Available online at www.derpharmachemica.com

Scholars Research Library

Der Pharma Chemica, 2015, 7(10):563-565
(http://derpharmachemica.com/archive.html)

ISSN 0975-413X
CODEN (USA): PCHHAX

Estimating the value of health degradation caused by SO_2 gas air pollution in Jakarta

Sri Listyarini

Faculty of Mathematics and Natural Sciences - Universitas Terbuka
Jl. Cabe Raya, Pondok Cabe, Tangerang Selatan, Banten, Indonesia

---

ABSTRACT

The objective of this research is to estimate the value of health degradation triggered by sulfur dioxide (SO_2) gases that releases from fossil fuel burning to produce energy in Jakarta. The prediction of the price that has to be paid by the Jakarta population who exposured by SO_2 gases and get LRI (lower respiratory illnesses) and CDA (chest discomfort among adults) deseases, and premature mortality is done by dynamic simulation. The result of this research is by 2025 the Jakarta population who will have health degradation caused by the SO_2 should pay more than 147 million US$.

Key words: *CDA (chest discomfort among adults), LRI (lower respiratory illnesses), premature mortality, GRDP (Gross Regional Domestic Product), sulfur dioxide (SO_2) gas*

INTRODUCTION

Fossil fuel burning to produce energy emits air pollutants, such as sulfur dioxide (SO_2) gas. Ostro (1994) mention that the desease caused by SO_2 gas air pollution are lower respiratory illnesses (LRI) for children, chest discomfort among adults, and premature mortality [1]. This research objective is to estimate the value of population health degradation due to the SO_2 gas air pollution in Jakarta using dynamic simulation model.

MATERIALS AND METHODS

The development of dynamic simulation model has 3 steps. The first step is regresion analysis on the time series secondary data for: SO_2 ambient concentration, population, Gross Regional Domestic Product (GRDP), vehicles, fossil fuel, electricity, rain, and temperature. The result is regresion equation as mention by Listyarini [2]:

$$Ambient concentration of\ SO_2 = -0.0021753 + 2.0710\,population + 0.16040\,PDRB + 1.3461\,FossilFuel + 1.2540\,Electricity + 0.83158\,Rain \quad \text{.....(1)}$$

The second step of dynamic simulation model development is literature review to analyse the former researches. Olsthoorn *et al.* [3] mention that the ambient concentration of SO_2 gas will be transformed to sulfat concentration (part of *secondary* PM_{10}) in this equation:

$$[Sulfat] = 0{,}073/2612{,}24*[SO_2]^{0{,}57}*100/86 \quad \text{..... (2)}$$

where:
[Sulfat] = sulfat concentration ($\mu g.m^{-3}$)
[SO_2] = SO_2 concentration ($\mu g.m^{-3}$)
2612,24 = convertion factor of SO_2 concentration from ppm to $\mu g/m^3$

Not all Jakarta population will suffer by SO_2 gas air pollution, Ostro [1] assume that 12,6 % of Jakarta population who will have health degradation because of air pollution. Ostro [1] dan Syahril *et al.* [4] give these mathematical equations:

a. Premature Mortality:

$$NP(t) = 0{,}002*\left[\frac{SO_2(t) - SO_2st}{SO_2st}\right]*P(t)*CM(t) \ \ for\ SO_2(t) > SO_2st \quad \text{..... (3)}$$

where:
NP(t) : number of population who die prematurely caused by SO_2 gas air pollution in year t
SO_2(t) : SO_2 gas ambient concentration ($\mu g/m^3$) in year t
SO_2st : SO_2 ambient concentration standard
P(t) : the amount of population in year t
CM(t) : mortality rate = 0,0035 (BPS, Bappenas, and UNFPA Indonesia, 2005)
VOSL (*Value of Statistical Life*) mention by Susandi [5] is US$144.000.

b. LRI (lower respiratory illnesses) in children:

$$NLRI(t) = 0{,}0001*\left[\frac{SO_2(t) - SO_2st}{SO_2st}\right]*\Pr C(t)*P(t)\ for\ SO_2(t) > SO_2st \quad \text{..... (4)}$$

where:
NLRI(t) : number of population who has LRI desease by the year t
PrC(t) : percentage or proportion of children under 14 years = 26,9% [6].

c. CDA (chest discomfort among adults):

$$NCDA(t) = 0{,}00005*\left[\frac{SO_2(t) - SO_2st}{SO_2st}\right]*\Pr A(t)*P(t)\ for\ SO_2(t) > SO_2st \quad \text{.. (5)}$$

where:
NCDA(t) : number of population who has CDA desease by the year t
PrA(t) : percentage or proportion of adult = 73,1% [6].

The third step of the development of model simulation in this research is to input all of the equations and variables from the first step and the second step in the stock-flow diagram (Figure 1). The existing condition data that are inputted to the stock-flow diagram are Jakarta condition in 2013 obtained from BPS [7].

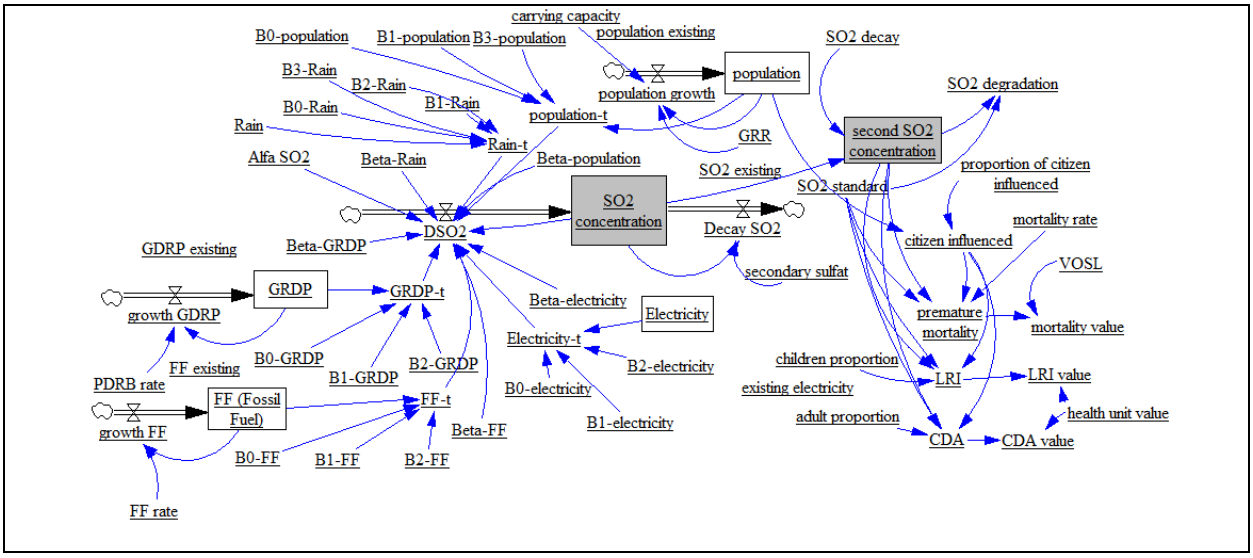

Figure 1. Stock-Flow Diagram of SO_2 Gas Air Pollution

RESULTS AND DISCUSSION

The dynamic simulation results represent that ambient concentration of SO_2 gas that above the standard started in 2019, that caused 18 children suffering from LRI desease, 25 persons suffering from CDA, and five person die prematurely. The value of those health degradation in 2019 is 936,155 US$. If this condition stay as bussiness as usual, and there is no effort to reduce the concentration of SO_2 gas air pollution, it is estimated that by 2025 there will be 2,837 children will suffer from LRI desease, 3,854 persons will suffer from CDA, and 738 person die prematurely. The total price for the health degradation caused by SO_2 gas air pollution will be 147,785,456 US$ by 2025.

One of this research result is that the ambient concentration of SO_2 gas depend on the rain and some the antrophogenic factors such as: population, GRDP, fossil fuel consumed, and electricity production. These antrophogenic factors can be managed by developing the public policies to reduce the concentration of SO_2 gas air pollution.

CONCLUSION

By 2025 it is estimated that the price of health degradation caused by SO2 gas air pollution that should be paid by Jakarta population will be 147,785,456 US$. The public policies developed by Jakarta Government should be complied by Jakarta population to maintain their health.

REFERENCES

[1]B. Ostro, *Estimating the health effects of air pollutans: A method with an application to Jakarta*, 1994, downloaded Oct, 15, **2015** from: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1994/05/01/000009265_3970716141007/Rendered/PDF/multi0page.pdf.
[2]S. Listyarini,, *Jurnal Sains dan Teknologi SIGMA*, **2009**, 12, 2, 103-115.
[3]X. Olsthoorn, M. Amann, A. Bartonova, J. Clench-Aas, J. Cofala, K. Dorland, C. Guerreiro, J.F. Henriksen, H. Jansen, and S. Larssen, *Environmental and Resource Economics*, **1999**, 14, 333-351.
[4]S. Syahril, B.P. Resosudarmo, and H.S. Tomo, *Study on air quality in Jakarta, Indonesia: Future trends, health impacts, economic value and policy options*, ADB, **2002**.
[5]A. Susandi, *The impact of international greenhouse gas emissions reduction on Indonesia*. Hamburg: Reports on Earth System Science, **2004**, downloaded Oct, 15, **2015** from: http://pubman.mpdl.mpg.de/pubman/item/escidoc:995064:1/component/escidoc:995063/BzE_4.pdf.
[6]Badan Pusat Statistik [BPS], Badan Perencanaan Pembangunan Nasional [Bappenas], *United Nations Populations Fund* [UNFPA], *Proyeksi Penduduk Indonesia **2000-2025***, BPS, Bappenas, dan UNFPA Indonesia, Jakarta, **2005**.
[7]BPS-Statistics of DKI Jakarta Province, *Jakarta in Figures*, BPS, Jakarta, **2014**.