The Economic Valuation of Health Impacts

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There is no denying that air and water pollution lead to serious negative impacts on health and various economic goods and services. The physical evidence is compelling. The valuation of these impacts, however, has frequently been ignored because it was thought that either:

a) it is too difficult to establish direct cause-effect relationships, or

b) placing monetary values on those effects, either health or productivity, was not feasible.

Nevertheless, recent advances in our understanding of these links, and progress in the art of valuation (the placing of monetary values on environmental effects), have demonstrated that much can be done.

This awareness has in turn led to increased use of environmental data and statistics to assess these impacts from pollution and to use this information in setting priorities in both NEAPs and NEHAPs.

Why are economic data important?

The use of data and its economic analysis are important for several reasons:

- **To compare benefits and costs.** Although we would like to live in a world with perfectly clean air and water, the costs of reaching this goal is beyond most countries. This means comparing the expected benefits of competing investments with the costs of each. Economic analysis, in the form of either benefit-cost analysis or, where benefits cannot be measured (or are not measured), the use of cost-effectiveness analysis, allows one to compare the benefits and costs of alternative projects and programmes.

- **To set priorities.** If one can compute the expected benefits of different actions, and then one compares this to the costs of each action, this information is a critical aid to setting priorities for action. The benefit of an analysis and the use of quantitative (and, in some cases, qualitative) results is that it helps societies make more rational decisions on allocating scarce financial resources. Public perception of comparative risks or comparative damage from different environmental problems may be significantly inaccurate. Sometimes, the problem that receives the most attention may in fact be a relatively minor problem compared to other issues. Economic analysis can help set priorities rationally, and help ensure the effective use of scarce resources.

- **To get the attention of decision makers.** Decision makers, especially those in the Finance and Planning Ministries, often respond better to quantitative analyses of alternative, competing investments. The use of numbers can indicate when the health impacts of certain environmental problems are large and can be addressed in a cost-effective manner. To merely say, when asked how important is a specific environmentally-related health threat, "It is very important!" is usually less persuasive than being able to

quantify the numbers of people adversely affected, the health outcomes, and the costs associated with these outcomes.

The major economic impacts of pollution

Urban and rural pollution affect many things that we care about. Four sets of impacts are most important:

- health impacts are the most important and the ones that receive the most attention. Also, it is often easier to estimate economic costs of health outcomes; this information is useful in getting the attention of decision makers.

- productivity impacts are often also very important and can be estimated fairly easily. If individuals or firms need to install special equipment or take special measures to protect themselves from pollution, these are measurable economic costs. If polluted air or water reduces the productivity of natural systems (crop or fishery production, for example), these are additional productivity costs. Also, in some situations, pollution (especially air pollution) may be so critical that industries are closed or transportation is restricted. Both of these steps impose important economic and social costs on society.

- ecosystem impacts may also occur when such things as underground aquifers are contaminated, or vegetative areas die due to pollution. Ecosystem impacts are harder to measure and value, and the true impact may not be felt for many years. Often they are included in a qualitative manner.

- aesthetic impacts are the last, but not the least, of urban pollution impacts. People feel "hurt" if they live in a polluted environment, which results in a loss of social welfare. Both rich and poor have a "willingness to pay" for a cleaner environment, but for the poor, low income levels do not allow them to take effective counter measures. Richer people have a larger ability to pay for an improved aesthetic environment.

Given the primary concern with human well-being, we will focus on the valuation of health impacts. This does not mean, however, that the other impacts are of secondary importance -- merely that we need to focus initial attention on health impacts since they are often large and measurable, and they can be valued.

The problem of valuation

Rapid progress in the economic "art" of valuation means that many environmental impacts can now be valued and placed within the framework of a more traditional economic analysis. Figure 1 presents a flow chart of valuation methodologies and offers guidance of which approaches are likely to be most useful when dealing with pollution impacts.

Figure 1. A Simple Valuation Flowchart
(Dixon et al., 1994)
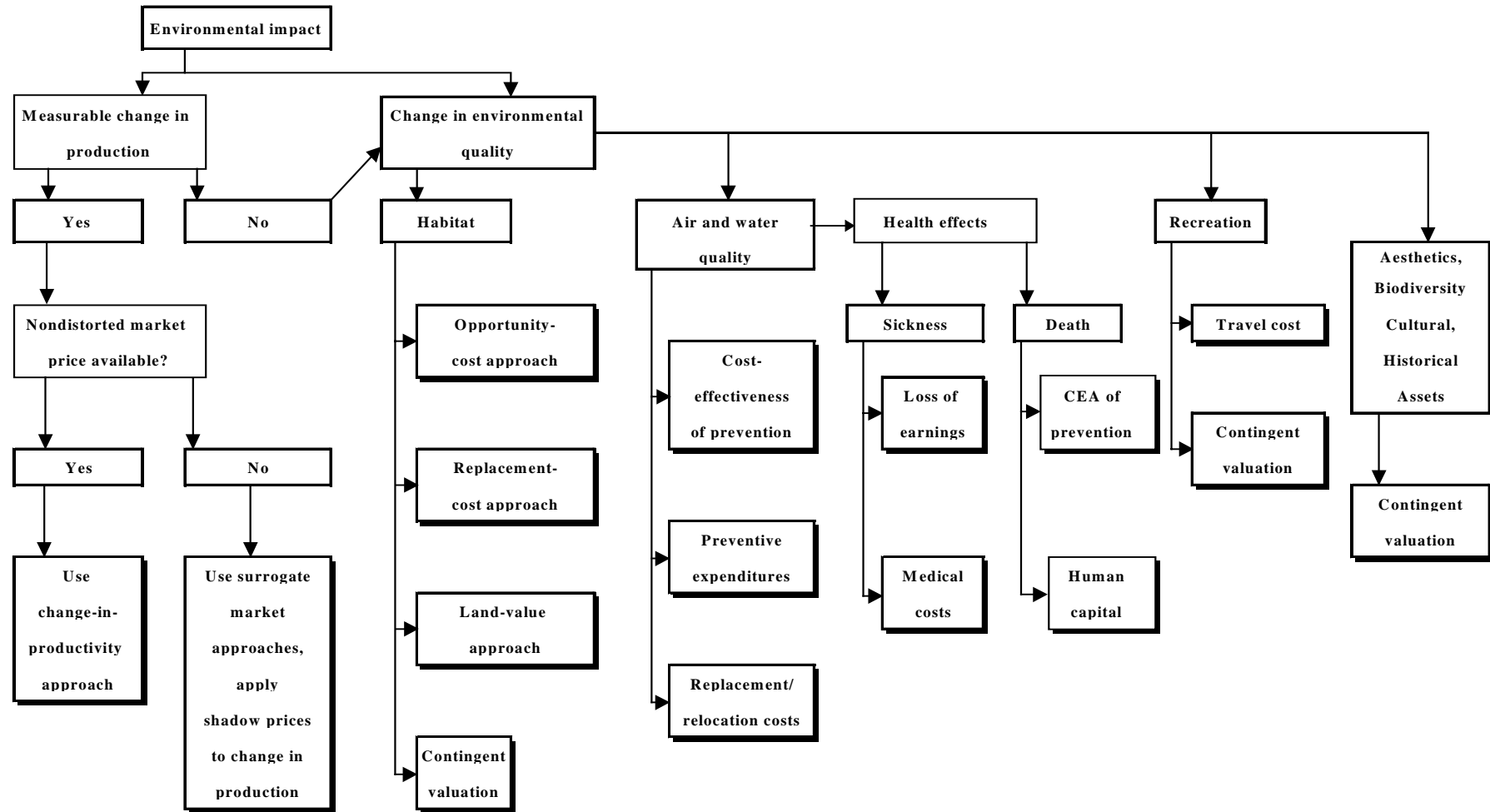
In general, the more direct and immediate the impact, the easier it is to identify monetary values. Health and productivity effects are in this category. More difficult to value are ecosystem and aesthetic impacts, although much can be done here also. (The use of various contingent valuation methods (CVM) based on the asking of hypothetical questions has expanded what is possible in identifying values for ecosystem or aesthetic impacts).
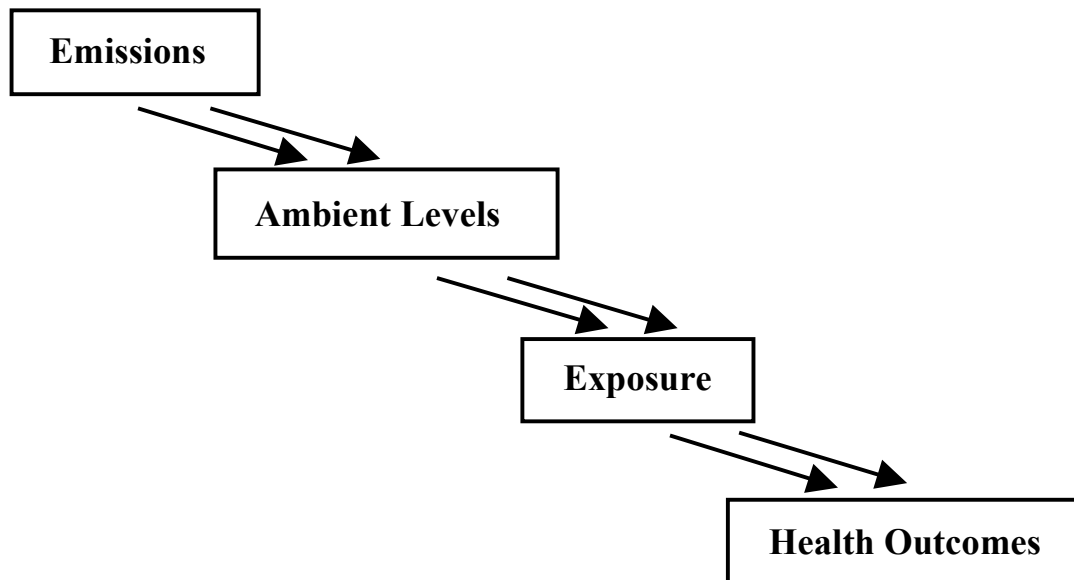
Focus on health effects

As mentioned earlier, we will focus on health impacts and those that are immediately visible, that is, those cases where the cause-effect link is clearest. Many water borne diseases are of this type as well as a number of acute air-related illnesses. This is not to say that long term, chronic impacts are not important. Rather, it is usually best to start with the most direct, easiest to quantify impacts, and then expand the analysis as time, resources, and data permit.

In urban areas, a fundamental question is whether air pollution is more damaging to health than water pollution. This will depend on the situation in each locale and the existence of mitigative measures or coping strategies. For example, two cities may have an equally serious water pollution problem with surface waters heavily contaminated with sewage and industrial waste. One city may have an effective system of potable water supply and have little water-related illness; the other may not, and the population is thus exposed to contaminated water resulting with a heavy burden of disease.

The causal sequence of disease transmission is thus very important. As seen in Figure 2, the analyst must clearly understand the link from emissions to ambient levels to exposure to health outcomes. Regulations often focus at the emissions stage, but what we are really concerned about are health outcomes and the resulting impacts on human welfare. The causal sequence is always important to deliberate when considering alternative actions.

Figure 2. The Causal Chain

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┌─────────────┐
│  Emissions  │
└─────────────┘
        ↘ ↘
      ┌──────────────────┐
      │  Ambient Levels  │
      └──────────────────┘
              ↘ ↘
          ┌────────────┐
          │  Exposure  │
          └────────────┘
                  ↘ ↘
              ┌──────────────────┐
              │  Health Outcomes │
              └──────────────────┘
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For example, climatic conditions may mean that even if levels of pollutant emissions are high when measured at the stack or at the point of liquid waste disposal, they may have little or no health impact since ambient levels of pollutants (in the air or water) may be low. Or, as is often true for water, even high ambient levels of water pollution may not result in health effects if people can protect themselves from exposure by using treatment (e.g. boiling, filtering) or alternative sources of water (e.g. bottled water, private wells). Physical pollution and elevated ambient pollution levels do not necessarily translate into health impacts.

However, protection from air pollution becomes more difficult if ambient pollution levels are high. Only a careful epidemiological analysis will determine if the pollution is a real problem or not, and the economic analysis can help determine the monetary value of some of these impacts on health, productivity, ecosystems, and aesthetics. Such an analysis was done in Santiago, Chile, which clearly demonstrated that, although both air and water were polluted, the health impacts of air pollution were much higher than from water pollution. These results indicated that air pollution control in Santiago was expected to yield much higher benefits per dollar invested than similar investments in water pollution.

Examples

Several examples were given at the Budapest Workshop of the application of this approach to urban pollution problems -- for example, in Jakarta, Santiago, and several cities in Russia. When water pollution is an issue, epidemiological studies are necessary to determine cause-effect links between contaminated water and disease. In the case of air pollution, the approach used here relies on the use of dose-response relationships that links changes in levels of ambient pollution to changes in health outcomes for various diseases.

The Jakarta case is given in the Addendum (reproduced from Dixon, et al. 1995) and illustrates the application of the approach in the case of air pollution. Basically, this consists of identifying existing levels of ambient air pollution, examining various technical options to reduce those levels, calculating the population exposed to the changed levels and then estimating health outcomes on the basis of dose-response relationships (Figure 3). In the case of Jakarta, it was found that the health benefits of reducing particulate pollution to the Indonesian standards included 1 200 fewer premature deaths per year, 40 600 fewer emergency room visits, and 6.3 million fewer restricted activity days among other benefits (see Addendum Table 2).

Figure 3.   Valuing Health Outcomes of Changes in Air Pollution Jakarta, Indonesia

- measure TSP levels

- estimate population exposed

- use dose-response relationships to estimate health outcomes

- examine costs of mortality and morbidity

While the Jakarta study did not place monetary values on the health outcomes projected to occur from reducing ambient pollution levels (although it could be done fairly easily), in a similar study in Chile, Eskeland and colleagues estimated the economic savings from reduced health care costs if particulate pollution were reduced in Santiago (Eskeland, 1994; Ostro et al. 1996.). As seen in Table 1 the overall benefit-cost ratio of the control strategy was 1.7 -- that is, the present value of benefits exceeded the present value of control costs by 70 per cent. Some components of the control strategy were more cost-effective than others (i.e. had a higher B/C Ratio -- as for control of pollution from fixed-sources or gasoline vehicles), but all components of the control strategy had a B/C ratio of more than 1. Moreover, it should be noted that the benefit estimate is a lower bound estimate since it only includes benefits from reduced particulate emissions and only values health benefits -- productivity, ecosystem, and aesthetic benefits are not included.

Table 1. Comparing Benefits and Costs
Santiago, Chile (Eskeland, 1994)

(US$ millions)

Pollution Source	Benefits	Costs	B/C Ratio
Fixed Sources	27	12	2.4
Gasoline Vehicles	33	14	2.4
Buses	37	30	1.2
Trucks	8	4	1.8
Control Strategy	105	60	1.7

The actual economic analysis of health effects does not need to be complicated. In fact, most of the work involved is the estimating of exposure levels and the changes in health outcomes. Once these health outcomes are identified and quantified, a number of approaches can be used to assign economic values. For sickness (morbidity), the most commonly used approaches rely on

information on loss of earnings and medical care costs (see Figure 1 and the Annex Box). Local data on these costs can be easily collected (as was done in Santiago and Russia), and can also be presented to decision makers to get their attention on economic and social costs of pollution.

For death (mortality), the problem of valuation is more complicated. No good technique exists -- information on the cost-effectiveness (CEA) of preventing deaths is useful but says nothing about the value of a life. When the cost of preventing an excess in death is low -- e.g. a few hundred or a few thousand (or tens of thousands) of dollars -- there is no need to go further with the analysis. The investment or action obviously makes sense, but when an action (i.e. asbestos removal from some manufacturing processes) may cost millions of dollars per life saved, is it a good investment? The answer, of course is "it depends" -- it depends on the value of a life saved, and alternative actions that can reduce premature death and total available resources. Hence the question of "value" of life cannot be ignored.

One widely known approach to estimate the "value" of a human life is the human capital approach. This approach is based on foregone earnings and treats a life as a piece of productive capital and estimates the production lost from premature death. This approach is full of methodological and moral problems, and should probably be avoided. We prefer another approach based on information on the willingness to pay of individuals to avoid premature death. These so-called willingness to pay measures are based on both contingent valuation approaches (using survey questions to determine values) and other available data (such as observing the "risk premium" individuals demand to do riskier jobs) and yield estimates of the value of a statistical life. Note that a statistical life is not any individual person's life, it represents the change in premature mortality across a population from any given cause. In addition, willingness to pay measures reflect the whole range of costs associated with premature death -- loss of production (as in the human capital approach), suffering, losses imposed on other family members and society, and all complex attributes associated with a human life.

These willingness to pay estimates are much higher, on average, than those derived from the human capital approach. In the United States, for example, the values used for a statistical life average several million dollars, with a commonly used value of about $3 million.

In the economic analysis of pollution related health costs, we recommend that values for morbidity be quantified and expressed in monetary terms, and that in general, values for mortality be presented qualitatively (numbers of deaths involved or avoided) or that a cost-effectiveness of prevention approach be used. The Jakarta study used this approach. In Santiago, a modified human capital approach was used to place some value on premature deaths. It is possible, however, to combine "apples and oranges" in the analysis and present some health outcomes in monetary terms (e.g. for sickness) and others in non-monetary terms (e.g. deaths).

In sum, the economic valuation of health impacts from pollution is a rapidly evolving field that demonstrates the potential for using economic analysis of health outcomes to help identify priority environmental problems, and efficiently target investments in pollution control. After the hard work of estimating expected changes in health status of a population associated with changing pollution exposure is completed, the economic valuation of these health outcomes can begin. The valuation of morbidity effects is fairly direct (at least for lost production and health care costs), but premature mortality poses difficult analytical and moral issues and has to be handled carefully. The rapidly expanding literature in this area illustrates much of what can be done, both in developed and developing countries.

References

Dixon, J.A. et al. (1994). *Economic Analysis of Environmental Impacts*. London: Earthscan Publications Ltd.

Eskeland, G.S. (1994). "The Net Benefits of an Air Pollution Control Scenario for Santiago", in World Bank (1994) *Chile. Managing Environmental Problems:Economic Analysis of Selected Issues*. Report No. 13061-CH, pp. 91-120.   Washington, D.C.: The World Bank.

Ostro, B. et al. (1996). "Air Pollution and Mortality: Results from a Study of Santiago, Chile". *Journal of Exposure Analysis and Environmental Epidemiology*, Vol. 6, No. 1, pp. 97-114.

Addendum:

**Estimating the Health Impact of Air Pollution:
Methodology and an Application to Jakarta[1]**

This case study presents an illustration of the use of one increasingly accepted methodology - the damage function approach using dose-response relationships - to estimate the health impacts of air pollution reduction. Additional information can then be used to place monetary values on these health effects - by either using the cost-of-illness approach to estimate monetary values of reduced illness (morbidity) or, in the case of death, estimates usually based on willingness-to-pay to reduce premature mortality.

Dose-response relationships are functions mostly based on data from the US, Canada, and the United Kingdom that relate information on changes in ambient air quality for different pollutants to different health outcomes. The principle is that changes in ambient air pollution levels for certain pollutants can be statistically related to observed changes in morbidity (sickness) and mortality (death) in a population. Through regression analysis, coefficients are estimated that are then multiplied by changes in ambient pollution concentrations and the population exposed. Most of this work has previously been done in Europe and the US and this case study shows an application of the approach to Jakarta (Ostro, 1994).

The estimated health impact can be estimated by the following relationship:

$$dH_i \;\; = \; b_i * POP_i * dA$$

where: dH_i = change in population risk of health effect i;
b_i = slope from the dose-response curve for health impact i;
POP_i = population at risk of health effect i;
dA = change in ambient air pollutant under consideration.

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[1]   This Annex is excerpted with permission from Dixon, *Economic analysis Environmental Impacts,* Second Edition Earthscan Publications Ltd, London 1994

An Application To Jakarta

Jakarta, the capital of Indonesia, is located in the tropics just south of the equator. The population is between 8.2 to 9 million, and the city covers some 650 km^2. Air and water pollution are both major environmental problems The results presented here focus on air pollution, particularly suspended particulate matter, often referred to as TSP (total suspended particulates) and the finer, more damaging, portion called PM10, or particles smaller than 10 microns in size. Pollution exposure is measured in various ways, often in terms of micrograms of TSP or PM10 per m^3 of air. (One can convert directly from TSP to PM10: PM10 is about 55 percent of the total TSP; that is, a level of TSP of 100 micrograms/m^3 is equal to PM10 measurement of 55 micrograms/m^3).

This study uses dose-response functions estimated in developed countries since none were available for local conditions in Jakarta. It is implicitly assumed, therefore, that the relationship between the levels of air pollution and subsequent health effects in the developed countries can be extrapolated to estimate the health impacts in Jakarta. It is recognized that there are significant differences between developed country and Indonesian populations in baseline health status, access to health care, demographics, and occupational exposures, among other factors. It is therefore likely that the model will under-estimate the health effects for Indonesia.

In the study, dose-response functions have been identified and adapted from the available literature (see Ostro, 1994, for details on the background studies). Since there are variations in the coefficients estimated by the various studies, three alternative assumptions about health effects are presented, with the central estimate being given the most weight. High (low) end estimates are calculated by increasing (decreasing) the coefficient by one estimated standard deviation.

Available epidemiological studies relate concentrations of ambient particulate matter and several adverse health outcomes including mortality, respiratory hospital admissions, emergency room visits, restricted activity days for adults, respiratory illness for children, asthma attacks and chronic disease. TSP is the measure particulates most commonly used in Indonesia. Therefore all dose response functions were adapted to be used with TSP concentrations.

Estimates were made of the benefits of reducing TSP levels from present levels in Jakarta (ranging from less than 100 to over 350mg/m^3 in certain parts of the city, to both the Indonesian standard (90mg/m^3) and the midpoint of the WHO guidelines (75 mg/m^3). In each case the estimates were based on information on population exposed to different levels of pollution. (This information is based on census data on population density and the results of citywide information on emissions and air quality monitory and the use of a dispersion model.)

Mortality

Premature mortality is a major problem associated with high levels of particulates. Based on a survey of the literature, a central estimate of the change in 'all-cause mortality' associated with a change in PM10 can be expressed as follows:

Central percentage change in mortality = 0.096 * change in PM10 with upper and lower estimates having coefficients of 0.130 and 0.062, respectively. The central estimate of the number of cases of premature mortality can be expressed as:

Change in mortality = 0.096 * change in PM10 * 1/100 * crude mortality rate * population exposed.

Assuming the crude mortality rate in Jakarta is 0.007, the range in changes in mortality (per person) is:

Upper estimate of change in mortality = 9.10 * 10^{-6} * change in PM10

Central estimate of change in mortality = 6.72 * 10^{-6} * change in PM10

Lower estimate of change in mortality = 4.47 * 10^{-6} * change in PM10

For example, if average PM10 levels decreased by 10 micrograms per m^3 for Jakarta, and if 5 million people were exposed to this reduction, the estimated health benefit would be 335 fewer cases of premature mortality per year:

6.72 * 10^{-6} (DRR coefficient) * 10 (change in PM10) * 5,000,000 (population) = 335

Morbidity

A similar approach was also used to estimate the effects of changes in air quality on air pollution-related illnesses. In each case a dose-response relationship was identified and was linked to a discrete health outcome:

Respiratory Hospital Admissions (RHA). Based on Canadian and US studies, there is a statistically significant relationship between the incidence of hospital admissions due to respiratory diseases (RHA) and ambient sulphate and TSP levels. The following functions are suggested per 100,000 population:

Upper change in RHA per 100,000   =   1.56 * change in PM10

Central change in RHA per 100,000   =   1.20 * change in PM10

Lower change in RHA per 100,000   =   0.657 * change in PM10

Emergency Room Visits (ERV). The relationship between emergency room visits (ERV) and TSP exposure based on US studies was adjusted by plus or minus one standard deviation from the central coefficient to generate high and low estimates for Jakarta:

Upper change in ERV per 100,000   =   34.25 * annual change in PM10

Central change in ERV per 100,000   =   23.54 * annual change in PM10

Lower change in ERV per 100,000   =   12.83 * annual change in PM10

Restricted Activity Days (RAD). Restricted activity days (RAD) include days spent in bed, days missed from work, and other days when normal activities are restricted due to illness, even if medical attention is not required. Studies from the US suggest a statistically significant relationship between particulates of various sizes and RAD. After standardizing on PM10 the relationship between RAD and PM10 is estimated as follows (these estimates are applied to all adults):

Upper change in RAD per person per year   =   0.0903 * change in PM10

Central change in RAD per person per year =   0.0575 * change in PM10

Lower change in RAD per person per year   =   0.0404 * change in PM10

Lower Respiratory Illness in Children (LRI). US studies suggest the following relationship between the occurrence of chronic coughs, annual change in bronchitis and other respiratory diseases in children and PM10, adjusted for a number of variables including the incidence of bronchitis in children:

Upper change in annual bronchitis　　=　0.00238 * change in PM10

Central change in annual bronchitis　=　0.00169 * change in PM10

Lower change in annual bronchitis　　=　0.0008　* change in PM10

This relationship is applied to the 34.7 percent of the population below the age of 18 in Jakarta.

Other estimates. Estimates were also made for a number of other air pollution-related illnesses. These included asthma attacks, respiratory symptoms, and chronic bronchitis. Annex Table 1 summarizes the dose-response estimates of the morbidity outcomes of changes in PM10 levels for all of these possible health outcomes, and presents the central estimate and the high-side estimate. Note that some of the effects are estimated per 100,000 people in the general population, while others are person or group specific (e.g. RAD per person, or asthma attacks per asthmatic).

Annex Table 1 - Morbidity Effects of 10 microgram/m^3 Change in PM10

Type of Morbidity	Central Estimate	High Estimate
RHA/100,000	12.0	15.6
ERV/100,000	235.4	342.5
RAD/person	0.575	0.903
LRI/child/per asthmatic	0.0169	0.0238
Asthma attacks/per asthmatic*	0.326	2.73
Respiratory symptoms/person	1.83	2.74
Chronic bronchitis/100,000	61.2	91.8

* Applies to the 8.25% of the Indonesian population that is assumed asthmatic. High estimates are obtained by increasing the coefficient by one estimated standard deviation.

An Application of the Approach to Jakarta. When the coefficients listed in Annex Table 1 were applied to Jakarta, Ostro was able to estimate health impacts associated with decreasing particulate levels to both the Indonesian standards (90 micrograms/m^3) and WHO standards (about 75 micrograms/m^3). In 1989 many parts of the city had levels between 100 and 200, and 'hot spots' with readings of 300 or 350 were common. Annex Table 2 presents the health benefits of reducing particulate matter to the Indonesian standard (90 micrograms per m^3). (Meeting the more stringent WHO standards would produce even larger benefits, of course, but would cost more to achieve).

The numbers of lives saved and illnesses avoided are impressive. Using the central or medium estimate of the dose-response relationships, Ostro estimated that each year in Jakarta the benefits from reducing particulates to Indonesian standards include 1,200 premature deaths avoided, 2,000 fewer hospital admissions, 40,600 saved emergency room visits, and over 6 million fewer restricted activity days, among other benefits for the population of 8.2 million.

Achieving Indonesian TSP standards will not be easy, however, and would involve major investments. To estimate which investments and control options should be undertaken, the policymaker would ideally like to compare the benefits to the costs. The benefits are largely due to health costs that are avoided, and a decrease in premature deaths. Placing monetary values on premature death or small changes in risks of mortality is very difficult, although estimating the cost of illness is easier (for a discussion of this, see the Box at the end of this case study). In this case

monetary values were not placed on the health outcomes. Still, presenting the impacts of TSP pollution in physical terms, as is done in Annex Table 2, can still be a powerful message prompting government action. At a minimum, a cost-effective approach can be applied to identify those policy interventions that produce the largest health benefit per dollar invested.

Annex Table 2 -   Health Benefits of Reducing Particulates in Jakarta to Indonesian Standards

Health effect	Medium estimate
Premature mortality	1,200
Hospital admissions	2,000
Emergency room visits (ERV)	40,600
Restricted activity days (RAD)	6,330,000
Lower respiratory illness (LRI)	104,000
Asthma attacks	464,000
Respiratory symptoms	31,000,000
Chronic bronchitis	9,600

Box
Economic Valuation of Health Effects

Ideally, valuation of health impacts should include both the out-of-pocket costs of illness such as medical costs, lost income and averting expenditures, and the less tangible effects of illness on well-being such as pain, discomfort and restriction in non-work activities. Health impacts valued by willingness-to-pay (WTP) incorporate all of these impacts, whereas a cost of illness (COI) approach only includes out-of-pocket expenses such as medical costs and lost income.

Ostro did not estimate the economic costs of mortality and morbidity in Jakarta, although estimates can be made fairly easily in the case of illness (morbidity). There is a sizeable literature on the cost of ill-health in the US.

WTP estimates to prevent or accept small changes in the risks of death are based on empirical evidence gathered in the US and Great Britain of people making actual tradeoffs between the risks of death and some benefit, such as income. In addition, some contingent valuation studies have been conducted in which respondents are asked directly what they would be willing to pay to reduce risks associated with, for example, work or traffic accidents. Considerable controversy exists over the 'value of life'. One commonly used value in the US is $300 for a .0001 reduction in risk. Thus, for a large population, the reduction in risk translates to $3 million per death avoided.

Economic costs for changes in morbidity are, of course, very country-specific. In the high cost, US medical care sector, some estimates of the costs of illness include the following (Ostro, 1992):

Respiratory Hospital Admission, RHA:
average stay - 10.13 days
average cost of stay - $26,898
lost day wage rate - $125
So, each RHA is assumed to cost $28,164

Emergency Room Visit, ERV:
average stay - 1 day
average cost per stay $133
lost day wage rate - $125
So, each ERV is assumed to cost $258

Restricted Activity Day, RAD:
20 percent of RAD result in lost work days, and the remaining 80 percent of RAD valued at one-third of the average wage rate.
lost day wage rate - $125
So, each RAD is assumed to cost $58

Lower Respiratory Illness in children (LRI):
2 weeks of illness per episode valued at $15 per day
two RAD per parent for care per episode
So, total per episode of BC is assumed to cost $326

These costs are for the US. To estimate the costs of ill-health in Jakarta, separate Indonesian-specific cost estimates are needed. These will be lower that US costs and may vary by type of illness, depending on relative differences between the US and Indonesia for labour and capital.

Sources:

Ostro, Bart. 1992 *Estimating the Health and Economic Effects of Particulate Matter in Jakarta: A Preliminary Assessment,* **paper presented at the Fourth Annual Meeting of the International Society for Environmental Epidemiology, 26-29 August. Cuernavaca, Mexico.**

Ostro, Bart. 1994 *Estimating Health Effects of Air Pollutants: A Methodology with an Application to Jakarta.* **Policy Research Working Paper 1301. Washington, D.C. the World Bank.**