Valuing Reduced Morbidity:
A Case Study of the Persian Gulf Environmental Damages

Morteza Rahmatian
Department of Economics
California State University, Fullerton
Fullerton, CA 92834

mrahmatian@fullerton.edu
http://business.fullerton.edu/mrahmatian/

Fall 2002

I. Introduction

During the 1991 Gulf War, 700 oil wells were set on fire by Iraq's troops as allied forces under operation "Desert Storm" forced them out of Kuwait. These fires burned for 10 months creating the most disastrous environmental problem ever recorded. The propose of this report is to estimate the health effects from the air pollution caused by this disaster. To estimate these damages this report employs the Contingent Valuation Method (CVM) to estimate the monetary value placed by those who are ill on certain symptoms of this unprecedented increase in air pollution.

In order to have the efficient provision of health, safety and environmental policies it is crucial to obtain a market valuation of risks to human health from air pollution in Tehran. In a world of scarcity, difficult decisions concerning tradeoffs between health and other desirable goods and services are unavoidable. It is hoped that this study will contribute to informing future policy decisions about the possible benefits of improving air quality.

There are no universally accepted market values for reducing the incidence of many symptoms of illness caused by air pollution that produce discomfort such as coughs, headaches, shortness of breath, etc. Similarly, there are no direct measures of how much we value small reductions in the risk of death in a given year. Consequently, economic values of these effects have been estimated by either using CVM or by hedonic studies where, market information is used to place a value on non-market goods, like the reduced incidence of illness.

To further explore the relationship between the willingness to pay for improvements in adverse health effects, a contingent valuation study was conducted. Using interviews, individuals with additional symptom days of illness from air pollution were asked to purchase reductions in these symptoms contingent upon the existence of a market for doing so. Based on our experience with focus groups and pre-testing, we chose to target valuing seven symptoms: coughing spells, shortness of breath, eye irritation, sore throat, headache, chest pain and asthma. Individuals were asked about the number of symptom days experienced in the previous month and their associated health history. For each of the individual symptoms, it is important to note that the values presented here are "one-day" willingness to pay (WTP) estimates for one less day of symptom occurrence.

The basic economic model of individual utility is set out in section II. Section III deals with data collection and reviews valuations due to changes in risk to human health. Section IV identifies populations at risk. Section V provides assessments of human health effects in the Southern part of Iran. Results are summarized in section VI and finally some concluding remarks are offered in section VII.

II. The Utility Model

The theoretical model that provides the setting for this analysis was first articulated by Maler (1974). Models that describe what an individual would pay for health improvements associated with air pollution are by now well established in the literature (Burger et al. (1987); Harrington and Portney (1987); Cropper and Freeman (1991). Such a model is reproduced in this paper to provide a framework for interpreting the willingness to pay (WTP) estimates obtained in our surveys.

An individual has preferences for various conventional market commodities as well as non-market commodities such as health morbidity symptoms. Depending on the context of non-market goods, it may be a single symptom or several symptoms, where it is represented by a vector. The individual takes the level of non-market goods as given – in effect it is a public good. By contrast, the individual can freely vary the consumption of the private market goods.

The approach is to allow air pollution to affect the duration of illness in a household production model of health. A marginal change in air pollution will therefore cause a marginal change in the duration of illness. Because there is a one-to-one correspondence between the air pollution and the duration of illness, the questions in the survey are asked to obtain the respondents' valuation of a marginal change in the duration of illness in the willingness to pay. This provides us with a partial indirect estimate of the value of reducing air pollution. This model also identifies the variables on which willingness to pay depends.

A person's willingness to pay to avoid an air pollution-related illness can be developed in the context of the following household production model. For instance, utility in one period depends not only on acute illness in that period, but also on the stock of acute illness experienced to that date. Thus, the actions a person would take to mitigate illness in one period would also depend on illnesses experienced in the past and on the realization that mitigating illness today would reduce the future disutility of illness. This modeling can be quite sophisticated, yet due to data limitations a simples approach is being followed in this paper.

Individual preferences are represented by a utility given as:

(1) $U = U(X, L, I, N; Z)$ Where:

X: Consumption goods
L: Leisure
I: Illness adjusted for its severity
N: Nature of illness
Z: Vector of individual characteristics

Note that $I = (D)(S)$, where D is the disutility that one receives from illness and S is the severity of the illness. Z is a vector of individual characteristics such as health history, age, etc. which affect the disutility received from I and N, as well as the utility received from X and L. The assumption is that the duration of respiratory illness D depends on air pollution P, on the nature of the illness N, and on an exogenous measure of the severity of air pollution E. E indicates how bad a case of N one has before anything is done to relieve one's symptoms. S on the other hand, measures the severity of illness after mitigating behavior, M, which includes medication taken and medical attention received.

(2) $$I(P, N, M, E) = [D(P, N, E)][S(M, E)]$$

The utility function is continuous and non-decreasing in its arguments and strictly quasi-concave in X. However, the utility function is not necessarily quasi-concave in M. Simply there is no compelling reason why quasi-concavity should apply; as indicated above, how the individual feels about is an empirical question. For instance, actions taken to mitigate illness in one period are independent of acute illnesses experienced in the past and are not motivated by the impact of these actions on the future utility.

The individual faces a budget constraint based on disposable income and prices of the market and non-market commodities. The quantity of illness enters the household's budget constraint by influencing the amount of productive time available to work. Specifically, the budget constraint is:

(3) $$Y + W(T - L - I) = P_X X + P_M M$$ Where

Y;	Nonwage income
W;	Real wage rate
T;	Total time
P;	Price

The health production model assumes that the individual allocates non-illness time (T – L – I) between work and leisure activities and income between medicine and other goods to maximize utility, subject to the budget constraint. This yields a set ordinary demand functions for both X and M.

If we determine what it would be worth to an individual to reduce air pollution, this would be the amount of money that could be taken away from that individual while reducing pollution and its symptoms and keeping the utility of that individual constant. Thus, the willingness to pay for a change in air pollution is equivalent to changes in D and the willingness to pay for changes in D. The value of a nonmarginal change in D may be defined using the following pseudoexpenditure function. This is the minimum value of expenditure minus wage income necessary to keep utility at U^0.

(4) $$E = \text{Min}\{P_X X + P_M M - W(T - L - D . S) + \lambda[U^0 - U(X, L, D . S, N; Z)]\}$$

Where, λ is a Lagrangian multiplier. Willingness to pay for a marginal change in D may be defined using equation 4 as the expenditure necessary to achieve U^0 at the original duration of illness, D^0, minus the expenditure necessary to achieve U^0 at the new (lower) duration of illness D^1:

(5) $WTP = E(P_X, P_M, Y, W, N, S, Z, D^0, U^0) - E(P_X, P_M, Y, W, N, S, Z, D^1, U^0)$

Equation 5 implies that the willingness to pay is expected to vary with income, price, individual characteristics, the nature of the illness, its severity and D^0 and D^1. Consequently, the willingness to pay can be regressed against all of the above variables.

III. The Data and Valuation of Changes in Risks to Human Health

During January 1998, data measuring contingent values for health symptoms of the residents of Busheher and Hormozghan were obtained. From this data, the health effects and the value of reducing pollution is estimated for a larger population. To do this, an extensive questionnaire was used to examine health symptom severity and frequency as well as individual avoidance evaluations. Bids were then elicited from the respondents to determine their willingness to pay for avoiding a day of the last month's symptoms due to air pollution. Despite the problems associated with CVM technique (Mitchell and Carson 1988), the incorporation of a cognitive psychology framework into the CVM technique represented another positive step in the development of survey instruments.

In the first part of the survey, general questions were asked regarding the respondent's health background and the frequency of which they experienced any of the health symptoms being monitored. The next section of the survey was designed to determine the individual's concern for better health and the willingness to pay to avoid the monitored symptoms. Although one does not usually find a dollar value placed on better health, nevertheless individuals are willing to pay some amount to avoid any discomfort. We were interested in finding out precisely how much a particular individual was willing to pay to avoid these symptoms. Thus, the respondents were asked to state their maximum willingness to pay, per symptom avoided, per day. This procedure constitutes a direct attempt to determine how much better health is worth, i. e., to generate a monetary value of improving health, which can be viewed as an indirect measure of the value of reducing air pollution.

In the last part of the survey, the respondents were asked to provide a set of socio-economic information regarding; gender, age, education, whether the respondent was the primary income earner, place of residence, size of household, and the household's monthly income. Knowledge of these parameters is necessary in accounting for the difference in WTP bids across individuals. Variations in socio-economic characteristics are assumed to help to explain at least partially the observed differences among individuals' willingness to pay for reducing the incidence of adverse health symptoms.

Table I summarizes the socio-economic variables of the sample; all values are means with their standard deviation in parentheses. There are 200 observations with the following characteristics: 37% of the sample were smokers, 46% were engaged in some sort of sport activity; 53% followed a specific diet. The sample is evenly divided between males and females with an average age of 34.26 years, an average education level of 14.31 years and an average monthly income of 903,570 1998 Rials.

Mean and median bids for several of the symptoms are given in Table II. Similar to the estimates of physical effects provided by other health studies, each of the monetary values of benefits applied in this analysis can be expressed in terms of a median value and a range around the mean estimate. The large disparity between the mean and median bids clearly indicates that responses varied tremendously from person to person (or at least, that some people gave very high bids). With the exception of headache avoidance, bids were fairly similar across symptoms. A large discrepancy between mean and medium avoidance bids represents the presence of outliers. Thus, the medium bids were used as the WTP valuation in the subsequent as opposed to the mean.

Simple ordinary least square regressions were estimated by running the willingness-to-pay avoidance bids against the set of socio-economic variables. The regression results are consistent with the findings in the literature that WTP to avoid symptoms is significantly different from zero. The bids offered to avoid a coughing spell for example, have a negative relationship with cigarette smoking and a positive relation with respect to age. Specifically, as an individual becomes older, the willingness to pay to avoid a coughing spell is larger and simultaneously the willingness to pay is smaller if the individual is a smoker. Furthermore, gender and average bids had an inverse relation in this data set. It appears that females place a higher valuation (bids) on symptom avoidance as opposed to men. The willingness to pay had a positive relationship with the duration of an illness, education, income and the number of symptoms experienced. The majority of the indicated socio-economic variables displayed the expected relationship with the bids offered providing independent validity for the survey instrument used in this report to estimate the value of reducing air pollution.

IV. Population at Risk

In this section the sample data is extended to extrapolate to the larger population. The global cost of the additional air pollution from the Gulf War and hence an indirect partial measure of the marginal value of reducing the additional air pollution due to war. Estimating the reduced incidence of physical effects form air pollution provides a valuable measure of the health benefits of reduced pollution for the individual in question. To compare and aggregate benefits across different groups, the benefit must be evaluated in monetary form. Assigning monetary value to avoided incidences of each effect permits a summation, in terms of Rials, of the monetized benefits realized as a result of air quality improvements.

It is important to recognize the substantial controversies and uncertainties that restrain attempts to characterize adverse human health and ecological effects of pollution in monetary terms. Too many monetary-based estimates of the value of avoiding outcomes such as the loss of human life, pain and suffering, or ecological degradation do not capture the full and true value to a society as a whole of avoiding or reducing these effects. This report attempts to place a monetary value on avoiding seven health symptoms, which restricts daily activities. These, too, are only a partial lower – bound estimate of the benefits of reducing air pollution.

To estimate the health effects of the pollutants due to impact of the Gulf War in the southern part of Iran, the following steps were taken to extend the analysis derived form our survey to this larger population.

1. An estimate of an exposure-response and or dose-response function specific to the local pollutant mix was derived. For this purpose a comprehensive survey was conducted. Specifically, the individual health history, gender, age, and the frequency of the seven health symptoms monitored (cough, shortness of breath, eye irritation, sore throat, headache, chest pain and asthma) were asked of respondents in Southern Iran.

2. Demographic data including population, spatial distribution within the region, and age were collected. Surveys were conducted for Busheher and Hormozghan. In addition, age and gender distributions were obtained through Iran's national statistics. This data along with the information obtained through the survey were used to estimate the total population at risk.

3. Ideally, time-activity profiles for the population would be created. This is necessary to determine the percentage of time the specific population spends outdoors exposed to outside pollution relative to the time spent indoors exposed to indoor pollution. Two different region's populations, with similar ambient concentrations, may experience different exposure to pollution because of different indoor/outdoor pollution concentration ratios or a different proportion of time spent indoors or outdoors. Unfortunately, specific data that would allow us to determine this for Southern part of Iran is not available. Therefore, based on the literature, Hall (1989), a value of 0.625 for the indoor-outdoor factor is used. This means the indoor population suffer from receive nearly 62.5 percent of the symptoms compared to those in outdoor.

4. Ambient air quality data for all pollutants of interest were collected. The World Health Organization (WHO) had a detailed list of pollutants due to the Persian Gulf disaster available for this part of the study.

5. An emission source inventory was identified. In this instance, the inventory source of pollution was the 700 oil wells set on fire and which were responsible for the increase in air pollution due to the Gulf War.

From this data, the health effects in the population of interest, given prevailing ambient concentrations, was estimated. Then, an estimate of the change in the frequency of adverse effects caused by variations in ambient concentrations was obtained. Population-specific micro-environmental factors come into play, including such variables as time indoors, in-transit, outdoors at work and school or home. An urban population with a large cohort under the age of 18, for example, will generally experience more exposure to air pollution than the older population because the younger cohort spends more time outdoors.

The air quality data from outdoor monitors and demographic data from southern part of Iran, under-pin the translation of the exposure–response estimates from epidemiological studies. Population-specific time-activity data were also a factor in the valuation, especially if there are reasons to expect that the populations are not closely comparable. Table IV summarizes the general population statistics for selected Provinces in the Southern part of Iran. Given the demographic and population density of these Provinces, some provinces were exposed to larger amounts of pollution compared to others. These factors assisted in identification of the populations at risk in estimating the final damage valuation.

V. Assessment of Health Effects in the Southern Part of Iran

Completing this assessment proved to be a complex task, in part because the data and results from each link must be congruent with the methodology and the data in each of the other links. Availability of a rich air quality database and relatively robust information about the population was supported by the development of a Regional Human Exposure model termed REHEX (Winer et al., 1989).

The characteristics of the REHEX are important in representing the full distribution of exposure in a population with diverse and sometimes atypical, activity patterns. Development of a REHEX and estimation of exposure-dose parameters for the southern part of Iran was the first step in this health effects assessment. Next, the relation between health effects and air quality were expressed in terms of frequency of occurrence at increments of exposure and dose (Mendelson and Orcutt 1979).

Air pollution - related symptoms were modeled in a new way to enable the use of results from clinical and epidemiological studies to evaluate the rate of occurrence of the seven symptoms which are the focus of this study: coughing, shortness of breath, eye irritation, sore throat, headache, chest pain and asthma. Table VI presents the mean, median and the standard deviations of the frequencies of these symptoms, on a monthly basis. Note that the adjusted median frequencies in this table reflect the fact that, according to our survey, individuals often experienced symptoms even in the absence of pollution due to age, smoking, stress and other causes. To obtain the net frequencies of the symptoms as a result of the additional pollution due to the Gulf War, the number of natural occurrences prior to the Gulf War must be deducted. Air quality and population data were linked via the REHEX, and the exposure/dose response functions were then used to estimate the health effects based on exposure and dose estimates from REHEX. The final link in this study is between the frequency of health effects and a set of economic values for such effects.

VI. Results

Nearly every resident of Bosheher, Esfehan Fars, Hormozgan, Kerman, Khosestan, Kohkeloyeh and Boyer Ahmad and Yazd in Southern Iran experienced some exposure to additional pollution during the 10-month period beginning February 1991 through November 1991. Nearly 45% of the population was exposed to levels of pollution above the first stage alert levels (a concentration representing a higher health risk than acceptable air quality standards). Age was determining factor since school-aged children received the highest exposure and experienced more adverse health effects. This is not surprising given that children were more active and spent more of their time outdoors where pollution concentration levels were higher.

We quantified the relationship between air quality, the amount of pollution people actually breathed, the health effects of breathing the pollution, and the economic benefits of preventing those effects. These valuations can be interpreted as the partial marginal benefit of reducing the additional pollution created due to the Gulf War. Such an estimate is a lower – bound but partial estimate of reducing pollution by a marginal amount equal to that caused by the Gulf War.

a. Sensitive Population in the Southern Part of Iran

We enumerated the number of people in each province at risk from air pollution using the results of the survey conducted by the ministry of health as the multiplier. An estimate of the total population in Southern Iran was obtained from the 1371 Iranian National Annual Statistics. Infants and the elderly experienced the lowest exposures per capita because they spent less time outdoors than other groups. School age children, college students, and adults working outdoors experienced the highest exposure per capita. School age children and adults as groups experienced the greatest damage. Though they constituted less than 28% of the population, these groups experienced more than 40% of the symptoms.

b. Construction of Appropriate Values Derivation of the WTP Adjustment Function:

The intensity of the marginal increase in air pollution experienced by the population in the Southern part of Iran as a result of the Gulf War led us to suspect that some individuals would experience multiple days of symptoms each month. This presented a problem for the accurate valuation of reduced symptom-days, because the value placed on, for example, the first day of reduced symptoms would not be expected to be the same as that for the tenth day due to simple economic theory of diminishing marginal utility. Empirical CVM work by Loehman et al. (1979), Rowe and Chestnut (1985), and Dickie et al. (1987) confirm that the total WTP to reduce N days of a symptom is significantly less than N times the WTP to reduce 1 day of a symptom for many minor symptoms related to air pollution. Thus, the application of the average WTP figures to multiple days of symptoms reduction would lead to an over estimation of the actual WTP.

No one study has thoroughly addressed this marginal-average WTP effect across various minor health effects. However, formally analyzing and accounting for this effect can be achieved by pooling data from Loehman (1979) Rowe and Chestnut (1985). The implication of this adjustment process is dramatic, as presented in Table VII. For example it shows that if 5 symptom days per person were reduced, the effect is to reduce total WTP by nearly 50 percent as compared to making no adjustments for diminishing marginal benefits. For 10 symptom days, the reduction was more than 70 percent. The result of this adjustment for the value of pollution-related symptoms is to reduce significantly the estimates of the total economic benefits of reducing air pollution compared to estimates yielded by the use of average WTP values from the survey. This adjustment is essential, so as to not artificially inflate the benefits of reducing pollution and health related illnesses due to this pollution.

Tables VIII and IX capture the total outdoor-indoor economic values respectively. To estimate the outdoor total economic values in Table VIII, the outdoor population is obtained from Table V, the frequencies of symptoms were taken from Table VI, the unit values from Table II were applied, and the multiple days adjusting factors were obtained from Table VII. The main distinction between Tables VIII and IX is the indoor population and the frequencies of symptom occurrence. In Table IX, the frequency of the symptoms was adjusted by the 0.625 indoor-outdoor factor as described in section IV.

It is noteworthy that bids for symptom combination reduction were less than the sum of the bids for each symptom separately. Specifically, the three symptoms combination was valued at about 80% of the summed separate symptoms (Hall et al., 1989). Likewise the bids offered for five symptom combinations (cough, shortness of breath, eye irritation, sore throat and headache) is valued at 55% of the summed symptoms separately because of the diminishing marginal utility argument for multiple day incidence reduction (Krupnick & Kopp 1988, Dickie 1987). Thus, the total value of a multiple symptom day will need to be adjusted by 55% of the summed value. Note that chest pain and asthma attacks were eliminated from the analysis due to zero median frequencies for the period in question.

The population in the Southern part of Iran was exposed to pollution at various degrees. Depending on population density, distance to the source of pollution, spatial distribution, the unemployment rate and population concentration in villages vs. major metropolitan areas the population exposed to pollution varied considerably. Once these factors are considered, the total population at risk was estimated at 45% of the general population.

Thus the final monetary value assigned for reducing pollution must be adjusted twice. Once by 55% for multiple symptom days and the second time by 45% to capture the general population at risk from such pollution. Therefore, the total adjusting factor of 0.2475 [(0.55)(0.45)] as presented in Table X is used in the final estimation of partial benefits of a marginal reduction in air pollution.

1. The final adjusting factor for the general population at risk is:

   (Multiple Symptom Factor)(Percent Population Exposed) = Adjusting Factor

   (55%)(45%) = 0.2475

2. The final monthly monetary value from X is:

   (Total Monthly Value)(Adjusting Factor) = Final Monthly Value

   (2,380,000,000,000)(0.2475) = **590,000,000,000 Rials**

3. Using the exchange rate of $1 = 8,000 Rials, this total monthly value can be transferred into Dollars.

   (Final Monthly Value)(Exchange Rate) = Final Value in Dollars

(590,000,000,000)(1/8000) = **$73,750,000**

4. The pollution continued for nearly 10 months until Kuwait's government officials symbolically put out the last oil well fire. As more and more oil well fires were put out, the extent of the pollution diminished to the point that in the months of September through November the level of pollution was substantially reduced. Thus an average of 5 months is used to compute the total value lost in health benefits due to air pollution from the burning oil wells.

   (Final Monthly Value)(5 Months) = Total Value Lost

   (590,000,000,000)(5) = **2,950,000,000,000 Rials**

   The same value presented in Dollars is,

   ($73,750,000)(5) = **$ 368,750,000**

These estimates can be interpreted as the lower – bound, partial estimate of the benefit of a marginal reduction of air pollution equivalent to that generated by the Gulf War. Comparing this value to the cost of reducing ambient pollution can provide policy makers with a guide to the net benefits of reducing air pollution in terms of reduced incidence of health related illnesses. Of course, a more compatible analysis would need to include the other benefits of reducing air pollution, such as mortality and damages to agricultural and agricultural goods. Including these other benefits would increase the benefits to an equivalent marginal reduction in air pollution.

VII. Concluding Remarks

This study has estimated the value of the health damage caused by the environmental degradation due to the 1991 Gulf war. Although, the values obtained are statistically similar to those obtained for other parts of the world, caution must be taken in generalizing these values. The results of our study do suggest that the WTP responses to avoid illness symptom are internally valid since the willingness to pay had a positive relationship with the duration of illness, education, income and the number of symptoms experienced as in other studies.

This study did not include all the adverse health effects that can be identified and valued in monetary form due to the additional pollution from the Gulf War. The contribution of air pollution to chronic illness, reduction in lung function and even death are three important factors that have not been translated into economic terms. This study was intended to serve as a base for future research by investigating one component of the cost from pollution, and hence the potential the potential benefits of reducing pollution.

There are many ways in which other researchers could improve upon this work. First, all adverse health effects can be considered. Second, mortality valuations can be included if there was any evidence of death. Third, the sample size (respondents) could be increased to better represent the population at large. Fourth, this study searched the valuation of a set of symptoms simultaneously. In the future, it would be an improvement if the respondents could be asked to concentrate on their most recent illnesses and then have valuations obtained individually.

Table I: Socio-economic Data (Standard Deviation in Parenthesis)

Number of observation	200
Smokers	37%

Sports	46%
Diet	53%
Male	59%
Female	51%
Age	34.26 Years (9.4)
Education	14.31 Years (2.96)
Household size	3.92 (1.4)
Head of household	55%
Average income	903,580 Rials (709,840)

Table II: Unit Value for Health Effect: In Rials

Symptoms	Mean Value	Standard Deviation	Median
Cough per day	18,390	(18,220)	12,000
Shortness of breath per day	21,800	(17,070)	17,500
Eye irritation per day	16,050	(12,550)	11,000
Sore throat per day	20,540	(23,190)	10,000
Headache per unit	32,370	(38,710)	20,000
Chest pain per unit	31,020	(33,790)	20,000
Asthma Attack per unit	40,510	(42,640)	30,000

Table IV. Population for Selected Provinces: Iran 1370

	Male	Female	Total
Boshehr	357477	333448	690925
Esfehan	1890489	1753321	3643810
Fars	1781721	1683312	3465033

Hormozghan	473716	446504	920220
Kerman	910378	871815	1782193
Khosestan	1617121	1533170	3150291
Kohkeloyeh &B. Ahmad	244930	230567	475497
Yazd	360632	327814	688446
Total	7636464	7179951	14816415

Table V. Indoor and Outdoor Total Population

	Male	Female	Total population
Outdoor	3,619,684	299,490	3,919,174
Indoor	4,016,780	6,880,461	10,897,241

Table VI. Dose response function

	Cough	Shortness of Breath	Eye Irritation	Soar Throat	Headache	Chest Pain	Asthma
Mean	12.55	9.98	8.66	5.71	13.72	1.63	0.38
Standard Deviation	4.071	4.786	4.25	5.012	5.101	2.565	1.502
Median	13	10	8	5	15	0.0	0.0
Adjusted Median	9	7	5	4	12	0.0	0.0

Table VII. Adjusted WTP to Reflect Multiple Days of Symptom Reduction. Values in Rials:

Number of days with symptom reduced	All days valued using average WTP	Days valued using adjusted WTP	Multiple Factor

1	1,000	1,000	1.00
2	2,000	1,410	0.705
3	3,000	1,700	0.566
4	4,000	1990	0.497
5	5,000	2,240	0.448
6	6,000	2,490	0.415
7	7,000	2,690	0.384
8	8,000	2,870	0.358
9	9,000	3,030	0.336
10	1,0000	3,160	0.316
12	12,000	3,410	0.284
15	15,000	3,870	0.258

Table VIII. Total Outdoor Economic Value; In Rials

	Number of Symptom	Unit Value	Mult. Days value	Mult. Days Factor	Total Adj. Value	Total Value
Shortness of Breath	7	17,500	122,500	0.384	47,040	184,000,000,000
Cough	9	12,000	108,000	0.336	36,288	142,000,000,000
Eye Irritation	5	11,000	55,000	0.448	24,640	96,600,000,000
Sore Throat	4	10,000	40,000	0.497	19,880	77,900,000,000
Headache	12	20,000	240,000	0.284	68,160	267,000,000,000
Total						**768,000,000,000**

Table IX. Total Indoor Economic Value; In Rials

	Number of Symptom	Unit Value	Mult. Days value	Mult. Days Factor	Total Adj. Value	Total Value
Shortness of	4	17,500	70,000	0.497	34,790	379,115,000,000

Breath						
Cough	5	12,000	60,000	0.448	26,880	292,918,000,000
Eye Irritation	3	11,000	33,000	0.566	18,687	203,539,000,000
Sore Throat	2	10,000	20,000	0.705	14,100	153,651,000,000
Headache	7	20,000	140,000	0.384	53,760	585,836,000,000
Total						**1,620,000,000,000**

Table X. Final Adjusted Monthly Value Reported in Rials and Dollars

	Monetary Value	Adjusting Factor	Total Adj. Value in Rials	Total Adj. Value in Dollar
Indoor	1,620,000,000,000	0.2475	400,000,000,000	$50,000,000
Outdoor	768,000,000,000	0.2475	190,000,000,000	$23,750,000
Total Value	2,380,000,000,000		**R 590,000,000,000**	**$73,750,000**

References

Berger, M. C., G. C. Blomquest, D. Kenkel and G. S. Tolly, Valuing Changes in Health Risk: A Comparison of Alternative Measures. Southern Economic Journal. 53 (1987), 967-984.

Chestnut, L. G., and D. M. Violette. (1984) "Estimates of Willingness to Pay for Pollution-Induced Changes in Morbidity: A Critique for Benefit-Cost of Pollution Regulation." Prepared for U. S. Environmental Protection Agency, Washington D.C.

Cropper, M. L. and M. A. Freeman, Valuing Environmental Health Effects, in "Measuring the Demand for Environmental Quality" (J. B. Barden and C. D. Kolstad, Eds.), Elsevier, Amsterdam, 1991.

Dickie, M. et al., (1987) "Reconciling Averting Behavior and Contingent Valuation Benefit Estimates of Reducing Symptoms of Ozone Exposure." Prepared for U. S. Environmental Protection Agency.

Hall, J. et al., (1989) "Economics Assessment of Health Benefits From Improvement in air Quality in the South Coast Air basin" Final report to South Coast Air Quality Management District. Contract NO. 5685

Harrington, W. and R. T. Portney, Valuing the Benefits of Health and Safety Regulation, Journal of Urban Economics, 22 (1987), 101 – 112.

Krupnick, A. J. and R. J. Kopp. (1988) The Health and Agricultural Benefits of Reductions in Ambient Ozone in the United States. Prepared for the Office of Technology Assessment. U. S. Congress, Washington D.C.

Loehman, E. T. et al., (1979) "Distribution Analysis of Regional Benefits and Cost of Air Quality Control," Journal of Environmental Economics and Management 6: 222-43.

Mendelson, R., and G. Orcutt. (1979) "An Empirical Analysis of Air pollution Dose-Response Curves." Journal of Environmental Economics and Management 6: 85-106.

Mitchell, E. C., and R. T. Carson. (1988) Using Surveys to Value Public Goods: The Contingent Valuation Method, John Hopkins Press, Baltimore Md.

Rowe, R. D. and L. G. Chestnut. (1985) "Oxidants and Asthmatics in Los Angels: A Benefit Analysis" Prepared for the USEPA, Washington DC, and the California Air Resources Board, Sacramento, CA.

Winer, A. M., F. W. Lurmann, L. A. Coyner, S. D. Colome, and M. P. Poe. (1989) "Characterization of Air Pollution Exposures in the California South Coast Air Basin: Application of a New Regional Human Exposure (REHEX) Model." Final Report to South Coast Air Quality Management District.