A Strategic Approach for Air pollution Reduction in Kathmandu Valley

Key Findings

- **Fine particulate matter ($PM_{2.5}$), polycyclic aromatic hydrocarbons (PAH) and benzene are air pollutants of concern in Kathmandu Valley.**
- **Concentrations of PM_{10} and $PM_{2.5}$ exceed WHO guideline values by a factor 2-10 indicating a serious risk for cardiovascular-respiratory diseases.**
- **The fraction of fine particles $PM_{2.5}$ and $PM_{1.0}$ (0.8-0.9) is large in PM_{10} indicating a high threat of PM-induced ailments.**
- **About 1,600 premature deaths per year are expected to occur due to exposure of the Kathmandu Valley population to PM_{10}.**
- **About 1-8 people in 100,000 would be expected to suffer from leukaemia due to benzene exposure.**
- **About 16-32 people in 100,000 would be expected to suffer from lung cancer due to PAH exposure.**
- **The options incorporated in the PREPair programme can lead to low-cost and realisable actions to combat air pollution in Kathmandu Valley.**

Introduction

Over the past two decades the issue of air pollution in the Kathmandu Valley has become of increasing concern as concentrations of ambient air pollution exceed international air quality guidelines and standards. The steady growth in road traffic has resulted in the increasing contribution of vehicle emissions to urban air pollution, especially particulate matter (PM), volatile organic compounds, polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO), and nitrogen oxides (NO_x). Uncontrolled motor vehicles, particularly those with diesel and two-stroke engines, are the most important sources of air pollution in Kathmandu Valley together with industrial emissions such as brick kilns and dyeing processes. Studies have shown that air pollution has significant impacts on human health. PM emissions pose a significant threat to health of the residents of the Kathmandu Valley as the emitted particles are inhaled and can cause damage to the respiratory and cardiovascular systems. Exposure to air pollutants can overload or damage natural bodily defence mechanisms causing, or contributing to, respiratory diseases such as asthma, chronic bronchitis, emphysema, and lung cancer. Fine particles are of particular concern as they are inhaled and can remain for several weeks in the lungs.

The serious air pollution challenges in Kathmandu Valley call for rapid approaches to assess the problem and derive solutions which are politically viable, low-cost and realizable in a step-wise way. This task can be addressed with the new EXCEL-based Programme for Rapid Evaluation of air Pollution (PREPair) developed by SEI within the IPS project.

Truck polluting the air

Source: Kathmandu Valley Environmental Outlook 2007

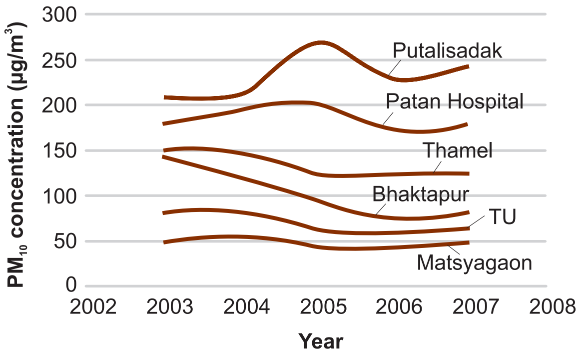
Programme for Rapid Evaluation of air Pollution

The SIM/AIR programme developed in 2005/6 was extended to a Programme for Rapid Evaluation of air Pollution (PREPair). The extensions include the following:

- A link to the emissions inventory workbook developed by the Stockholm Environment Institute (SEI) and Global Atmospheric Pollution Forum (GAPF).

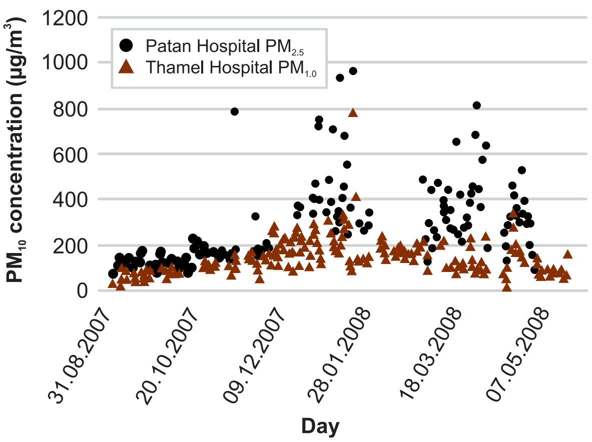
- An interface with The Air Pollution Model (TAPM) and Atmospheric Transport Modelling System (ATMoS) to enable realistic dispersion modelling using local or synoptic meteorological data.
- Calibration and validation of the modelling simulations with monitored data.
- Provisions to highlight co-benefits such as CO_2 savings and reduction of health impacts; introduction of positive externalities for scenario analysis.
- The introduction of $PM_{2.5}$ as the key pollutant.
- Insertion of a library of policy interventions covering a number of institutional, technical, political, legal and economic areas.
- Improvements to the user interface including the provision of technical information related to SIM-air for outreach purposes.

As a pilot case study, the PREPair programme is being implemented for the Kathmandu Valley, Nepal.



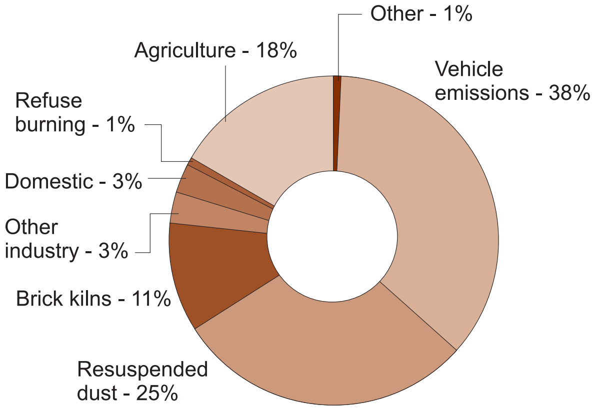
PM_{10} concentrations at the six monitoring sites in Kathmandu Valley

Source: MoEST (2006); ICIMOD private communication



24-hour concentrations for $PM_{2.5}$ at Patan Hospital and for $PM_{1.0}$ at Thamel, 07.09.2007-22.05.2008

Source: SEI/ICIMOD 2008



Source apportionment of PM_{10} in Kathmandu Valley

Source: Gautam 2006

Emissions

Vehicle emissions and emissions of re-suspended dust from poorly maintained and uncleaned roads are the main sources of PM_{10} in Kathmandu Valley, contributing approximately 63 percent of all PM_{10} emissions. Agriculture and brick kilns are the third- and fourth-highest contributors of PM_{10}. Other industries and domestic sources are minor contributors of PM_{10}. PM_{10} and $PM_{2.5}$ emissions from road transport are higher by one to two orders of magnitude than the emissions from combustion in manufacturing industry, residential emissions, and emissions waste burning and agricultural activities.

Residential emissions of CO and NMVOC are higher than those from road traffic while NO_x emissions are mainly due to transport. Emissions of PM_{10} from road traffic are approximately 16 times higher than those of CO and 26 times than those of NO_x.

Outdoor air quality

Annual PM_{10} concentrations exceed the WHO guideline value of 20 µg/m³ by a factor of 2.5 at the site with the lowest PM_{10} concentrations (Matsyagon) and by a factor of 10-13 at the site with the highest PM_{10} concentrations (Putalisadak). 24-hour PM_{10} concentrations exceed by a factor between two and six the WHO guideline value of 50 µg/m³.

Routine monitoring with a DustTrak monitor was performed between September 2007 and May 2008 at Patan Hospital site ($PM_{2.5}$) and Thamel ($PM_{1.0}$). For the monitoring period of eight months, the mean of $PM_{2.5}$ at Patan Hospital is 269 µg/m³ and the concentrations range between 67 and 965 µg/m³ at this site. Similarly, $PM_{1.0}$ has an average of 137 µg/m³ and ranges between 20 and 774 µg/m³. These results indicate an enhanced risk of health impacts exist for residents in the area around these monitoring sites. $PM_{2.5}$ was approximately 5-8 times higher than the WHO guideline value of 25µg/m³. Compared to PM_{10} at both sites the $PM_{2.5}$ and $PM_{1.0}$ fraction are high, approximately 0.83 and 0.92, respectively. This means that most of PM_{10} is particles in the fine fraction and therefore particularly dangerous to human health. Benzene concentrations in Kathmandu Valley range approximately between 2 and 10 µg/m³. PAH concentrations have been observed between 2 ng/m³ and 40 ng/m³.

Impact of air pollution in Kathmandu Valley

Health impacts of Kathmandu Valley's air pollution can be quite severe. The number of in-patients in major hospitals in Kathmandu Valley suffering from chronic obstructive pulmonary disease (COPD) has significantly increased between 1992 and 2003. The increase in the number of COPD in-patients is highest in the winter season when the air pollution is also high.

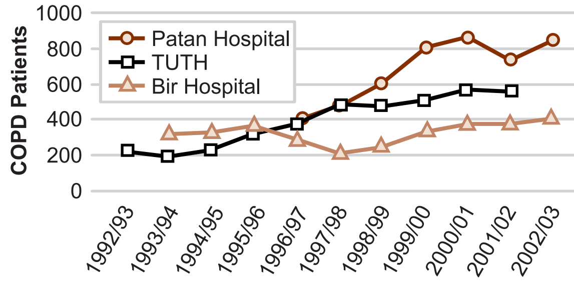
The Ministry of Environment, Science and Technology (MoEST) estimated in 2005 that Kathmandu Valley's air pollution results in approximately 1,600 premature deaths per year. The estimate of Clean Energy Nepal/Environment and Public Health Organization (CEN/ENPHO) on avoidable costs of exposure to air pollution indicates that the total benefit of reducing Kathmandu Valley's PM_{10} levels to 50 µg/m^3 would amount to US$1.86 billion per year.

Using the WHO unit risks for benzene and PAH the number of people expected to suffer from leukaemia due to benzene exposure amount to 1-8 persons per 100,000 and for PAH to 16-32 persons per 100,000. Benefits of reducing benzene and PAH concentrations to half their current values would amount to US$ 30-70 million per year.

Additional benefits of reducing air pollution in Kathmandu Valley could be a positive impact on tourism. Tourists think that air pollution is the number one issue in Kathmandu Valley in which improvement is required. Tourists shorten their stay in Kathmandu Valley if they cannot see the mountains.

Air quality management

The legislative framework to control air pollution in Nepal is fragmented over 16 different acts and laws. The1997 Environment Protection Act covers environment conservation; pollution control and prevention; conservation of natural heritage sites; operation of environmental funds; incentives to minimize pollution; and compensation for environmental damage. Nepal has set national ambient air quality standards for NO_2 and lead which coincide with the WHO guideline values; PM_{10} and SO_2 standards are lenient against the guideline values of the WHO; the SO_2 standard is much more stringent than the EU limit value and USEPA standard.



Tendency in the number of COPD in-patients 1992-2003
Source: CEN/ENPHO 2003

The 1993 Motor Vehicle and Transportation Management Act empowers local authorities to prescribe standards for the examination of vehicles and to fine violators of traffic and transport rules. Since 2000 the importation of reconditioned second-hand vehicles has been banned. Three wheelers using compressed or liquid natural gas are almost fully exempt from taxes.

In 2000 Nepal adopted emission standards for new gasoline or gas-operated vehicles (cars, light-duty vehicles, two-wheelers and three-wheelers) exhaust emissions of CO, HC and NO_x. The Hartridge smoke unit for diesel vehicles has also been limited.

Outdated Bulls Trench Brick Kilns (BTBKs) are not being registered any more in Kathmandu Valley. The legal and administrative process has started to replace existing BTBKs by Vertical Shaft Brick Kilns (VSBKs).

As the particulate exhaust from motor vehicles and re-suspended dust from paved and unpaved roads are the major sources of air pollution in Kathmandu Valley measures to reduce motor vehicle emissions are a first step to obtain cleaner air. Such measures include use of cleaner fuels; traffic management; regulation and control of public bus transport; introduction of segregated lanes; incentives for using non-motorized transport means; enforcement of the ban on the import of obsolete vehicles and phase-out of old and polluting vehicles; physical restraints such as limiting the use of vehicles on specific days or in specific areas; parking policies; and road pricing (tolls, congestion charges).

A very polluted day in Kathmandu Valley
Source: Kathmandu Valley Environmental Outlook 2007

A clear day in Kathmandu Valley

Recommendations:

Use of low sulphur fuels.
Low sulphur fuels should be used as they reduce the emissions of ultra fine sulphates which are a serious threat to health.

Regulation and control of public bus transport
Use of efficient and comfortable public transport systems can help reduce transport emissions by reducing use of private vehicles. High standards of quality of service need to be implemented.

Segregated lanes and non-motorized transport
Segregated lanes should be introduced for the different modes of transport – public, cycling and walking in order to smooth the traffic flow and pollution, and reduce traffic accidents.

Traffic management
Traffic management measures are necessary and should include computerised traffic light control, network and junction design, parking controls, reducing the supply of space allocated to car parks, speed limits, avoiding obstacles leading to acceleration- and deceleration driving, restricted access for non-essential traffic, bus priority lanes, pedestrian areas and cycling facilities.

Bus rapid transport (BRT)
The introduction of bus rapid transport should be considered as an efficient and comfortable means to reduce the use of private vehicles and transport emissions.

Open fires and waste burning
Open fires and burning of tyres should not be permitted in Kathmandu Valley. Hazardous wastes should be burned at high temperatures and/or treated before deposition of their residues.

Obsolete technologies and brick kilns
Technologies imported into Nepal should follow the same state-of-the-art technology as in developed countries in order to avoid health and environmental impacts that will be more costly to sort out once the technology is installed. Bull trench brick kilns should be replaced by vertical shaft brick kilns.

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