VALUATION OF THE ECONOMIC DAMAGE BY PM_{10} DUST CONTAMINATION TO THE HEALTH OF THE POPULATION COMMUNITY

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TÓM TẮT

ĐỊNH GIÁ THIỆT HẠI KINH TẾ DO Ô NHIỄM BỤI PM_{10} ĐẾN SỨC KHỎE CỘNG ĐỒNG DÂN CƯ

Ở Việt Nam, thiệt hại kinh tế do ô nhiễm môi trường không khí gây nên các bệnh về đường hô hấp chưa được tính vào bảng giá trị thiệt hại kinh tế, mà coi nó như một loại chi phí ẩn. Để có thể định giá được thiệt hại kinh tế, bài báo này thực hiện dựa trên số liệu nồng độ trung bình của toàn bộ đợt quan trắc trên đường Láng Hạ- Giảng Võ và đường Nguyễn Trãi, Thanh Xuân, Hà Nội với nồng độ PM_{10} là 0.318mg/m^3, mức biến thiên dA là 0.168µ/m^3 và 0,366 mg/m^3 và dA là 0.216 µ/m^3 tương ứng. Số liệu phỏng vấn dịch tễ học của 123 người tình nguyện thuộc 6 nhóm người dân dễ bị tổn thương, các hệ số b_i - độ dốc của đường cong liều lượng- đáp ứng, công thức tính thiệt hại được áp dụng công thức của Bart Ostro[3] về đánh giá hiệu ứng tác động đến sức khỏe do ô nhiễm môi trường không khí.

Với tính toán ban đầu cho thấy, người dân sống trong môi trường ô nhiễm PM_{10} (0.3-0.4mg/m^3) phải chi trả từ 95 đến 118 đô la /người/năm cho khám và chữa bệnh.

Đây là những kết quả ước tính ban đầu, con số tổn thất kinh tế do ô nhiễm bụi PM_{10} tới sức khỏe cộng đồng có thể thấp hơn nhiều so với thực tế vì còn nhiều yếu tố chưa được thống kê hết trong nghiên cứu này.

Keywords: *Air pollution, PM_{10}, Economic damage, Community vulnerable.*

1. INTRODUCTION

In Vietnam, the economic losses caused by environmental pollution, especially the traffic air environment, have not been included in the table of economic losses, but considered as a kind of hidden cost. There have been some publications on the calculations related to economic losses caused by environmental pollution[9,10], but not many and have not attracted the attention of scientists as well as managers. Therefore, the World Bank[11] has supported Vietnam to implement the project on assessing the level of air exposure due to traffic to the health of the community in Hanoi. The scientific basis for this project is based on the guiding documents of Bart Ostro[3], other publications[4,5,6] and other countries' experiences[7,8]. The calculated constants are applied to the cases that inherit the published statistics in the world1[1,2,3,4] to help readers better understand the research of statistical excellence in large community

Calculating the total economic damage caused air pollution[3]

• ***The total value of economic damage, T_{EC}***

This calculation is only approximate, because of many different factors, causing various health effects and causing various diseases. Theoretically, it can estimate the number of affected people and estimated economic damage of each element separately, then summing them together. But this value is always lower than reality, because of the general public is only an approximate sense. The total value of economic damage ware calculed by the relationship of Bart Ostro and others[1,2,4,5] folowing such as:

$$\mathbf{T_{EC} = \sum T_i\, dH_i} \qquad [1]$$

Where: T_{EC}: The total value of economic damage, Vi - Value economic loss of an effect on the impact of air pollution. dH_i - Change in population risk of health effect i;

• ***The change in population risk of health effect i, dH_i*** [1,2,3]

The estimated the change in population risk of health effect can be estimated by the following relationship as folowing[3]

$$\mathbf{dH_i = b_i * POP_i * dA} \qquad [2]$$

Where 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

• ***Economic loss due to leave is calculated from the formula, Ti[1,2,3]***

Ti = Σ number of off work days * 8 hours / day * Σ wages / hours [3]

Σ number of off work days = Σ population * percent of adult * The number of restricted activity days * RRAD.

Index of Restricted activity days:

Δ RRAD/person/year = 0.0114 * current RRAD * dA (which RRAD = 3)

Factor 0.0114, RRAD = 3 are taken from statistics epidemiological.

2. RESEARCHING METHOD

The total economic damage caused by air pollution risks, which impact on human health, are calculated from sources such damage:

- Economic losses due to lost work days
- Economic loss due to premature death
- Economic loss due to medical treatment, including the cost of treatment (medication and examination), travel expenses, the cost of training health care costs of hiring and other expenses)[1,3.]

The estimation of the health and economic effects after methodology of U.S. Environmental Protection Agency (EPA) for particulate matter. To estimating the economic value associated with changes in air pollution, there are factors must be determinated such as the risk population, level of changing in air pollution (PM_{10}). The range of upper changes, central change and lower change are used after publicated papers of Bart Ostro[3].

2.1. Selection of the most vulnerable and most at risk population [3,4.]

The study was caried out on the risk impact from air pollution originating from traffic operations to public health, particularly respiratory diseases. Key research are vulnerable people, namely the objects are most at risk, such as people living and working on both sides of the road as sellers, motorbiker, students, traffic police... on Lang Ha - Giang Vo and Thanh Xuân, HaNoi (315 people)[3].

The population of Ba Dinh: 241,200 (According to Statistical Yearbook 2015). Population of Lang Ha-Giang Vo street approximately 11,200 people. The population of Thanh Xuan is 262,600 people and Polulation of Nguyen Trai streed approximately 14.600 people (the approximate number base on of statistics of homes and agencies along the way).

2.2. Equipment to PM_{10} determination

****** PM_{10} measurement equipment:***

For PM_{10} we used the pDR-100AN model manufactured by Thermo Inc., USA.

The instrument estimates mass concentrations ranging from 0.001 to 400 mg/m^3.

The instrument has an accuracy of ± 5%.

The concentration measurement range is 0.001 to 400 mg/m^3.

The monitor has an internal data logger which can store more than 13,391 data points. The monitor is very portable as it weighs only 0.5kg. This instrument's performance has been

widely studied under different operating conditions (Wu, Delfino, Floro et al. 2005, Chakrabarti, Fine, Delfino, et al. 2004, Muraleedharan and Radojevic 2000)

** Measurement equipment of Temp, RH and GPS*

The performance of the particulate matter monitors is highly dependent on temperature (T) and relative humidity (RH) conditions. The $PM_{2.5}$ monitor (model pDR-1500) has internal sensors for T and RH. However, for the model pDR-1000AN we needed to use external climate sensors. We used the model U12-013 HOBO sensors made by Onset, USA.

The range of measurements are - Temperature: -20° to 70°C (-4° to 158°F) and RH: 5% to 95% RH. This product can store up to 43,000 measurements of 12-bit resolution readings. The sensors have an accuracy of Temperature: ± 0.35°C from 0° to 50°C (± 0.63°F from 32° to 122°F); RH: ±2.5% from 10% to 90% RH (typical), to a maximum of ±3.5%.

The resolution is Temperature: 0.03°C at 25°C (0.05°F at 77°F), RH: 0.03% RH. The sensor weighs 46g.

3. RESULTS AND DISCUSION

3.1. PM_{10}, CO dust monitoring results on Giang Vo-Lang Hạ, Ba Dinh

This article uses the test results of the average dust concentration monitoring of PM_{10}, $PM_{2.5}$ and CO at locations on Giang Vo, Lang Hạ, Ba Dinh district[3]. Due to the relatively low $PM_{2.5}$ and CO content, the research team did not include it in this report.

Table 2. PM_{10} dust concentrations on surveyed Lang Ha-Giang Vo road (Duration: 8/2014- 9/2015)

Street	CO (mg/m^3)	PM_{10} (mg/m^3)	$PM_{2.5}$ (µg/m^3)
Lang Ha - Giang Vo	25.5	0.318	91.19
Nguyen Trai	22	0.366	101.63
VN Standard 05:2013/MONRE	30	0.15	50
dA(GV-LH)	**4.5**	**0.168**	**41.19**
dA (NT)	**8.0**	**0.216**	**51.63**

(Source: WB Project[3]: Consulting services for exposure and health effects for Hanoi (Package 01b/HP3The East-West Center (EWC), USA [Sub – Consultant: Institute ofnvironment Science and Public Health (IESH)]

3.2. Determination of change in population in Ba đinh district.

Determination of change in population is likely to be the impact of PM_{10} pollution and health risks in Ba Dinh District as folowing.

With ***population*** POP of Ba Dinh: 241,200 (According to Statistical Yearbook 2015).Population of Lang Ha - Giang Vo street approximately 11,200 (the approximate number base on of statistics of home and agencies along the way).

With the averadge PM_{10} is dA = 168 µg/m3

Change in mortality[1,2,3]

Change in mortality (Max) = $9.1x10^{-6}$ * 168 * 11200 = 17 cases of premature deaths

Change in mortality (Aver) = $6.72x10^{-6}$ * 168 * 11200 = 13 cases of premature deaths

Change in mortality (Min) = $4.47x10^{-6}$ * 168 * 11200 = 8 cases of premature deaths

The number of human deaths will decrease by an average of 13 cases if the PM_{10} in the air on Lang Ha – Giang Vo conformed to Vietnam standards. PM_{10} pollution levels. In Lang Ha – Giang Vo streed possibility every year about 8 cases in minimum and 17 cases in maximum of premature deaths.

Respiratory Hospital Admissions RHA [1.3.6.7]. Change RHA per 100,000 people:

Max = 1.56 * 168 µg/m^3 (change in PM_{10}) = 262 (per 100,000 people)

Average = 1.20 * 168 µg/m^3 (change in PM_{10}) = 202 (per 100,000 people)

Min = 0.657 * 168 µg/m^3 (change in PM_{10}) = 110 (per 100,000 people)

Change in total RHA = Change in RHA per 100.000 x (Population of Lang Ha - Giang Vo street/ 100.000)

Max = 262 * (14600 / 100.000) = 29 (cases)

Average= 202 * (14600 / 100.000) = 23 (cases)

Min = 110 * (14600 / 100.000) = 12 (cases)

Thus, there are an average of 23 cases of hospitalization due to diseases related to respiratory dust pollution.

Emergency Room Visits

Change in ERV per 100,000:

Max = 34.25 * 168 µg/m^3 (Change in PM_{10}) = 5754 (per 100,000)

Average = 23.54 * 168 µg/m^3 (Change in PM_{10}) = 3955 (per 100,000)

Min = 12.83 * 168 µg/m^3 (Change in PM_{10}) = 2155 (per 100,000)

Change in total RHA = Change in RHA per 100.000 x (Population of Lang Ha - Giang Vo street/ 100.000)

Max = 5754 * (11200 / 100000) = 644 (cases)

Average = 3955 * (11200 / 100000) = 443 (cases)

Min = 2155 * (11200 / 100000) = 241 (cases)

Thus, among the total number of people living and working in Lang Ha - Vo there are an average of nearly 443 emergency cases every year involving the respiratory tract caused by air pollution.

Restricted Activity Days- RAD

Change in RAD/person/year:

Max RAD/person/year = 0.0903 * dA = 0.0903 * 168 = 15.17 (days)

Average RAD/person/year = 0.0575 * dA = 0.0575 * 168 = 9.66 (days)

Min RAD/person/year = 0.0404 * dA = 0.0404 * 168 = 6.79 (days)

Total RAD = (Change in RAD/person/year) x (Population of Lang Ha - Giang Vo street)

Max = 19.50 * 11200 = 169,908 (days)

Aver = 12.42 * 11200 = 108,192 (days)

Min = 8.73 * 11200 = 76,017 (days)

Thus, there are an average number of about 100,000 working days lost every year due to the labor-related diseases respiratory tract.

3.3. The total value of economic damage, T_{EC}

Economic loss due to leave is calculated from the formula:

Σ Ti = Σ * number of off work days * 8 hours / day * Σ wages / hours

Σ number of off work days = Σ population * percent of adult * The number of restricted activity days * RRAD.

Index of Restricted activity days:

Δ RRAD/person/year = 0.0114 * current RRAD * dA (which RRAD = 3)

Factor 0.0114, RRAD = 3 are taken from statistics epidemiological

This calculation is only approximate, because of many different factors, causing various health effects and causing various diseases.

	GV-L H	NG-TRAI
Σ * number of off work days	11.000	18.000
Working time/day (hours)	8	8
Wage/hours (4usd/hour)	4	4
Population peoples	11.200	14.600
Index of Restricted activity days	3	3
Economic loss/person /year	94.285 (USD)	118.356(USD)

4. CONCLUTION

Being exposed to PM_{10} dust, these people will suffer respiratory diseases, have to quit their jobs and suffer not only health but also economic damage. The paper has tested the method of evaluating the economic losses of the most vulnerable objects in the air polluted by mobile emissions. Initial results show that these people have to pay between 95 and 119 USD / person / year due to exposure to PM_{10} dust. The calculations above are preliminary, much lower than the reality, but it is a known number of economic losses that can be calculated.

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