SANDEE

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The Benefits of Making the Air in Nepal's Kathmandu Valley Safe to Breathe

Air pollution is a significant health problem in Nepal's Kathmandu Valley, where rapid urbanization has resulted in a significant deterioration in the region's air quality. In response to this growing crisis, and to help drive the enforcement of pollution related legislation, a SANDEE study has estimated the value of the health benefits that would result if air pollution were brought down to a safe level. The study is the work Naveen Adhikari from the Central Department of Economics at Tribhuvan University, Kathmandu.

The study finds that cleaning up the region's air would bring an annual welfare gain of NPR 266 per year (USD 3.70) to each individual in the valley's two main urban areas (Kathmandu and Lalitpur). Taking into account the total population of these cities, the study finds that bringing air pollution down to a safe level would result in total benefits worth NPR 315 million (USD 4.37 million) per year. The Government of Nepal has a current initiative to implement a long-term energy plan to reduce emissions from fossil fuels, promote the use of renewable energy and reduce air pollution. If this energy Master Plan is implemented, the study finds that the benefits from improved air quality over the next twenty years could be as high as NPR 6,085 million (USD 80.53 million).

The Pollution Challenge

Kathmandu Valley, consisting of three administrative districts, Kathmandu, Lalitpur and Bhaktapur. is the fastest growing urban area in the country. As mentioned above, air pollution is a major problem in the region. In particular, levels of particulate matter (PM10) in the air generally exceed the national ambient air quality standards (NAAQS) in the core city area. Although there are many sources of air pollution, including industry and agriculture, dust particles and vehicular emissions are the most significant.

An inventory of emission sources by the Ministry of Population and Environment (MoPE) indicates that the quantity of exhaust fumes produced by vehicles increased by more than four times between 1993 and 2001. The increase in vehicular emissions is mainly due to the operation of poorly maintained polluting vehicles such as trucks and buses and growth in the number of automobiles, which is rising at a rate of over 15% per year. In addition to vehicular emissions, poor infrastructure, road congestion and the seasonal operation of brick kilns further worsen air quality in Kathmandu Valley. Brick kilns operate during the winter and contribute to an increase in air pollution levels during this season. Moreover, the Valley being surrounded by 500m-1000m-high hills, has a bowl-like topography and low wind speeds. These factors create poor dispersion conditions, allowing any air pollution to remain in place for a long time.

The Government Response

The Government of Nepal has implemented several policies to tackle pollution. These are primarily aimed at controlling emissions from vehicles and brick kilns. Among the initiatives taken by MOEST (the Ministry of Environment Science and Technology) are a ban on diesel-operated three-wheelers (tempos), the introduction of electric and gas-powered vehicles and a ban on the new registration of brick kilns. As previously mentioned, the Government is also preparing an energy master plan. This is designed to reduce air pollution to safe levels through the use of cleaner fuel options such as LPG, CNG or electricity.

This policy brief is based on SANDEE working paper No. 69-12, 'Measuring The Health Benefits From Reducing Air Pollution In Kathmandu Valley' by Naveen Adhikari, from the Central Department of Economics, Tribhuvan University, Kirtipur, Kathmandu, Nepal. The full report is available at: www.sandeeonline.org

Data collection for the study

The survey for this study was conducted during September 2008, using a pre-tested questionnaire and a series of health diaries. 120 households were interviewed and information was gathered from a total of 641 individuals regarding their socio-economic profiles and individual health characteristics. The average size of the surveyed households was 5.42. Out of the 641 individual members, almost 51 percent were female. The age of the individuals in the sample ranged from 1 to 87 with an average age of 34 years.

The questionnaire sought information on accommodation, income and expenditure, household health information, and indoor air-quality information. It also sought information on various socio-economic and demographic characteristics such as age, gender, education level, marital status, occupation, and smoking habits; the household health section of the questionnaire collected information on current health stock and symptoms of chronic illness. To capture the degree of exposure to indoor air pollution levels, information was collected on how households cooked (for example, whether cooking was done using gas, firewood or kerosene), the availability of air conditioning and the use of insecticides and pesticides.

The health diaries were used to capture information on air pollution variation and its effect on human health. Given the seasonal variation in air pollution levels, diary data was collected for a total of 12 weeks. Information was collected for three weeks in a row during four different seasons: the post-monsoon period and the winter, summer and monsoon season. Three trained enumerators collected the data during September-October 2008, January-February 2009, April-May 2009 and July-August 2009.

The study used a two-stage stratification process for selecting households. The main reason for adopting this approach was to capture the residents' exposure to air pollution and their ability to avoid such exposure. For the first stage stratification, the location of the air pollution monitoring stations was first identified. Three representative monitoring stations were then selected (Thamel, Putalisadak and Patan).

After locating the monitoring stations, a radius of 500m was drawn from the monitoring station using GIS technology. The area falling within this 500m radius was then divided into four sub-areas. Having coded the roads in the different blocks, a road was randomly selected from each block. Households were then chosen from each road. A total of 40 households were then chosen around each monitoring station.

The households were also stratified based on a wealth indicator (whether the household had a four-wheel or two-wheel vehicle). In addition, since the continuous exposure of an individual to air pollution causes illness, the researchers only interviewed those individuals who had been residing at each selected locality for at least five years.

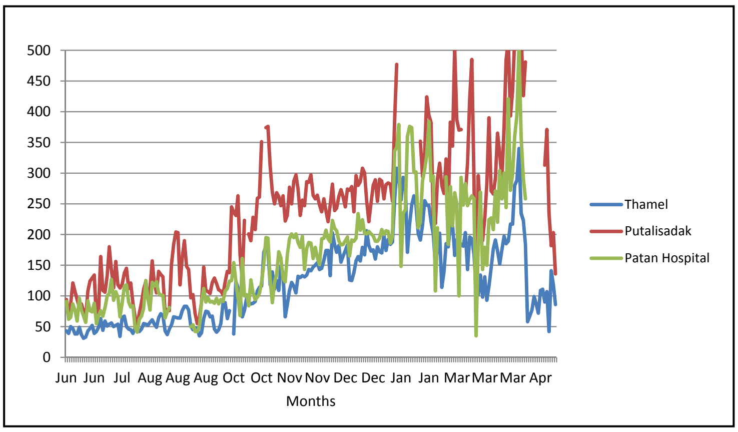
Traffic jam in Kathmandu

To help justify the implementation of such programs, the research team measured the potential benefits of reducing air pollution to a safe level. To do this, they assessed how many days people suffer from illness due to air pollution and how much these 'lost' or 'restricted' days costs in terms of lost earning. They also assessed the amount people pay for mitigating activities. Mitigating activities include travel to a clinic to consult a doctor, medicines, laboratory tests and hospitalization. Once these costs of illness were assessed, the researchers were then able to calculate the savings that would result from a drop in pollution for both individuals and the Valley.

Collecting Data Across Seasons

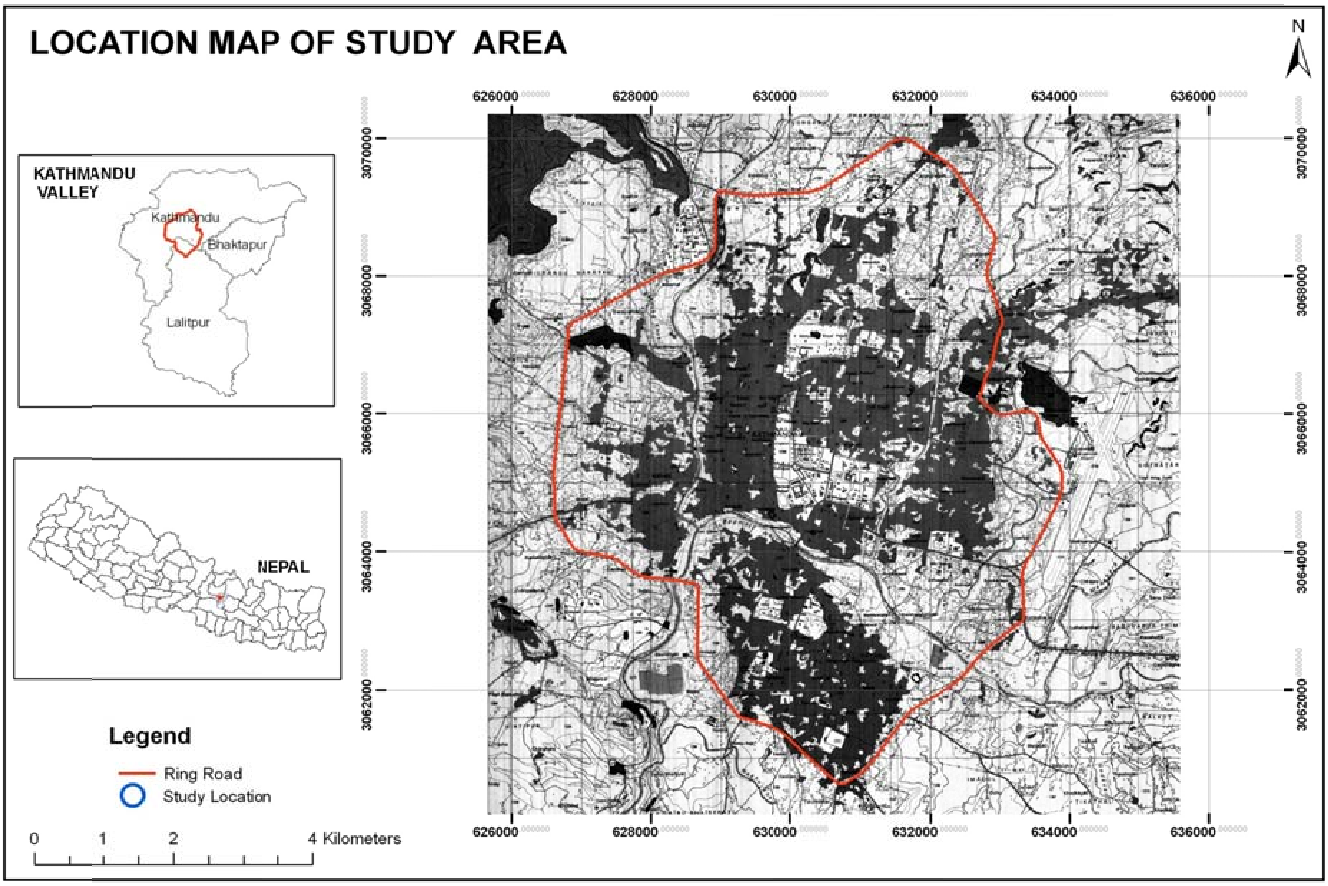
Several studies have attempted a similar approach to estimate the cost of illness. However, these have had various limitations because of methodological issues and data problems. To overcome these limitations, Adhikari's study aimed to capture the seasonal variation in air pollutants and the effect of this variation on human health. To do this, data for this study was collected over four seasons from 120 households (641 individuals) and in three different locations. Information on the socio-economic characteristics of households and individual family members were collected using a household survey. In addition, four rounds of health information were collected from individuals through health diaries.

Figure 1: Average PM10 at Various Monitoring Stations in Kathmandu Valley (July 2007-May 2008)



Source: MOEST (Various Reports)

Figure 2: Study Area Map



Air pollution information was obtained from MOEST. In order to monitor the air pollution variations in the Kathmandu Valley, the agency has set up six monitoring stations in different locations. These locations include areas by the roadside, residential areas, areas that fall under the 'urban background' category and areas that fall under the 'valley background' category. Data were also collected on other climatic variables such as temperature, rainfall and humidity from the Department of Meteorology. Household data was then matched with air pollution data to allow welfare benefits to be estimated (to see how this was done and for more details on the data collection process, please see the side bar).

The study finds that PM10 at roadside stations and residential areas often exceeds the national ambient air quality level of 120 $\mu g/m^3$. It also finds that PM10 levels at 'urban background' stations have sporadically exceeded the safe level. Only the readings from the 'valley background' stations normally remain within the safe level. The average PM10 level during the study period was 254.75 $\mu g/m^3$. Therefore, the average change required to reduce pollution to a safe level of 120 $\mu g/m^3$ (the national ambient air quality standard) would be 134.17 $\mu g/m^3$.

The results show that PM10 is one of the major factors contributing to air-pollution-related diseases in the Kathmandu Valley. The results also suggest that age has an impact on a person's probability of falling ill due to exposure to air pollution – this decreases up to a certain age but increases thereafter. The study also finds that an individual with a history of chronic disease has a higher probability of falling ill than someone without such a history. In addition, the probability of an individual falling ill is higher if a household does not live in a cement house and if they use kerosene for cooking.

The Economic Benefits of Pollution Clean Up

The study shows that a unit reduction in the level of PM10 pollution would save individuals 'lost' or 'restricted' due to illness caused by air pollution. Based on the estimated models, Adhikari's study suggests that a reduction in pollution to 134 $\mu g/m^3$ in PM10 (to keep pollution at a safe level) would save an individual 0.39 days per annum. The average wage rate in Kathmandu is NPR 273.35 per day. Thus, an employed person would enjoy benefits worth NPR 105 per year if air pollution were brought down to a safe level. Nearly 37 percent of the individuals in the study sample were employed. Thus, air pollution clean-up could bring time savings worth NPR 58.5 million (USD 0.81 million) for the entire city.

When it comes to mitigating costs, if air pollution is reduced to a safe level (down to the national ambient air quality

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The South Asian Network for Development and Environmental Economics (SANDEE) is a regional network that seeks to bring together analysts from the different countries in South Asia to address their development-environment problems. Its mission is to strengthen the capacity of individuals and institutions in South Asia to undertake research on the inter-linkages among economic development, poverty, and environmental change, and to disseminate practical information that can be applied to development policies. SANDEE's activities cover Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka.

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standard of 120 μg/m^3) the annual welfare gain to an individual would be NPR 161 (USD 2.25) per annum. Taking into account the projected population of the Kathmandu metropolitan and Lalitpur sub-metropolitan areas for 2009 (obtained from the census report), the total annual gain due to reduced mitigation costs would be NPR 256.60 million (or USD 3.56 million).

The total benefits of air pollution reduction are calculated as the sum of benefits from avoided restricted activity days and saved mitigating costs. For individuals this amounts to NPR 266 (USD 3.70) per annum. The annual sum of benefits to the entire city amounts to NPR 315 million (USD 4 million). It should be noted that this is an underestimate as it does not take into account expenditures on averting activities. Such activities include the number of days that an individual stays indoors to avoid exposure, the extra miles they travel per day to avoid polluted areas in the city, the use of a mask while traveling, etc.

The estimates of the health benefits from reduced air pollution in Kathmandu compare well with available estimates from other cities in the sub-continent. For example, the monetary gain of USD 3.70 (the saved costs to an individual) compares well with similar findings from other studies: USD 3.66 in Kanpur and USD 4.00 in Dhaka.

Longer Term Implications for Policy Makers

As mentioned above, in order to assess the long-term implications of these results, the study assessed the value of the potential benefits that would be produced by the Government of Nepal's long-term energy Master Plan, which seeks to control air pollution in the Valley. If the plan is implemented properly, it will result in a reduction of air pollution over the next few decades. In light of this, the study used its results to calculate the discounted benefit flow that could occur during the next 20 years.

The study finds that the discounted benefit of implementing the energy Master Plan for the population of Kathmandu and Lalitpur for the next twenty years (2010 to 2030) would be NPR 6086 million (USD 85 million). This is based on the assumption that economic factors will not change significantly during the given time period. Some caveats apply. Mitigating expenditure could increase over time because of an increase in income and medical prices. The population growth rate could also significantly increase the cost of illness for the entire city over the next twenty years.

This estimate provides useful information to stakeholders interested in air pollution regulation initiatives. It can be used to assess any costs related to the energy Master Plan. It will therefore enable policy makers to assess the economic viability of the plan within a cost-benefit framework and compare it to any other air pollution programs under consideration. Hopefully this will help drive the implementation of financially viable policies and provide the basis for long-term clean energy initiatives in Kathmandu Valley.

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