Air Quality Status and Management in Kathmandu Valley

Make the City Air Breathable

Photo courtesy: Jerome Lorieau, Getty image

Kathmandu valley covered with thick air pollutants.

INTRODUCTION

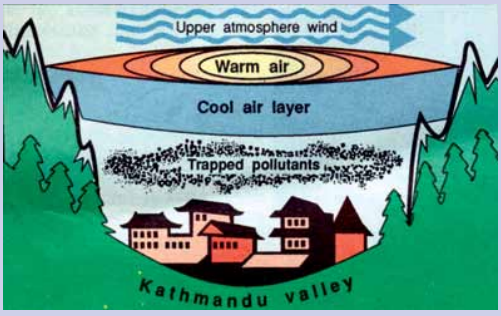
Air pollution has become a serious environmental concern and a public health risk in Kathmandu Valley. Studies show that the concentration of particulate matter less than 10 microns (PM_{10}) in the Valley's ambient air is already several times higher than WHO safer limit and Kathmandu is one of the most polluted cities in Asia with regards to PM_{10} and $PM_{2.5}$ level (WHO, 2014b; CAI-Asia, 2006). Although levels of gaseous pollutants such as oxides of nitrogen, oxides of sulphur, and ozone have not been found to be very high, they may increase in the future with increasing motorization. Furthermore, levels of toxic chemicals such as polyaromatic hydrocarbons (PAH) may also be high due to combustion in brick kilns and diesel vehicles (MOEST, 2005). According to Environmental Pollution Index 2014 published by Yale University, Nepal ranked second last after Bangladesh in terms of air quality and its effect to human health.

Nepal is the fastest urbanizing country in South Asia and Kathmandu Valley is the fastest growing metropolitan area in the region (World Bank, 2012). The valley has observed rapid urbanization and population growth in last few decades. The annual population growth rate is in the Valley 4.3 % and the annual motorization rate is 12% (CBS, 2011; DoTM, 2014). The valley is especially vulnerable to air pollution due to haphazard urbanization, rapid motorization, valley centric industrialization and its topography.

> *"Air pollution has now become the biggest environmental cause of premature death, overtaking poor sanitation and a lack of clean drinking water"*
>
> *- OECD, 2012*

KATHMANDU VALLEY IS VULNERABLE TO AIR POLLUTION

The unique topographic features coupled with high emissions of pollutants make the valley particularly vulnerable to air pollution. The valley is surrounded by hills forming bowl-shaped topography, which restricts wind movement and retains the pollutants in the atmosphere. This is especially bad during the winter season (Nov-Feb) when thermal inversion occurs in the valley late night and early morning. Cold air flowing down from the mountains is trapped under a layer of warmer air and acts as a lid. As a result, the pollutants are trapped close to the ground for extended periods of time.

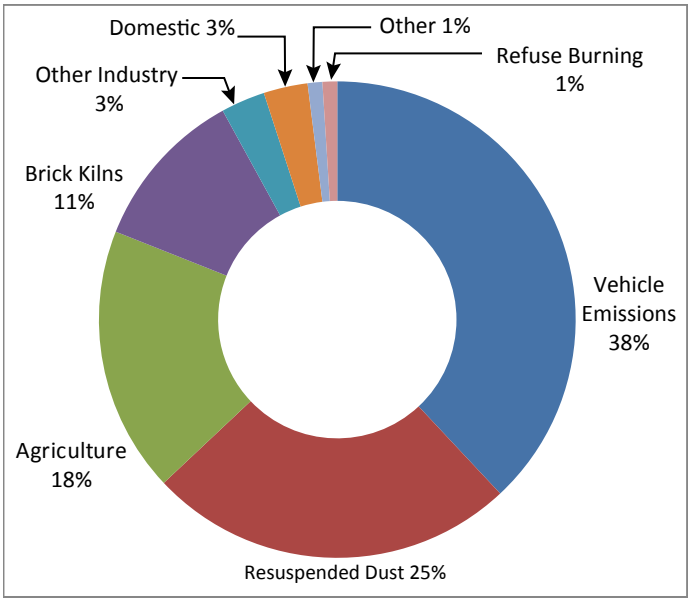


(Source: CSE India)

Atmospheric Inversion over Kathmandu Valley during Winter

SOURCES OF AIR POLLUTION

Vehicular exhaust and re-suspended road dust from unpaved and poorly maintained roads are the major sources of air pollution in Kathmandu Valley. Unprecedented growth of motor vehicles and ongoing road expansion drive has further degraded the air quality in the valley. Various studies have shown that high levels of fine particles in ambient air. It is estimated that 63% of total PM_{10} in Kathmandu Valley comes from vehicles and re-suspended road dust (Gautam, 2006). However, an emission inventory published by ICIMOD shows that transport sector generated approximately 98% of total PM_{10} emission (i.e. 85.2 kt of PM_{10}) in 2010 and 69% of total emission loads.

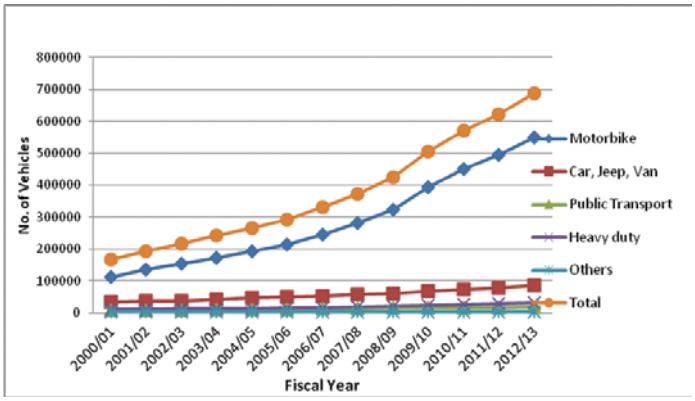


(Source: Gautam, 2006)

Fig. 1 Sources of PM_{10} in Kathmandu Valley

"The impacts of transport-related air pollution effect all urban residents, but there is substantial evidence that it affects the poor and vulnerable groups more than others. In fact, the social groups that are most seriously impacted are often not those that cause the pollution.

-UN-Habitat, 2013"



(Source: DoTM, 2014)

Fig. 2 Vehicle Registration in Bagmati zone (FY 2000/01-2012/13)

In past ten years, the number of registered vehicles in Bagmati Zone has increased by nearly three times. According to the data from Department of Transport Management, around 688,028 vehicles have been registered in Bagmati zone till fiscal year 2012/13, which accounts for 45% of total vehicles registered in Nepal. Of the registered vehicles, 93% are cars and motorbikes, which are generally private. The annual growth rate of the vehicles in Bagmati zone for the last ten years is 12%. Except for motorbike that has a large share of Euro III

Photo courtesy: Damodar Dhital

Vehicular emissions is the major contributor of air pollution in the valley

Photo courtesy: Rajan Thapa

Over one hundred of brick kilns are operated in the valley during dry season

technology (75%), other types of surveyed vehicles (buses, vans/microbuses, taxis and 3-whellers) were at most Euro II or lower (Shrestha et.al, 2013).

Brick kilns are other major source of air pollution in the valley. According to 'All Nepal Brick Kiln Association', there are around 104 brick kilns operating in the Kathmandu Valley alone. As these kilns operate during the dry season, the level of the pollution from the brick kilns is significant, particularly in the peri-urban communities of Lalitpur and Bhaktapur where most of the kilns are located.

Regular power cut has led to increasing usage of diesel generators (DG) sets as an alternative source of electricity in industries, commercial and non-commercial sectors, which is contributing to air pollution in the valley. Preliminary findings of a study on a diesel power generation is Kathmandu Valley shows that around 66.5% of the total diesel sold in Kathmandu Valley in 2012/13 was used for generating electricity from DG sets totaling to nearly 71,000 kl and this emitted nearly 400 tonnes of PM_{10}. The commercial sector (hotels, restaurants, shopping malls, banks etc.) was found to be the largest source of emissions from diesel power generation accounting to around 77% of total PM_{10} emissions. The emission from diesel generator is significantly high during the dry season when the load shedding is at its peak.

Photo courtesy: Bhushan Tuladhar

Black smoke from DG sets

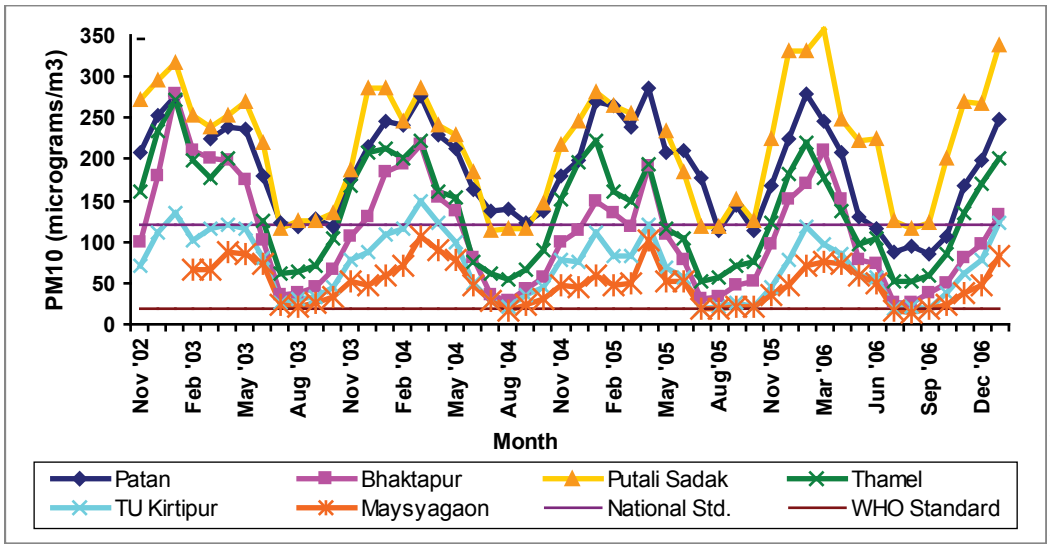
> ***Studies show that the concentration of particulate matter less than 10 microns (PM_{10}) in the Valley's ambient air is already several times higher than WHO safer limit and Kathmandu is one of the most polluted cities in Asia.***

STATUS OF AMBIENT AIR

Several studies have shown that Kathmandu's air is seriously polluted, particularly during the dry season (Nov-May). Ambient air quality monitoring data from 2002 to 2006 (Fig 3) shows that the high traffic density areas such as Putalisadak and Patan have very high level of PM_{10} levels exceeding WHO guidelines by several times and National Ambient Air Quality Standard (NAAQS) (MoEST, 2006).

Although data are for 2-hr average, the results suggest that the PM level has potential for high health risks to city dwellers in the valley.

The 2012 emission inventory by ICIMOD indicates that PM_{10} pollution hotspots were along the main roads and in industrial areas, and $PM_{2.5}$ hotspots include the road network, the city core area, and industrial areas. The ambient air quality monitoring showed that the daily PM_{10} level from October 2013-March 2014 in urban core areas (Putalisadak) exceed the NAAQS at all times and several times higher than the WHO guidelines. The data shows that the air quality has further degraded compared to previous years.

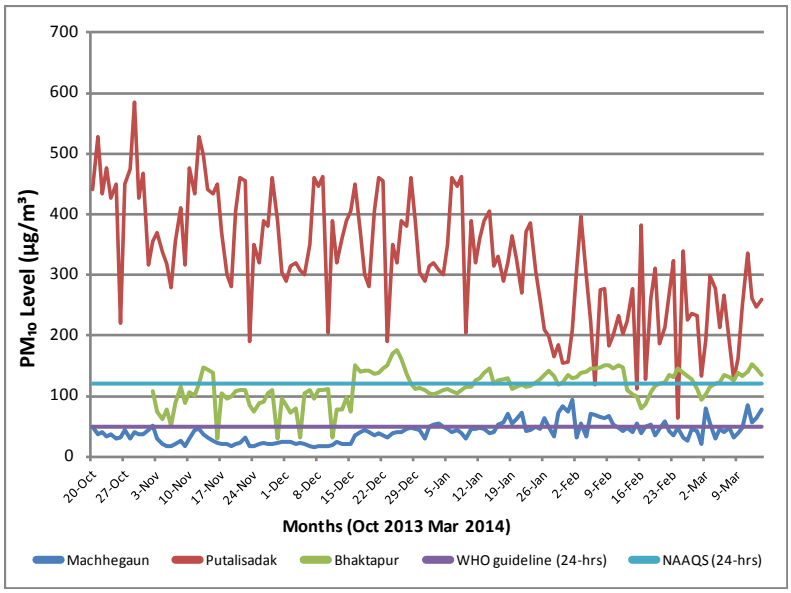


(Source: MoSTE)

Fig. 3 Monthly PM_{10} Levels in Kathmandu Valley Nov 2002- Dec 2006

> *In the year 2012, ambient air pollution was responsible for 3.7 million deaths, representing 6.7% of the total deaths. About 88% of these deaths occur in low- and middle-income countries,*
>
> *– World Health Organization, 2014*

Study on exposure to airborne particulate matter shows in Kathmandu valley in 2009 showed high personal $PM_{2.5}$ exposures with hourly personal $PM_{2.5}$ levels reached >500 µg/m^3 and averaged 51.2 µg/m^3 (Gurung A. and Bell M.L., 2012). A quick assessment of the current state of ambient air quality near the road construction sites conducted by Clean Energy Nepal/Clean Air Network Nepal in April 2014 showed that the 2-hour average concentrations of particulate matter (PM_{10} and $PM_{2.5}$) during monrining rush hour at three locations (Putalisadak, Sohrakhutte, and Maharajgunj) were found to be three to seven times of the NAAQS and upto 16 times higher compared to WHO guideline value. Putalisadak was found to be the most polluted site with the average PM_{10} level of 781 µg/m^3 and $PM_{2.5}$ level of 260 µg/m^3.



(Source: MoSTE, 2014)

Fig. 4 Daily PM_{10} Levels in Three Air Quality Monitoring Stations Oct 2013-Mar 2014

Photo courtesy: Rajan Kathet

Dust pollution due to road expansion

IMPACTS OF AIR POLLUTION

Air pollution is a major environmental risk to public health. New findings of WHO reveals strong link between air pollution exposure and cardiovascular diseases such as strokes and ischaemic heart disease, as well as cancer. This is in addition to air pollution's role in the development of respiratory diseases (WHO, 2014).

Few studies done on health impacts of Kathmandu's air quality have also indicated that, air quality is a major public health risk. In 2005, the Ministry of Population and Environment estimated that ambient air pollution was responsible for up to 1,600 premature deaths in the Kathmandu Valley. A NHRC/WHO study based on the Environmental Burden of Disease (EBD) approach, estimated 1,926 cases of premature death per year (NHRC/WHO, 2009).

Records from major hospitals in the Kathmandu Valley show that Chronic Obstructive Pulmonary Disease (COPD) has been steadily increasing (CEN/ENPHO, 2003). The number of COPD patients admitted to hospitals is highest during the winter season, when air pollution is at its peak. CEN/ENPHO (2003) also estimated that a reduction in PM10 levels in the Kathmandu Valley to comply with international standards would reduce 1,35,475 cases of acute bronchitis in children, 0.5 million asthma attacks, 4,304 cases of chronic bronchitis and thousands of hospital admissions and emergency room visits.

The health impacts also translate into economic costs. The World Bank estimated that Nepal's annual health cost attributed to urban air pollution was USD 21 million in 2007, equivalent to 0.29% of the GDP. Another study estimates that the reduction in air pollution from the current level to national ambient air quality standard would save Kathmandu and Lalitpur NRs 315 million annually (Adhikari, 2012).

Tourism, one of the major sources of country's economy, is adversely affected by air pollution in the valley. A survey of tourists in Thamel found that 54% of the tourists rated air quality as either very bad or fairly bad (CEN/CANN, 2012).

Photo courtesy: Sara Germain, Theguardian

Levels of particulate matters in urban core areas are several times higher than the WHO safer limit

> ***"Fine particulate matter is associated with a broad spectrum of acute and chronic illness, such as lung cancer, chronic obstructive pulmonary disease (COPD) and cardiovascular diseases. Worldwide, it is estimated to cause about 16% of lung cancer deaths, 11% of COPD deaths, and more than 20% of ischaemic heart disease and stroke. Particulate matter pollution is an environmental health problem that affects people worldwide, but low- and middle-income countries disproportionately experience this burden."***
>
> ***- World Health Organization, 2014***

RESPONSES TO AIR POLLUTION

I. GOVERNMENT INITIATIVES

"If the concentrations of PM_{10} in Kathmandu Valley could be reduced to levels below 50 µg/m³, 1,600 deaths out of the total population of 1.8 million, could be avoided, based on the levels of PM_{10} found in 2003.

– Ministry of Population and Environment, Government of Nepal, 2005"

POLICIES AND STANDARDS: The government has introduced several policies, legislation and standards related to air pollution. However, these have not been followed up with comprehensive plans and programmes.

- Interim constitution 2007 has guaranteed every person the right to live in a clean environment as a fundamental right and mandate state to make necessary arrangements to maintain clean environment.
- Environmental Protection Act introduced in 1997 make legal provision to maintain clean and healthy environment by minimizing adverse impacts as far as possible.
- Climate Change Policy 2011 has aimed at moving in low carbon development path, which provide co-benefits for reducing the air pollution.
- National Ambient Air Quality Standard (NAAQS) was introduced in 2003 and updated in 2012 (see Fig. 5).

Parameters	Time Weighted Average	Concentration max (µg/m³)	WHO Guidelines (µg/m³)
TSP	Annual	-	-
	24-hours	230	-
PM_{10}	Annual	-	20
	24-hours	120	50
$PM_{2.5}$	Annual	-	10
	24-hours	40	25
SO_2	Annual	50	-
	24-hours	70	20
NO_2	Annual	40	40
	24-hours	80	-
CO	8-hours	10,000	-
Lead	Annual	0.5	-
Benzene	Annual	5	-
Ozone (O_3)	8-hours	157	100

Fig. 5 National Ambient Air Quality Standard (NAAQS), 2012

- Nepal Vehicle Mass Emission Standard (NVMES) was introduced in 2000 and revised in 2012. Now all vehicles except for heavy equipment vehicles imported to Nepal require compliance with EURO III emission standard.
- Euro III Standard Fuel: Nepal Oil Standard started supplying EURO III standard of fuel since 2010.
- Emission standards for in-use and new diesel generators (DG) sets, industrial boilers, cement industries and crusher industries were introduced in 2012. However, implementation of the standards and its compliance has not been effective yet. The government has also introduced brick kiln stack emission standard in 2008.

AMBIENT AIR QUALITY MONITORING SYSTEM: MoSTE started monitoring ambient air quality through six monitoring stations in 2002. The equipment however stopped functioning in 2007 and in 2013, the Ministry has resumed air quality monitoring in three of the stations: in Bhaktapur, Machhegaun and Putalisadak by measuring PM_{10} levels on a daily basis.

VEHICLE INSPECTION AND EMISSION TESTING: Nepal initiated activities for monitoring of exhaust emissions in the valley in 1993 and issuance of Green Sticker system was enforced since December 1999. The vehicle emission testing is only limited within Kathmandu valley and is applicable only to three and four wheelers. However, the inspection and emission testing system has not been effectively implemented.

BAN ON POLLUTING VEHICLES: The government banned the operation of heavily polluting diesel three wheelers and import of new two-stroke and second hand vehicles in 1999, in an effort to combat air pollution in Kathmandu Valley. This initiative prompted the scaling up of electric vehicles (Safa tempo) for public transportation.

BAN ON THE HEAVILY POLLUTING MOVABLE BULL TRENCH KILN: In 2003, old polluting brick kilns in Kathmandu Valley were banned by the government following significant protests from the local people. This was followed by the introduction of less polluting technologies, mainly Fixed Chimney & Vertical Shaft Brick Kilns (VSBK).

POLLUTION TAX ON FUEL: The government started to collect pollution tax of NRs. 0.5 from each liter of petrol and diesel sold in the Kathmandu Valley in 2007. However the provision to deposit the pollution tax to Environment Protection Fund as decided in Financial Act 2002/03 has not been implemented yet and the amount collected has remained unspent.

ROAD IMPROVEMENT, FOOTPATHS AND CYCLE LANES: The government has initiated road expansion campaign to improve the traffic flow, and has built sidewalks and cycle tracks to promote walking and cycling. Under Kathmandu Sustainable Urban Transport Project, the government is improving the public transport system and pedestrianizing the urban core areas.

Photo courtesy: www.dewalt.org

VSBK technology emits less emission than other brick kilns commonly used

II. PRIVATE INITIATIVES

PUBLIC TRANSPORT: The public transport service in Kathmandu Valley is exclusively provided by the private sector. Although it is not efficient it still provides its services to thousands of people, as 28 % of the travel in Kathmandu is on public transport.

Sajha Yatayat, has restarted its service in 2013 under cooperative model with 16 standard buses of Euro 3 emission standard. It is now currently operating in two routes in Kathmandu Valley. The other landmark in public transport system in Kathmandu valley was introduction electric trolleybus system from in 1975, with aid from Chinese government. The system was formally closed in November 2009 marking the end of an era of government direct role in public transport service. .

OPERATION OF ELECTRIC VEHICLES: Around 600 electric three wheelers (SAFA Tempos) are currently operating in Kathmandu Valley in 17 routes providing service to over 10,000 people daily. .

III. INITIATIVES FROM NON-GOVERNMENTAL INSTITUTIONS

Many non-governmental institutions have played an active role in research, policy advocacy and campaigns for clean air and promoting sustainable urban mobility in Kathmandu valley. Some of the key organizations working on air pollution related issues are Clean Energy Nepal, Clean Air Network Nepal, Nepal Forum of Environmental Journalists (NEFEJ), Environment and Public Health Organization (ENPHO), International Centre for Integrated Mountain Development (ICIMOD), and LEADERS Nepal. . Academic institutions such as Kathmandu University, Tribhuwan University and Pokhara University conducts research on air pollution related issues. International organizations and developmental agencies have played key role in supporting government for improving the air quality such as establishment of air quality monitoring stations by DANIDA, promotion of electric vehicles by USAID, introduction of Vertical Shaft Brick Kiln (VSBK) technology by SDC, and KSUT project supported by Asian Development Bank.

> *"If the entire fleet in the Kathmandu Valley would comply with Euro III then the emission would decrease, as compared to the base case, by 44% for toxic air pollutants."*
>
> *- Shrestha, et. al., 2013*

WAYS AHEAD FOR BETTER AIR QUALITY

Urgent action needs to be taken to make the city's air breathable and reduce the impact on public health, economy and environment. Some of the key steps to be taken are listed below:

- Develop and implement an Clean Air Action Plan with both immediate and long-term strategies and targets to reduce the air pollution in Kathmandu Valley
- Improve public transportation system and introduce Bus Rapid Transit system
- Promote clean transportation such as walking, cycling and electric vehicles
- Introduce more stringent emission standards and fuel quality standard.
- Effectively implement the green sticker system and remove gross polluters
- Regularly monitor air quality
- Promote energy efficiency and cleaner technologies in industries, such as Vertical Shaft Brick Kiln and zigzag kiln technology for brick productions
- Promote alternative energy such as solar for electricity generation
- Effective waste management system to stop disposal of waste in public places and control open burning of waste
- Establish a dedicated and sustainable funding mechanism by effectively using the environmental tax for improving air quality

"Cleaning up the air we breathe prevents non-communicable diseases as well as reduces disease risks among women and vulnerable groups, including children and the elderly."

- Dr Flavia Bustreo, WHO Assistant Director-General Family, Women and Children's Health.

REFERENCES:

ADHIKARI, N, 2012	:	Working Paper, No 69-12 Measuring the Health Benefits from Reducing Air Pollution in Kathmandu Valley, SANDEE
CBS, 2012	:	National population and Housing Census 2011 (National Report), Central Bureau of Statistics
CEN/ENPHO, 2003	:	Health Impacts of Kathmandu's Air Pollution, Clean Energy Nepal
CEN/CANN, 2010	:	Identification of Indoor and Outdoor Particulate Concentration and its Chemical Composition in Kathmandu Valley, Clean Energy Nepal
CEN/CANN, 2013	:	Study of Health Effects of Air Pollution Exposure on Children At Selected Schools of Kathmandu Valley, Clean Energy Nepal
CEN/CANN, 2013	:	Diesel for Power Generation: Inventories and Black Carbon Emissions in Kathmandu Valley, Nepal, Clean Energy Nepal
CEN/UN-HABITAT	:	Urban Mobility in Kathmandu: Status and Trends, Clean Energy Nepal
CEN/CANN, 2014	:	Air Quality Monitoring at Major Traffic Intersections of Kathmandu (Summary of Findings)
CAI-ASIA, 2006	:	Urban air quality and its management in Asia: Status Report 2006, Presented at the Regional Dialogue of Air Quality Management Initiatives and Programs in Asia. 12 October. Bangkok, Thailand.
ICIMOD, 2012	:	Rapid Urban Assessment of Air Quality for Kathmandu Nepal, International Center for Integrated Mountain Development
GURUNG A. & BELL M.L., 2012	:	Exposure to airborne particulate matter in Kathmandu Valley, Nepal
MoSTE, 2013	:	Monthly Air Quality Monitoring Datasheet, Ministry of Science, Technology and Environment
NHRC, 2009	:	Situation Analysis of Environmental Health in Nepal, Nepal Health Research Council
SARAF. A, 2005	:	Health Impact of particulate Pollution in Children: A Case Study of Kathmandu, Nepal, NHRC
SHRESTHA ET. AL., 2013	:	Analysis of the vehicle fleet in the Kathmandu Valley for estimation of environment and climate co-benefits of technology intrusions, Atmospheric Environment
WORLD BANK/ENPHO, 2007	:	Nepal Country Environmental Analysis, Analysis of Urban Environmental Issues, Draft Report, The World Bank and Environment and Public Health Organization
YALE UNIVERSITY, 2014	:	Environmental Performance Index (http://epi.yale.edu/epi)
WHO, 2014A	:	Ambient and Household Air Pollution and Health (http://www.who.int/phe/health_topics/outdoorair/databases/en/)
WHO, 2014B	:	Ambient (outdoor) air pollution in cities database 2014 (http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/)
WORLD BANK, 2012	:	Urban Growth and Spatial Transition: An Initial Assessment Nepal

This factsheet was published in March 2014 as part of MaYA (Manav-kendrit Yatayat Abhiyan) – A campaign for people-centric transportation system being implemented by Clean Energy Nepal, with support from UN-Habitat. For more information on the campaign, please contact:

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