Measuring the Economic Costs of Morbidity and Mortality of Urban Air Pollution in Bangalore and Hyderabad Cities and the Suitability of WHO Methodology – Environmental Burden of Disease

Urban air pollution is an important environmental factor that is effecting a large portion of urban dwellers in developing economies. Due to the limitations of dose and impact nature, direct measurement of negative implications of urban air pollution is difficult and WHO has developed indirect methods such as Environmental Burden of Disease. However, in this study to measure the economic costs of urban air pollution, we find that WHO methodology needs modifications to suit local conditions.

Introduction

According to World Health Organization (1996), air pollution defined as "substances put into the air by the activity of mankind into concentrations which is sufficient to cause harmful effects to health, property, crop yield or to interfere with the enjoyment of property". Air pollution is primarily a serious environmental problem in urban areas, which imposes economic and environmental costs to the society. Air pollution is associated with both short-term and long-term increase in ill-health and mortality (Krzyzanowski et al 2005), including cardiovascular diseases, respiratory diseases, upper and lower respiratory infections, and lung cancer (Cohen et al 2004). The United Nations Environment Programme has estimated that globally 1.1 billion people breathe unhealthy air (UNEP, 2002). The World Health Organization (WHO) has estimated that urban air pollution is responsible for approximately 800,000 deaths and 4.6 million lost life-years each year around the globe (WHO, 2002).

During the last few decades, India has undergone a dramatic shifts and urbanization is one of them. Associated with urbanization is acute deterioration of air quality, primarily due to automobile and industrial emissions in urban areas, thus exposing a large segment of urban population to the harmful effects of the air pollution. Due to the inherent limitations in establishing the direct cause and effect relationship between exposure and health implications, economic implications of such exposure can be measured by proxy methods such as Comparative Risk Assessment (USEPA), Environmental Burden of Disease (WHO). This study, in its original scope of research is an attempt to quantify the economic costs of urban air pollution in two cities, viz., Bangalore and Hyderabad using suitable matrix – ‘Environmental Burden of Disease’ as developed by the WHO. Hyderabad and Bangalore cities were chosen as they are similar in lacking the efficient public transportation system and contribution of private vehicles in urban transportation is quite significant.

Air Quality Monitoring Network in India

India’s air quality monitoring network, originally called the National Ambient Air Quality Monitoring (NAAQM) was initiated in 1984 with seven stations. This network was established by Central Pollution Control Board (CPCB) in coordination with the SPCBs under the Air (Pollution and Control) of Pollution Act, 1981 to collect, compile and disseminate information on air quality. This program has been expanded to the nation-wide, renamed National Air Quality Monitoring Programme (NAMP). NAMP
determines status and trends of ambient air quality to see if it is compliant to the National Ambient Air Quality Standards (NAAQS). The NAAQS have been notified for seven parameters: Suspended Particulate Matter (SPM), PM10, NO2, SO2, CO, Ammonia (NH3) and Pb. Additional parameters, such as Hydrogen sulfide (H2S) and Polycyclic Aromatic Compounds (PAHs), are also being monitored in selected sites. Pollutants are monitored every 24 hours (i.e., 4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have at least 104 observations in a year for all stations. The NAAQS helps to identify non-attainment cities in order to develop the necessary preventive and corrective measures by taking into account the geographical and climate conditions in order to better understand the natural cleansing process of generated pollutants. As of 2010, the NAMP consists of 342 operational stations monitoring in 128 cities/towns in 28 States and four Union Territories.

Rapid urbanization and industrialization in Indian economy have thrown series of negative externalities, for instance, higher concentrations of air pollutants. This multiple exposures have made large chunk of population prone to higher risk of both fatal and nonfatal diseases, thus having a serious impact on overall economy. One way to reduce this unwanted economic and health loss is to assess the disease burden of a risk factor (be it air or water pollution) on human health estimated fully, as well as its distribution in the population. The outcome of the assessment is information system that can be used:

a) to guide policies and strategies both in the health sector and in the environmental sector;
b) to monitor health risks; and
c) to analyse the cost-effectiveness of interventions.

Health ministries, researchers, bodies responsible for setting standards, scientific advisory groups, and international aid organizations require such estimates. Some measures were developed such as Comparative Risk Assessment Framework (CRA) and Global / Environmental Burden of Disease (EBD).

**Comparative Risk Assessment Framework (CRA)**

In recent years, quantitative health risk assessment and comparative risk assessment (CRA) procedures have been used to quantify human health risks associated with particular environmental exposures and rank them according to the magnitude and severity of health damage. These estimates can then be subsequently used for assessing the economic impact of such damage. Together, they can serve as the basis for the design of an environmental management plan that will integrate this information with resource availability and assign priorities for allocation of resources. The CRA process was originally developed by the United States Environmental Protection Agency (USEPA 1989\(^1\)) to determine how environmental priorities, based on health risks, lined up with the level of resources devoted to mitigating problems within the EPA’s mandate. US EPA has compiled the health risk information on most of the major environmental contaminants in the form of an electronic database - Integrated Risk Information System. Data from IRIS was used in conjunction with recent epidemiological studies were

used to quantify the exposures and health effects. The CRA approach is being used now, not only in the United States, but also in several cities throughout the world, for the design of environmental management program. However, lack of accurate population exposure information is major limitation of CRA in Indian context.

Global Burden of Disease Concept

The GBD concept, first published in 1996, constituted the most comprehensive and consistent set of estimates of mortality and morbidity (Murray & Lopez, 1996), and WHO now regularly develops GBD estimates at regional and global level for a set of more than 135 causes of disease and injury (Mathers et al., 2002; WHO, 2002a). A GBD study aims to quantify the burden of premature mortality and disability for major diseases or disease groups, and uses a summary measure of population health, the DALY, to combine estimates of the years of life lost and years lived with disabilities. WHO also supports National Burden of Disease (NBD) studies to obtain country-specific estimates for input to national policy. The national studies are based on the GBD concept and the data can be used in EBD assessments to estimate the contributions that environmental risk factors make to the overall disease burden (Mathers et al., 2001).

Methodology

Although the basic approach for estimating the EBD is common to every environmental risk factor, the calculations vary according to the information available in the country, and the form in which this information is held. An assessment of the EBD requires the following data for each risk factor:

1. the distribution of risk factor exposure within the study population;
2. the exposure-response relationship for the risk factor;
3. the DALYs lost to disease for the risk factor of interest (or other epidemiological information, such as mortality rates or disease incidence, if DALYs are not available).

The distribution of the risk factor exposure in the population (i), and the exposure-response information (ii), are combined into an impact fraction, which is applied to the disease estimates (iii). The impact fraction is the percentage of the population risk that can be attributed to hazardous exposures or risky behaviours, multiple levels of exposure, or to incomplete elimination of exposure. When exposure is measured in terms of increasing levels of pollutants, the approach is called an exposure-based approach. If it is not possible to specify a continuous numerical relationship between the proximal cause of disease and the disease outcomes, for example because of competing relationships between exposures, an alternative approach is to select characteristic exposure scenarios. In this way, the study population can be divided into defined exposure scenarios, each of which has a corresponding specific health risk.

Mid Course Correction of Methodology

However, after conducting preliminary investigations, it was found that as described in WHO methodology, it would be difficult to monitor/measure the communities that were benefited due to interventions to reduce pollution as the present air quality monitoring network limited in its coverage
and also the non-maintenance of health data by State run hospitals and unwillingness to share the health data by private hospitals. Therefore, with consultations with medical practitioners and other experts, the following methodology was adopted.

Air Quality Data procured from the Pollution Control Boards and this data would be level to which the community in respective part of the urban city exposed to. Duration of exposure and the Impacts of exposure to the pollution measured by direct interaction through structured schedules in different parts of the city so as to gather information/community perceptions from areas of heavily polluted, moderately polluted, polluted and non-polluted areas. Details pertaining the air pollution related health costs also collected. Further, from select hospitals of the city, details will be collected to estimate the expenditure due to air pollution related health costs.

**Findings**

Though the relationship between air pollution and health costs is not established mathematically, this study found that there is direct relationship between the exposure to air pollution and health costs of the households. This study was severely limited by the extreme paucity of health data, but establishes that households are spending part of their income to due to bad air quality. Community exposed to higher air pollution in Bangalore was found to spend more money than the community living in non-polluted area. For instance, subclinical household expenses in Yeshwantpur, polluted area, were Rs 811 and clinical medical expenses were Rs. 17,536 while only Rs 364 and Rs 4,641 for subclinical and clinical expenses for community from non polluted area. In Hyderabad, the household expenditure was Rs. 839 in Taranaka area where pollution is higher compared to Rs. 364 spent by the households from Zoo Park which was reported to be low in air pollution load.

**Way Forward**

So far, the legal measures for controlling the urban air pollution is mandatory “Certificate of Pollution Under Control’ for all automobiles. But this mode of control is based on concentration based standard and even though each vehicle is under pollution compliance status, sheer number of automobiles making this legal measure as absurd. It would be more effective to put up public signposts hinting that entire community in particular area of city is spending so much of money due to air pollution and this direct information may have better results than displaying concentration of various air pollutants to ordinary citizen as he fails to understand the implications of exposure to them.

Further, For similar future studies, they should modify WHO methods to overcome region specific limitations and should explore the ‘linkages between active drug units sold and air quality of that area’ to measure economic costs of urban ambient air pollution.