monitoring System in Kathmandu Valley	• Expand the existing network of two air quality monitoring system to represent the air quality in the valley	By 2020	DOE	
	• Introduce gaseous pollutants (Nox and CO at Ratnapark) and ozone little outside the city center (Bhaktapur)	By 2020	DOE	
	• Ensure that the monitoring system are calibrated and properly maintained as per the manufacturer's instruction	Regularly	DOE	
	• Provide training to DOE staffs for quality control and data assessment	By 2017 and regularly	DOE	
	• Conduct campaign monitoring in pollution hot spots like near industries and construction sites	By 2017 and regularly	DOE	
	• Use passive samplers to determine toxic pollutants like benzene, PAH by using local capacity	By 2017	DOE and Private laboratories	
	• Disseminate the results using mass media and social media	Immediate	DOE and mass media	
	• Publish the AQI in newspapers daily basis	Immediate	DOE and media	
Development of Inventory of Sources and Pollutants	• Establish a Technical Committee at DOE with technical representatives from key stakeholders and experts in the field	By 2017 and continue	DOE and Stakeholders	
	• Divide Kathmandu Valley into grid of 2 km by 2km and establish the database on sources air pollutants in each grid and regularly update the database	By 2018	Technical Committee	
	• Identify the appropriate Emission Factors for different sources- mobile, stationary and area sources for different type of pollutants	By 2018	Technical Committee	
	• Keep updating the EF factors	Regularly	Technical Committee	
Source	• Support research on source apportionment studies by students at	By 2018 and	DOE and	

Apportionment and Dispersion Modelling	universities	regularly	Universities	
	• Support universities to do the dispersion modelling of point sources and area sources	By 2018 and regularly	DOE, DHM and Universities	
Impact Assessment System on Health, Economy and Environment	• Coordinate with NHRC to initiate research works in partnership with hospitals (preferably teaching hospitals) on the impact of air pollution on human health	By 2017 and regularly	MOPE/DOE MOH NHRC	
	• Coordinate with major hospitals to develop database on the status of air borne diseases in the valley and regularly update it	By 2017 and regularly	MOPE/DOE MOH NHRC	
	• Establish partnership with universities (environmental departments) to conduct economic impact of air pollution	By 2017 and regularly	MOE/DOE and Universities	
	• Monitor the archeological buildings to assess the impact of air pollution	By 2017 and regularly	DOE, Archeology Department, Universities	
System on Development and Evaluation of CAAP	• Establish a High Level Committee headed by the minister of MOPE with representative of secretary or joint secretary level of key development ministries and mayors to evaluate the effect of Clean Air Action Plan	By 2017	MOPE, Line ministries, and Municipalities	Specifically on air pollution
	• Organize the Committee meetings every three months to evaluate the implementation status of the CAAP	By 2017 and regularly	MOPE	
	• Develop annual report on air quality status and publish it	Initiate this FY and annual basis	DOE	
AQS Development and Evaluation System	• Review AQS every two air to include new pollutants or change the limit of target pollutants	By 2018 and every two year	MOPE	
	• Set new AQS goals in line with WHO interim targets and guideline values	By every five year	MOPE	

Table 6.3 Clean Air Action Plan for Kathmandu Valley-Environmentally Sustainable Transport System

Issue	Actions	Time Frame	Institutional	Remarks

			Responsibility	
Road Infrastructures	• Highest priority for completion of the expansion of Tribhuwan Highway (Kalanki-Nagdhunga), Ringroad (Kalanki-Koteswor), and other portion of national highways and ring road in the valley	By 2017	DOR	
	• Ensure Melamchi water supply project is in full compliance to the approved EMP	Regularly	DOE, Melamchi project	
	• Highest priority for the completion of works on expansion of the feeder and newly initiated road	Regularly	DOR and Municipalities	
	• Improvement and construction of foot-path in all the urban roads to reduce traffic congestion with the additional infrastructure to accommodate road side vendors in major commercial junctions	Regularly	DOR and Municipalities	
	• Road shoulders also to be pitched with immediate effect	Regularly	DOR and Municipalities	
	• Incorporate in design of new roads and expansion of existing roads the recommendations made for climate resilient roads (NSTS)	Regularly	DOR and Municipalities	
	• Ensure that contractors are not engaged in more than one contract and strictly follow the timeline and penalty mechanism	Immediate and Regularly	DOR and Municipalities	
	• Highest priority on making the feeder roads, urban roads, district roads, highways are paved with highest quality and maintained on regular basis without potholes	Immediate and Regularly	DOR and Municipalities	
	• Make provisions that the road maintenance works is carried out in night time	Immediate	DOR and Municipalities	
Traffic Management	• Implement route reorientation plan developed by the Kathmandu Sustainable Urban Transport Project	Immediate and Regularly	DOTM	
	• Arrangement for alternate passage like sky-over, sub-way, etc	Regularly	DOR, Municipalities	
	• Special lane arrangements for mass transport vehicle are to be worked out and enforced.	By 2018	DOR, DOTM and Traffic Police	
	• Compulsory arrangement for running in the left side of	Immediate	Traffic police	

	road for slow moving vehicles			
	• Expansion of road width, proper sewage management and improvement in quality of such facilities	Regularly	DOR Municipalities , Sewage Department	
	• Repair and maintenance of water supply, telephone, sewage, electricity on roads to be done only in night time	Regularly	Traffic Police, DOR, NEA, KUKL, NTC	
	• Proper facilities and effective management of public transport stop over at roadside	Regularly	DOR, Municipalities	
	• Complete ban on running small shops at footpath and piling of construction materials	Immediate	Municipalities	
	• Smokeless vehicles only provision in tourist and cultural sensitive places	By 2018	Municipalities	
	• Allow certain time only for entry of goods heavy duty vehicles to enter valley and also movement of goods vehicle inside the cities	By 2017	Traffic Police and DOTM	
Efficient Public Transport System	• Conduct the detailed feasibility study of pollution free mass transit system and establish bus rapid transit and bus lanes	By 2018	DOTM	
	• Develop integrated bus transport system with routes, bus stops, transit points, ticket counters and monthly ticket passes	By 2018	KSUTP	
	• High priority on detailed design of metro system in the valley	By 2019	MOIDT and DoR	
Promotion of NMT system and Greenery	• Make walking safe and comfortable	Immediate	DOR	
	• Make separate cycle lane in possible roads	By 2018	DOR,	

			Municipalities	
	• Make master plan for walking and cycling routes in whole valley including plan for conservation and expansion of greenery in the valley to promote cycling and walking	By 2018	KVDA	
	• Establish public parks in the city areas	Regularly	Municipalities	
	• Convert the public land occupied by security agencies into public parks	Immediate	MOD, MOH, KVDA	
	• Make inner city of valley and other appropriate areas only cycling and waling areas	By 2017	Municipalities and Traffic Police	
Nepal Vehicle Mass Emission Standard	• Enforce the EURO-IV standard immediately	Immediately	MOPE	
	• Declare that EURO-V will be applicable from next … years (in line with vehicle supply countries)	Immediately	MOPE	
Effective I/M System	• Review the current IN-USE Vehicle Emission Standard in accordance with EURO standard vehicles	By 2017	MOPE	
	• Vehicles plying inside Kathmandu Valley must have the valid green sticker issued by authorized agencies.	By 2017	MOPE	
	• Make the authorized dealer workshop to issue the green sticker (to be purchased from DOE) in the beginning and gradually authorized other standard workshops	By 2017	MOPE	
	• Review the validity period of green sticker focusing on	By 2017	MOPE	

Comment [u1]: Year is missing here

	polluting vehicles			
	• Introduce on road monitoring program to catch the highly visible polluting vehicles or authorize the traffic police to catch such polluters and send for maintenance	By 2018	DOE, DOTM and Traffic Police	
	• No duties on emission testing equipments	Immediate	MOF	
	• Introduce I/M system in major cities	By 2017	MOPE and DOTM	
	• Develop criteria for accreditation of private workshops			
Promotion of Zero Emission and Cleaner Vehicles	• Minimum possible duties on zero emission vehicles and economic incentives for hybrid vehicles	In coming budget	MOF	
	• Develop bus terminals with charging system to encourage zero emission public transport buses	By 2020	Municipalities	
	• Develop infrastructure to promote electric buses/trams	By 2020	Municipalities	
Fuel Quality	• An effective monitoring system to ensure that the imported fuel is as per stated standard and not adulterated in the route and distribution system	Immediate	NBSM and NOC	

Table 6.4 Clean Air Action Plan for Kathmandu Valley-Environment-Friendly Construction Activities

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Legal Aspects	• Declare Kathmandu Valley an environmentally sensitive area to ensure that all major construction activities require develop IEE/EIA with EMP	By 2017	Cabinet	
	• Develop guidelines/manuals for environment-friendly construction management in infrastructure projects	Regularly	MOPE and Sectoral Ministries	
	• Make mandatory provisions in the agreement with the contractor to follow the above guidelines	Regularly	DOR and Municipalities	
	• Develop guidelines for environmentally sensitive building construction (private houses)	Regularly	DOR and Municipalities	
	• Make mandatory provision while issuing the permit for construction to follow the above guideline	Regularly	DOR and Municipalities	
	• Highest priority on monitoring of EMP by MOPE and Sectoral Ministries	Regularly	MOPE	
	• Introduce EURO standard for heavy duty construction equipments and vehicles	Immediate	MOPE	
	• Make mandatory requirements for contractors in terms of human resources and machineries/ equipments (international standard) to bid for road and other projects in the valley	By 2018	MOPIT and sectoral ministries	
	• Use of economic instruments (reward and penalty) to promote timely completion of assigned construction works	By 2018	Development ministries, municipalities, MOF	
	• Promotion of steel structures over concrete structures	By 2017	MOUD, Municipalities	
Better Coordination	• A permanent coordinating body between different institutions involved in construction in roads or along the roads (electricity, communication, water supply, sewage,	Immediately	DOR, NEA, NTC, KUKL, Municipalities	
	• Plantation along the roads including in the middle of major highways (ring roads)	Regularly	DOR, Municipalities	
	• Promote greenery in houses	Regularly	MOPE, MOF, Municipalities	

Table 6.5 Clean Air Action Plan for Kathmandu Valley-Reducing Emissions of Industries in Valley

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Brick Kilns	Ensure compliance of prescribed emission standards • All industries must have sampling port, platform and ladder to facilitate monitoring • Make mandatory provisions of self-reporting of compliance every month in the season • Inspection of industries by environmental inspectors at-least once in a month in the season	By 2017	DOE and DOCSI	
	Involve private sector in stack monitoring • Development of accreditation criteria • Accreditation of private capable laboratories/companies • Determination of fees for stack monitoring	By 2017	DOE and NBSM	
	No custom and VAT on the import of stack monitoring equipment	By 2017	MOF	
	Promote the cleaner brick technologies in the existing industries • Provision of progressive tax on emission load above reference level of 200 mg/Nm^3 • Soft loan to industries to change technology and to develop facilities to run during rainy season		MOPE, MOI, MOF	
	Introduce standard on coal with high calorific value, lowest feasible sulfur content, and low ash content and enforced	By 2017	MOPE, NBSM	
	Alternative construction materials to bricks should be identified and promoted	Continuous		
	No new registration of brick kiln industries inside the Kathmandu Valley	Immediate	IPB/MOI	
Industries with Boilers	Review of Emission standards for industrial boilers including provision of efficiency based on the regional practices and ensure compliance to the standards • All industries must have sampling port, platform and ladder to facilitate monitoring • Make mandatory provisions of self-reporting of compliance every	By 2017	DOE, DOI, DOCSI	

	month in the season • Inspection of industries by environmental inspectors at-least once in a month in the season			
	Promote technologies with comparative cleaner fuels • Minimum possible duties on replacement of existing boilers • Provision of soft loan	By Next FY	MOI, MOPE, MOF	
Other Industries	Maintain database of industries –industries with furnaces and other fuel burning	By 2018	DOE, DOCSI	
	Prepare best practices for small scale furnaces and introduce to the industries	By 2018	MOI	
	Ban use of discarded Mobil in furnaces	Immediate	DOE	
	Review the negative lists of industries not allowed in the valley with particular focus on air polluting potentials	By 2017	IPB/MOI	

Table 6.6 Clean Air Action Plan for Kathmandu Valley-Environmentally Sound Management of Wastes (dealing with toxic air pollutants)

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Incineration of Hospital Wastes	• Current practices of operation of incineration without any control system stopped immediately in hospitals	Immediate	DOE, DOH	
	• Enforce the ban on the open burning of the hospital wastes in the complexes	Immediate	DOE, DOH	
	• All health institutions have waste segregation system in place	By 2017	DOE, DOH, Municipalities	
	• Detoxification of hospital wastes by using autoclaving in all facilities is made mandatory	By 2017		
	• No duties on waste autoclaving and other detoxification technologies	Immediate	MOF, MOH, MOPE	
	• Ensure compliance to the incineration emission standards in hospitals with control system including monitoring of toxic pollutants	Immediate	DOE	
	• Ensure that health institutions maintain record of waste generation and their disposal	Immediate	DOE, Municipalities	
	• Promote private sector to build hospital waste management facilities to provide service to small health institution (Government to provide appropriate location and legal system for collection of fees)	By 2018	Municipalities, MOPE, MOH	
Refuse Burning	• Make waste collection system effective and restrict dumping of wastes at public places	By 2017	Municipalities	
	• Promote composting at household level	Continuous	Municipalities	
	• Enforce strictly ban on open burning of the wastes	Immediate	Municipalities, DOE	
	• Educate public the health impacts of burning of wastes with plastics	Continuous	Municipalities, DOE, Mass media	
	• Expand electric cremation facilities at Pashupati and Teku	By 2019	Pashupati Area Development Fund, and KMC	

Table 6.7 Clean Air Action Plan for Kathmandu Valley-Promoting Cleaner Fuel and Technology to Minimize Domestic Pollution (Indoor Air Pollution)

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Energy Switch and Promotion of Cleaner Technologies	• Hydropower generation sector to be linked with the air pollution reduction by promoting domestic, transport and industrial preference to electric energy	By 2020	NPC	
	• Long term strategy on promoting electricity as a major mode of domestic cooking and heating	By 2020	NPC, MOE, MOPE, MOF	
	• Minimum duties on energy efficient cooking and food conserving appliances	Coming FY		
	• Promotion of LPG in domestic cooking particularly replacement of fire wood	Continuous	Municipalities	
	• Promotion of efficient cooking stoves in rural areas where fuel wood abundant	Continuous	AEPC	
	• Introduction of standards on coal and enforcement	By 2017	MOPE and NBSM	
	• Promote exhaust in kitchens	continuous	DOE mass media	

Table 6.8 Clean Air Action Plan for Kathmandu Valley-Public Awareness

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Planning and Capacity Building	• Develop action plans for public awareness	By 2017	MOPE	
	• Publication and distribution of awareness materials including public notices;	By 2017 and regular	MOPE	Recommendation of Task Force
	• Training to health professionals on air pollution and its impact on human health;	By 2017 and regular	MOLTM	
	• Training to teachers and students on air pollution and its impacts;	By 2017 and regular	DOH	
	• Mobilize mass communication media on public awareness	By 2017	MOPE	
Partnership with Mass Media and Use of	• Sign and MOU with Representative of Electronic Media, Print Media for promoting awareness on air pollution	By 2017 and continuous	MOPE	

Social Media	prevention and dissemination of status on air quality and awareness program as part of social responsibility			
	• Negotiate with social media to use free of cost	By 2017	MOPE	

Table 6.9 Clean Air Action Plan for Kathmandu Valley-Strengthening the Policy and Legislative Framework

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Sectoral and Environmental Policies, Strategies and Plans	• Approval of the Draft Environmentally Sustainable Transport Strategy	Immediate	MOIDT and Cabinet	
	• Review of Transport Management Legislations as per the provisions of the approved strategy including legal provision on vehicle retirement	By 2017	MOIDT	
	• Approval of the Draft National Low Carbon Development Strategy for Nepal	By 2017	MOPE and Cabinet	
	• Approval of National Pollution Control Strategy and Action Plan	By 2017	MOPE and Cabinet	
	• High priority of approval of the master plan developed on Kathmandu Valley, Road Network, Land Use and Traffic Management	By 2017	Concerned Ministries and Cabinet	
Review of Legislations	• Review the Environment Regulation as per the NPCSAP with particular focus on use of economic instruments based on PPP	By 2017	MOPE	
	• Review of sectoral legislations as per the provision of low carbon development strategy and pollution control strategy	By 2018	Sectoral Ministries	
Land Use Plan	• Develop land use plan for Kathmandu Valley and Implement	By 2018 and continue	Kathmandu Valley Development Authority	

Table 6.10 Clean Air Action Plan for Kathmandu Valley-Institutional Arrangement for Effective Implementation

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Coordination Mechanism	Establish the high level coordination body under the chairmanship of minister for MOPE with high level representative from key stakeholders and elected representative of local bodies	Immediately	MOPE	
Institutional Capacity Building	Institutional strengthening of the DOE with clear legal mandate and financial and human resources	Regular	MOPE	Recommendation of Task Force
	Institutional strengthening of the DOTM with clear legal mandate and financial and human resources	Regular	MOLTM	
	Institutional strengthening of the Traffic Police with clear legal mandate and financial and human resources	Regular	DOH	
	Nepal to become member of CCAC to benefit from its knowledge networks	By 2017	MOPE	
Creation of New Institution	Establish the Kathmandu Valley Transport Management Authority	By 2018	MOIDT	

Table 6.11 Clean Air Action Plan for Kathmandu Valley-Financing the Action Plan

Issue	Actions	Time Frame	Institutional Responsibility	Remarks
Pollution tax and User charge	• Continue the Implementation of fuel tax provision of fiscal Act, 2053 and develop guideline for utilization of this money for the implementation of the CAAP	Immediate and continue	High level committee	
	• A provision of levying tax on import of coal into the valley	By next FY	MOF	
	• A provision of levying certain paisa per brick produced in Kathmandu valley.	By next FY	MOF	
	• Progressive taxes on renewable of vehicles after 10 years	By Next FY	MOF	
	• Road maintenance tax on vehicles		MOF	
	• Develop guideline for the use of the fund generated by the above sources	By 2017	MOPE, MOF and Municipalities	
Green Climate Fund	Develop project proposals with huge mitigation benefits (metro system, traffic management, industrial emission reduction, carbon sequestration, promotion of electric vehicles, etc)	By 2018	MOF, MOPE and Sectoral ministries	
	Provide soft loan to private vehicle owners and industries to move to clear mode of transport and modern technology utilizing the provisions of GCF	By 2018	MOF, MOPE and private body	
	Provide technical support to Town Development Fund to apply for accreditation to GCF as National Implementing Entities	By 2017	MOPE and MOF	

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Annex 1: Air Quality Management Action Plan for Kathmandu Valley in Nepali

Annex 2: Stakeholder Consultation meeting and National Workshop