

## Cost of Trans-boundary Haze Externalities

**Jamal Othman**  
**Mohd Shahwahid H.O.**

### ABSTRACT

*This paper attempts to assess the economic value of the trans-boundary 1997 haze damages on health in Malaysia. Valuing the damage will help policy makers appreciate the scale of the problem as the values can be readily compared with other losses or the merits of alternative resource use. It also facilitates the establishment of common cross-country environmental policy framework, which will benefit the affected region as a whole. The impacts on health are especially highlighted in this paper, as there is sufficient market data for the employment of appropriate secondary valuation technique, namely the Dose-Response Function. Policy implications, based on the findings of the study are offered. This study contributes substantially to the literature on environmental valuation in Malaysia. The Dose-Response Function would not be made possible without the given haze episode, where all relevant health data and pollution level were collected nationwide and on a daily basis. The Malaysian Dose-Response coefficient may also be transferred to other similar studies via a Benefit Transfer Protocol.*

### ABSTRAK

*Kertas ini menganggar nilai ekonomi kesan isu pencemaran udara antara sempadan jerebu 1997 terhadap kesihatan di Malaysia. Penilaian ini akan membantu pembuat dasar memahami skala masalah kerana nilai yang diperolehi boleh dibandingkan dengan kerugian lain atau faedah dari penggunaan alternatif sumber. Ia juga membantu pembentukan kerangka bersama bagi dasar alam sekitar serantau yang akan memberi kebaikan kepada semua negara yang terlibat. Kesan terhadap kesihatan diberikan fokus kerana terdapat maklumat pasaran yang cukup untuk membenarkan pemakaian teknik penilaian sekunder yang wajar, khususnya Fungsi Dose-Response. Implikasi dasar dari penemuan kajian dibincangkan. Sumbangan penting kajian ini ialah dari segi sumbangannya terhadap literatur penilaian alam sekitar di*

*Malaysia. Episod jerebu 1997 telah membenarkan pemakaian Fungsi Dose-Response secara efektif, kerana maklumat yang diperlukan seperti data kesihatan dan paras pencemaran udara sedia dikumpul di seluruh negara setiap hari. Koefisien Dose-Respons yang dianggar untuk Malaysia juga boleh dipindahkan untuk kajian lain yang berkaitan dengan menggunakan Protokol Benefit Transfer.*

## INTRODUCTION

Unlike acid rains which characterize the trans-boundary environmental problems in many industrial regions of the world (such as Northeast Asia (Japan, Korea and Taiwan) and Europe), the “fast growth” South-east Asian region is rather prone to an international environmental pollution of a different kind – the haze. Haze is caused by the accumulation of fine particles in the air, which are hardly visible to the naked eye. The particles may result from some natural phenomena and/or human activities. The main natural source of haze is forest fires, while haze from deliberate forest burning, open burning of rubbish, emissions from factories and motor vehicles is attributable to human activities. Persistent accumulation of haze particles in the air may reduce sun’s rays and visibility.

For most Indonesians and Malaysians, the haze is not an unusual phenomenon. In Malaysia, it has gained prominence in April 1983, August 1990, June and October 1991 and since then it recurs annually, usually from the months of August to October. However, the haze of 1997 was unprecedented in terms of intensity, duration and coverage. It started in early August and the sky remained dull until some three months later. The haze caused much inconvenience and disruption to the Malaysian economy. The haze has raised the incidences of respiratory diseases, forced a decline in agricultural crop and fishing yields and caused disruption to transport services, manufacturing output and the tourism industry.

The cause of the 1997 haze is suspended smoke particulate from large-scale forest and plantation fires, particularly in Southern Sumatra and Central Kalimantan, both in neighboring Indonesia. The forest fires, to some extent, are attributable to land preparation for extensive ex-situ oil palm expansion. Given freer agricultural trade under WTO rules, palm oil is expected to benefit considerably as production and exports of its main competitor, soybean oil, has been heavily subsidized (Jamal et al.

1998). This has led to greater investment by both Indonesian as well Malaysian companies (reverse investment) for oil palm cultivation in Indonesia.

The haze in 1997 reached a new urgency in Malaysia when the readings from the Air Pollution Index (API) went beyond the dangerous level (API > 500) and that a state of emergency was declared for 10 days in Sarawak, a Malaysian state neighboring the Indonesian Kalimantan. The Malaysian API is obtained from the measurement of fine particles (below 10 microns) and several gases – carbon monoxide, sulphur dioxide, nitrogen dioxide. Table 1 shows the API for Malaysia.

TABLE 1. The Malaysian air pollution index

API	Diagnosis
0-50	Good
51-100	Moderate
101-200	Unhealthy
201-300	Very unhealthy
301-500	Dangerous

Persistent hazy conditions cause ill effects to all individuals, especially to high-risk groups such as children, senior citizens and people who are already suffering from asthma, bronchitis, pneumonia, chronic lung diseases, cardio-vascular problems, allergies, and those who work outdoors.

This paper attempts to assess the economic value of the 1997 haze damages on health in Malaysia. Valuing the damage will help policy makers appreciate the scale of the problem as the values can be readily compared with other losses or alternative resource use. It will also facilitate the establishment of common cross-country environmental policy framework which will benefit the affected region as a whole. The impacts on health are especially highlighted in this paper, as there is sufficient market data for the employment of appropriate valuation technique, namely the dose-response function. Policy implications, based on the findings of the study are offered.

## VALUING THE HAZE IMPACTS ON HEALTH – METHODS

The production function approach is used to estimate the value of the haze impacts on health in Malaysia. This approach links air quality and production relationships. Degradation of air quality causes firms and households to reduce the production of goods and services or to seek preventive or mitigation measures to reduce the impacts of the haze. Firms use factors of production including environmental input to produce goods and services. Generally, the production function for a firm can be shown:

$$Y = f(I, K, H (M, Q))$$

Where  $Y$  is the output produced,  $I$  and  $K$  are labor and capital inputs while  $H$  is individual's (workers) health status which is assumed to be a function of  $M$  – preventive and mitigation/ curative measures and  $Q$  which measures the hygienic quality of the environment, in this case air quality. Assuming  $(\partial Y/\partial Q) > 0$ , a decrease in  $Q$  will reduce  $Y$ , *ceteris paribus*. Therefore, to maintain societal welfare to the level prior to the change in  $Q$ ,  $M$  must need to be increased. This change in  $M$  combined with the value of productivity loss can be used to estimate the cost of the haze on health. However,  $M$  which is based on observed market prices only measures cost of illness partially. The appropriate measure of cost of illness is individual maximum willingness to pay (WTP) to prevent haze related illness, pain, discomfort and loss in ability to enjoy leisure activities. The WTP is in essence an equivalent surplus welfare measure.

This study estimates the value of  $M$  using the dose-response function (DRF), which is a class of production function methods. Based on the value of  $M$ , the cost of illness is then calculated using the benefit transfer approach. The dose-response approach aims to estimate incremental costs over a "normal" situation. Haze incidents normally occur in Malaysia, albeit insignificantly, even without the outbreak of forest fires in Indonesia. This study is interested in the incremental impacts occurring in 1997 relative to domestically sourced impacts in previous years. The following sub-sections discuss the methodology used in calculating the Cost of Illness (COI), which includes the cost of outpatient, inpatient, and self-treatment and the value of productivity loss as a result of the haze. It is then followed by sections on results, and policy implications.

COUNTING THE COST OF OUTPATIENT, SELF-TREATMENT AND INPATIENT

Haze-related medical cases comprised outpatient, self-treatment and inpatient treatment. Symptoms of illness related to the haze are itchy throat, coughing, difficulty in breathing, nasal congestion, painful and watery eyes, a runny nose, cold attacks, itchy skin, and chest pains. The estimation of total increment in haze related health cases and subsequently the economic value of the haze impacts on health used a DRF. The DRF provides a relationship between a dose of haze (measured by API) and related illness that it causes.

Two DRFs were estimated. The first established the impact of the haze on outpatient treatment cases at public hospitals and clinics, while the other for the haze impact on in-patient treatment at public hospitals.

The increment number of patient seeking treatment for haze related illness at public and private medical providers is as follows:

$$NT = \sum_i (DRC1 * POP_i / 10,000 * CHL_i * HD_i * F1) \quad (1)$$

The increment number of patient who went for self-treatment is calculated as:

$$NST = \sum_i (DRC1 + DRC2) * POP_i / 10,000 * CHL_i * HD_i * F1 * F2 \quad (2)$$

The incremental total cost of treatment and self-treatment is as follows:

$$TCTST = (NT * PT) + (NST * PST) \quad (3)$$

where:

- NT = the total incremental number of patient seeking treatment for haze related illness in Malaysia;
- DRC1 = the dose response coefficient for out-patient treatment cases per 10,000 population at public hospitals and clinics in Sarawak;
- DRC2 = the dose-response coefficient for in-patient treatment cases per 10,000 population at public hospitals only;
- POP<sub>*i*</sub> = population at risk for state *i*;
- CHL<sub>*i*</sub> = difference between average API in state *i* and the normal API of 25;
- HD<sub>*i*</sub> = HD<sub>*i*</sub> is the number of hazy days for state *i*;

- F1 = the factor of 2 to reflect the summation of public and private out-patient treatment cases. The average ratio of public to private outpatient treatments is 1:1;
- F2 = the factor of patients seeking self-treatment;
- TCTST = the total cost of treatment and self-treatment;
- PT = the price of out-patient treatment;
- PST = the shadow price of self-treatment.

Application of Equations 1-3 requires the estimation of the dose-response coefficients (DRC1 and DRC2). Unpublished data on daily APIs (August 5 – October 22 1997) and outpatient treatment cases are available from the Health Ministry for the states of Sarawak, Johore, Penang, Kuala Lumpur, and Selangor. We postulated that the most affected state in terms of intensity and duration would provide the best estimates of dose-responds coefficients, in which case is Sarawak. Sarawak experienced a range of haze incidence from a low API of 39 to an extremely high reading of 831 in a period of 45 days from September 1 to October 15.

To verify this, we ran individual dose-response function for each state. As expected, Sarawak gave the best fit ( $R^2 = 0.55$ ). Except for Selangor, the regression for all other states did not provide reasonable fit. The results for Sarawak are shown below:

$$\text{POPT} = 3.44 + 0.0124 \text{ API} \quad (4)$$

(10.69)\*\*\*                      (8.48) \*\*\*

Adj. R-Sq = 0.54

Values in parentheses are t-ratios

where POPT is the number of outpatient treatment cases in public health clinics and hospitals. The mean number of cases per 10,000 population for Sarawak was 4.89, while the maximum and minimum API were, 831 and 27, respectively. Average daily API was 129.

A regression on pooled cross-sectional and time series data for Sarawak, Johore, Penang, Selangor, and Kuala Lumpur incorporating slope shifters for outpatient treatment cases and state dummies was made. In this regression, Sarawak was used as the reference state. The results are:

$$\begin{aligned}
 \text{POPT} = & 3.438 + 0.0124 \text{ API} - 0.008 \text{ SSKL} - 0.0086 \text{ SSPNG} \\
 & (9.08)^{***} \quad (7.20)^{***} \quad (-0.76) \quad (-1.49) \\
 & + 0.009 \text{ SSJOH} - 0.00032 \text{ SSSGOR} - 1.20 \text{ DJOH} + 1.51 \text{ DKL} \\
 & (0.81) \quad (-0.04) \quad (-1.36) \quad (1.37) \\
 & + 1.334 \text{ DPNG} - 0.95 \text{ DSGOR} \\
 & (2.21)^{***} \quad (-0.98) \quad (5)
 \end{aligned}$$

Adj. R-Sq = 0.12

Values in parentheses are t-ratios

Where:

- SSKL = the API slope shifter for Kuala Lumpur
- SSPNG = the API slope shifter for Penang
- SSJOH = the API slope shifter for Johore
- SSSGOR = the API slope shifter for Selangor
- DKL = dummy variable for Kuala Lumpur
- DPNG = dummy variable for Penang
- DJOH = dummy variable for Johore
- DSGOR = dummy variable for Selangor

The coefficient for API in Equation 5 was significant and the same as Equation 4. The coefficients for all other API slope shifters were not significant. This suggests that the dose-response coefficient for Sarawak can plausibly be used to represent the true DRC1 for the haze affected states.

The estimation of DRC2 also used the data on the number of in-patient treatment cases per 10,000 population in public hospitals and API data for the state of Sarawak. The dose-response coefficient was 0.000055 and statistically significant at 99 percent confidence level. The adjusted R-sq was 0.13.

The notation F2 in Equation 2 is a factor which reflects the proportion of people seeking for self-treatment in state  $i$ . Interviews with medical doctors in Sarawak suggest a factor of 1 for Sarawak and Sabah and 0.5 for most states in Peninsular Malaysia. The number of hazy days in state  $i$  ( $HD_i$ ), is 60 for Sarawak, 75 for Kuala Lumpur and Selangor and 30 days for the other at-risk states. The population at risk in state  $i$  ( $POP_i$ ) is 18,018,795. This figure is the entire population of

Malaysia excluding the haze-free states of Kelantan, Terengganu, and Pahang.

In calculating the total incremental cost of outpatient treatment (Equation 3), it is assumed that no significant price changes have occurred with respect to medical treatment fees as a result of the haze. The price of medication and outpatient treatment (PT) used a private clinic rate of RM25 per visit. This rate is assumed to be the shadow price for public clinics to incorporate government subsidies to public clinics and hospitals. For people seeking self treatment, although the financial cost is far less than PT, the shadow price for self treatment (PST) is assumed equal to PT to consider the foregone opportunity of obtaining a doctor's advice.

Besides outpatient treatment, the haze also increased the number of inpatient treatment especially acute asthma and bronchitis cases. The number of admitted cases and the total number of daily admissions were calculated using Equations 4 and 5 below:

$$NA = \sum_i (DRC2 * POP_i / 10,000 * CHL_i * HD_i * F3) \quad (4)$$

$$NDA = NA * LH \quad (5)$$

$$CA = NDA * PH \quad (6)$$

Where:

- NA = the increment number of admissions to both public and private hospitals;
- $CHL_i$  = the difference between the average haze index in state  $i$  and the normal haze index of 25;
- DRC2 = the dose-response coefficient for the number of hospital admission cases in public hospitals;
- $HD_i$  = the number of hazy days in state  $i$ ;
- F3 = the factor of 1.22 which reflects public and private hospitalization cases, based on the ratio of 1:0.22 for the number of available public to private hospital beds;
- $POP_i$  = the population at risk in state  $i$ ;
- LH = the assumed average length of 5 days for length of stay in hospitals per patient;
- NDA = the increment number of days of hospital admission throughout the country;
- CA = the incremental cost of hospitalization; and



PH = the price of hospitalization per day assumed to be RM125, calculated based on the cost of hospital admission to outpatient treatment of 5:1.

COUNTING THE LOSS OF PRODUCTIVITY

The haze-related illnesses also caused a decline in productivity. Specifically, losses in production were caused by depleted workforce and diminished health of the available workforce. The incremental number of workdays lost during hospitalization and outpatient medical leave was calculated using Equations 7 and 8. This involves only adult patients and is calculated based on information of the incremental number of hospital admissions, the percentage of adults admitted, and the average length of stay in hospitals.

The reduced activity days experienced by the working population at risk is calculated using Equation 9. Equation 9 requires information on adult out-patients and adults who sought self-treatment, an estimate of the number of reduced activity days experienced by individuals at risk, and a factor which reflects workers' reduced productivity. The total man-days of productivity losses of the workforce is obtained by adding the incremental workdays lost during hospitalization and sick leave among out-patients and the reduced productivity days (Equation 10). Multiplying the number of man-days by the average wage rate yield an estimate of the incremental productivity loss from haze-related illness (Equation 11).

$$NWDL = NA * AAR * LH \quad (7)$$

$$NSL = ATR * NT * LMC * MCR \quad (8)$$

$$NRAD = ([NT + NST] * ATR * LRA - NWDL - NSL) * F4 \quad (9)$$

$$TNWDL = NWDL + NSL + NRAD \quad (10)$$

$$TPLI = TNWDL * W \quad (11)$$

where:

NWDL = the incremental number of workdays lost due to hospitalization;

NA = the incremental number of patients hospitalized;

AAR = the percentage of adult patients admitted to hospital;

LH = the assumed average length of stay in hospitals, 5 days;

- NSL = the incremental number of days of medical leave granted to adult outpatients;
- ATR = the proportion of adults seeking treatment, 49 percent;
- LMC = the average duration of medical certificate, assumed to be 2 days (decided upon consultation with medical practitioners);
- MCR = the proportion of outpatients seeking treatment and obtaining sick leave, estimated to be 15 percent (decided upon consultation with medical practitioners)
- NRAD = the number of reduced productivity days experienced by workers at risks;
- LRA = the number of reduced productivity days per individual at risk (decided upon consultation with medical practitioners);
- F4 = the factor of 0.3 for reduced productivity for individuals at risk but still working;
- W = the average daily wage rate per employee, RM26.50.

The cost of illness (COI) quantifies medical costs and lost productivity (in terms of lost wages) associated with illness. But the COI grossly understates the total welfare impacts of illness, because it does not consider pain and suffering or loss in ability to enjoy leisure activity. Studies on willingness to pay (WTP) estimates for illness prevention, pain and discomfort indicate that these WTP estimates exceed COI estimates. For asthma symptoms the WTP/COI ratio of affected individuals ranges from 1.6 – 2.3 (Asian Development Bank 1996). To incorporate for the pain and suffering or loss in ability to enjoy leisure activity, the COI estimates are multiplied by a factor of 2 to approximate WTP for the health effect of the haze. This usage of WTP/COI ratio adjustment is admittedly uncertain, but is better than not making any adjustment at all, which is a definite downward bias.

The ratio of those not seeking treatment from government and private clinics in the rural areas in Malaysia is not as high as in Indonesia, which is reported to be in the range of eleven people for every single outpatient treatment (Mohd Shahwahid and Jamal 1998). Dr George Chan, the Deputy Chief Minister of Sarawak is quoted to have said that in Sarawak, rural clinics have sufficient medical supplies to treat patients suffering from URTI and asthma (Sarawak Tribune, October 2 1997). A ratio of 1:1 for those seeking treatment between private and public medical facilities and those seeking self treatment or the purchase of medicine is used in this analysis for the states of Sabah and

Sarawak while the ratio of 1: 0.5 is used for the affected states in Peninsular Malaysia.

According to the *Sarawak Tribune* (23 September 1997) the proportion of children to adult seeking treatment for haze related diseases are as given in the Table 2. The overall ratio of children to adult is 1:0.95 or 49 percent.

TABLE 2. Proportion of children among those seeking treatment

Haze related diseases	Proportion of adults among those seeking treatment	Ratio of children to adult seeking treatment
URTI	0.53	1:1.15
Asthma	0.53	1:1.12
Conjunctivitis	0.39	1:0.24
Bronchitis	0.79	1:2.50
Total	0.49	1:0.95

Source: *Sarawak Tribune* 23 September 1997.

Based on the above information, together with the Dose-Response Function coefficients, the following section presents the results of the estimation of the adjusted cost of illness of haze externalities in Malaysia.

#### ADJUSTED COST OF ILLNESS – RESULTS

The results for the adjusted COI for the haze effects are shown in Tables 3 through 6. A description on the estimation process is shown at the footnotes for each table.

The population at risk is from all states in the country, except for Kelantan, Trengganu and Pahang. The population at risk was estimated to be about 18 million people. But the incidence of risk varies among states, in terms of intensity of the haze, and length of the haze. The incremental cost incurred by the population at risk for treatments of haze related illnesses from both public and private clinics and hospitals, and for self treatments mainly on the purchasing of medicine, was estimated to be RM5 million during the period August-October 1997-96

TABLE 3. Incremental cost of outpatient treatment and self-treatment arising from the August-October 1997 haze

DRC (outpatient) per 10,000 population <sup>1</sup> (DRC1)	0.0125
DRC (inpatient) per 10,000 population at public hospitals only (DRC2)	0.000055
Incremental number seeking treatment <sup>2</sup> (NT)	141,112
Incremental cost of treatment sought <sup>3</sup> (CNT)	RM3,527,803
Incremental number seeking self treatment or directly buying medicine <sup>4</sup> (NST)	59,593
Incremental cost of medicine bought when not seeking treatment <sup>5</sup> (CNST)	RM1,489,835
Incremental total cost of treatment and self treatment <sup>6</sup> (TCTST)	RM5,017,638

<sup>1</sup> Dose response coefficient for reported number of outpatient treatment cases in public hospitals only.

<sup>2</sup>  $NT = \text{Sum over state } i \text{ } CHL_i * DRC1 * HD_i * F_1 * POP_i / 10,000$ , where  $CHL_i$  is the difference between the average haze index in state  $i$  and the normal haze index of 50; DRC1 is the dose response coefficient for the number of outpatient treatment cases in public hospitals in Sarawak;  $HD_i$  is the number of hazy days in state  $i$ , *i.e.*, HD is 60 days for Sarawak, 75 days for Kuala Lumpur and Selangor, and 30 days for other states at risk;  $F_1$  is the public and private outpatient treatments factor of 2 to reflect the 1:1 ratio of public to private clinic outpatient treatments;  $POP_i$  is the population at risk in state  $i$ . The total population at risk is 18,018,795 which include the whole population of Malaysia with the exception of Kelantan, Trengganu and Pahang.

<sup>3</sup> Assuming that demand for treatment and medicine is price inelastic (close to zero) so it is assumed that price of outpatient treatment and medication (PT) is equal to RM25 per visit. Therefore  $CNT = NT * PT$ .

<sup>4</sup> Computed as in 1 but with an additional multiplication by  $F_2$ , which is the factor of those seeking self treatment in state  $i$ , *i.e.*,  $NST = \text{Sum over } i \text{ } CHL_i * (DRC1 + DRC2) * HD_i * F_1 * F_2 * POP_i / 10,000$ . Interviews with medical doctors in Sarawak suggest a factor of 1 in Sarawak and Sabah, and at most 0.5 in the states of Peninsular Malaysia. It should be noted that in Malaysia there are various rural medical posts, even for remote aboriginal communities. For instance, in Sarawak there are 1,718 village health representatives serving 165,000 people in 956 rural villages.

<sup>5</sup> Assuming that demand for treatment and medicine is price inelastic (close to zero), hence it is assumed that cost of medicine for self treatment (PST) is equal to the cost of the benefit of the lost consultation, equal to RM25 per case, *i.e.*,  $CNST = NST * PST$ .

<sup>6</sup> Computed as  $TCTST = CNT + CNST$ .

TABLE 4. Incremental cost of hospital admissions arising from the August-October 1997 haze

Dose Response Coefficient per 10,000 population <sup>1</sup> (DRC2)	
0.000055	
Incremental number admitted <sup>2</sup> (NA)	379
Incremental number of days admitted <sup>3</sup> (NDA)	1894
Incremental cost of hospitalization <sup>4</sup> (CA)	RM236,750

<sup>1</sup> Dose response coefficient for reported number of admission into public hospitals only.

<sup>2</sup> NA is the number of admission into both public and private hospitals, i.e.,  $NA = CHL_1 * DRC2 * HD_1 * F2 * POP_1 / 10000$ , where F2 is the public and private hospital admission cases factor of 1.22 to reflect the 1:0.22 ratio of available public to private hospital beds (Department of Statistics, Malaysia (1997). *Yearbook of Statistics Malaysia*).

<sup>3</sup> It is assumed that the average length of stay in hospitals (LH) is 5 days.  $NDA = NA * LH$ .

<sup>4</sup> The price of hospitalization per day (PH) is assumed at RM125, i.e., 5 times higher than the price of outpatient treatment (benefit transfer). It is also assumed that the price elasticity of demand for hospitalization is very inelastic (close to zero).

(Table 3). The incremental cost incurred on hospital admission was estimated to be RM0.23 million during the same period (Table 4).

The country incurs productivity losses as a result of the haze-related illnesses suffered by population at risk. These productivity losses occurred in terms of foregone production opportunities during the idled workdays of hospital admission and sick leaves obtained by a fraction of the population at risk. Among those population not hospitalized and not granted sick leave, they managed to continue working but are believed to experience reduced activity days arising from haze related illnesses suffered. These sources of haze related productivity losses are estimated to be RM4.3 million (Table 5). The summation of all three types of incremental costs of illnesses arising from the haze was estimated to be RM9.2 million.

For illness prevention, pain discomfort, loss in ability to enjoy leisure activity, the WTP/COI ratio of affected individuals ranged between 1.6 to 2.3 for asthma (ADB 1996). The estimates of COI are multiplied by a factor of 2 to approximate WTP for the health effect of the haze. From the above estimations, it can be summarized that the adjusted cost of

TABLE 5. Productivity losses from haze related illnesses arising from the August – October 1997 haze

Incremental number of adults hospitalized <sup>1</sup> (NAA)	151
Incremental number of workdays lost during hospitalization <sup>2</sup> (NWDL)	757
Incremental sick leave days obtained by adult outpatients <sup>3</sup> (NSL)	20,743
Incremental total workdays lost <sup>4</sup> (TNWDL)	21,501
Incremental productivity foregone from workdays loss <sup>5</sup> (CPFWDL)	RM 596,776
Reduced activity days <sup>6</sup> (NRAD)	141,068
Productivity loss from reduced activity days <sup>7</sup> (CPLRAD)	RM3,738,302
Incremental productivity loss from illnesses <sup>8</sup> (TPLI)	RM4,308,078

<sup>1</sup> The Department of Health cites a proportion of 40 percent for adult admission (AAR). NAA = NA\*AAR.

<sup>2</sup> It is assumed that the average length of stay in hospitals (LH) is 5 days. NWDL = NAA\*LH.

<sup>3</sup> The proportion of adult to children seeking treatment is 0.95:1, so the proportion of adults seeking treatment (ATR) of 49 percent is used. Interviews with medical practitioners suggest that the average length of medical certificates for sick leave (LMC) is 2 days and the proportion of outpatients seeking treatment obtaining sick leave (MCR) is 15 percent. So NSL = ATR\*NT\*LMC\*MCR.

<sup>4</sup> TNWDL = NWDL + NSL.

<sup>5</sup> Average wage per employee (W) computed from the annual wages and salaries of Malaysians is RM26.50 / day. CPFWDL = TNWDL\*W.

<sup>6</sup> NRAD is computed by summing the number of adult outpatient and self treatment days net of total workdays loss and multiplying by a factor (F3) of 0.3, which represents the reduced activity experienced during each working day by individuals at risk. So NRAD = ((NT + NST)\*ATR\*LRA - TNWDL)\*F3, where LRA is the length of reduced activity days experienced by individuals at risks which is suggested to be 5 days by medical practitioners interviewed.

<sup>7</sup> CPLRAD = NRAD\*W.

<sup>8</sup> TPLI = CPFWDL + CPLRAD.

TABLE 6. Adjusted incremental cost of illness (RM) arising from the August-October 1997 haze

Incremental hospitalization cost (CA)	236,750
Incremental total cost of treatment and self treatment (TCTST)	5,017,638
Incremental total Productivity loss from Illness (TPLI)	4,308,078
Incremental cost of Illness <sup>1</sup> (COI)	RM 9,562,466
Incremental adjusted cost of illness or willingness to pay to avoid the illness <sup>2</sup> (ACOI)	RM19,124,932

<sup>1</sup> COI = CA + TCTST + TPLI.

<sup>2</sup> For illness prevention, pain, discomfort, loss in ability to enjoy leisure activity, the WTP/COI ratio of the affected individuals ranges from 1.6 – 2 (ADB 1996). The estimates of COI are multiplied by a factor (F4) of 2 to obtain the adjusted cost of illness or WTP to avoid the health impacts of the haze. So ACOI = F4\*COI.

illness arising from the 1997 haze externalities during the period August to October was RM19 million (Table 6).

## POLICY IMPLICATIONS AND CONCLUDING REMARKS

The haze impacts on health of RM19 million might be minute compared to the total computable damage of about RM800 million to the Malaysian economy (Mohd Shahwahid and Jamal 1998). The study, however, assumed that the haze related sicknesses are only sustained in the short-run. Had it been otherwise in reality, the health impacts would certainly be much higher. This is an area of future research.

The 1997 haze, although posed considerable economic and health difficulties, has brought a number of positive outcomes. First, it has helped create awareness about the importance of environmental quality and good governance in resource management. This has hastened the way for faster implementation of measures to curb the haze. Following the 1997 haze incident, Malaysia and Indonesia signed a memorandum of understanding to implement short and long term measures to prevent the recurrence of the haze, particularly at its sources. The MOU was signed on Dec 11 1997. But, it should be noted that long before the 1997 haze, some common understanding about the haze problem was already in place. Specifically, an ASEAN Cooperation Plan on Trans-boundary Pollution was agreed upon as a response to the 1994 haze. The Plan provides for (1), early warning and preparedness of local

communities, (2) prohibition of biomass burning during dry periods, (3) sharing of information and (4) promoting investment in alternative uses of biomass. There were also longer-term measures, which include awareness building to eliminate the use of fire as a land clearing method and zero-burning strategies in all economic sectors. Apparently the ASEAN Cooperation Plan has remain unimplemented to a large extent, resulting in large-scale open burning practices in Indonesia in 1997. In Malaysia, the 'zero-burning strategy' is being implemented for agricultural crop replanting activities. The unprecedented proportion of the 1997 haze in terms of intensity and duration and subsequently its external diseconomies to neighboring countries are expected to compel member countries to fully observe all the provisions of the Plan.

As noted earlier, the 1997 haze has been to some extent attributed to unsustainable land clearings by large plantation firms in Indonesia for conversion to agriculture, particularly oil palm. Some competing vegetable oil producers have regarded the land clearing practice (open burning) as sort of "environmental subsidy" for oil palm production. In a trading world charged with green consumerism issues, this regard may have detrimental trade impacts on palm oil, a vital commodity for both Indonesia and Malaysia. It is only wise that both Indonesia and Malaysia address this trans-boundary pollution issue by adopting effectively the recommendation of the ASEAN Cooperation Plan and identifying 'win-win' or 'win-no lose' situation in oil palm investment, considering Malaysia is relatively land scarce while having the distinct advantage in capital and technology.

An important contribution of this study is its contribution to the literature on environmental valuation, especially in terms of the methodological rigor. The Dose-Response Function employed in this study utilized time series data of about 80 observations. This would not be made possible without the given haze incident, where all relevant health data and pollution level were collected nationwide and on a daily basis. The Malaysian Dose-Response coefficient may also be transferred to other similar studies.

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Jamal Othman  
Faculty of Economics  
Universiti Kebangsaan Malaysia  
43600 UKM Bangi  
Selangor Darul Ehsan

Mohd Shahwahid H.O.  
Faculty of Economics and Management  
Universiti Putra Malaysia  
43400 UPM Serdang  
Selangor Darul Ehsan