UNIVERSITI PUTRA MALAYSIA

PREDICTING SULPHUR DIOXIDE DISPERSION FROM MULTIPLE SOURCES IN MAJOR CITIES IN KLANG VALLEY, MALAYSIA USING INTEGRATED MM5-SMOKE-CMAQ MODEL SYSTEM

CHNG LOI KOK

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By

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Faculty : Environmental Studies

The emission of sulphur dioxide has increased along with the industrialization and urbanization which become the public's major concern. It is well known as the precursor of acid precipitation, which could bring negative impacts on the environment and human health. It is important to have a reliable estimation of sulphur dioxide emissions in order to formulate effective strategies for mitigation purposes. Hence, emission source estimation and air quality assessment using air quality modeling system becomes essential in the process of developing an

appropriate air quality plans. The goal of the study will be focused on the relationship between pollution emission changes and the meteorological condition thus affecting the air quality in the

study area. The primary objectives of the study is to establish an emission inventory from different types of sources in Klang Valley, to simulate meteorological and dispersion of sulphur dioxide in Klang Valley region using integrated model MM5-SMOKE-CMAQ, and evaluate the performance of the model. Simulation on the meteorology condition using Fifth Generation Mesoscale Model (MM5) was carried out and emission inventory was simulated using Sparse

Matrix Operational Kernel Emission (SMOKE) model. The meteorological profiles from MM5 and

emission data from SMOKE model were used to simulate the dispersion of sulphur dioxide using

Community Multiscale Air Quality (CMAQ). The evaluation of CMAQ model revealed that the model performed better in 12-hour averaged sulphur dioxide concentration with high correlation value of 0.87 and low RMSE of 1.87E-03 ppmv. These results justify the use of integrated model MM5-SMOKE-CMAQ modeling system in the Klang Valley region which has complex terrain and land use. The model showed maximum SO_2 concentration (0.041ppmv) was located at Shah Alam industrial zone, followed by Klang industrial zone and other cities such as Kajang, Petaling, Gombak and Cheras showed relative low SO_2 concentration. The model also showed that the highest level of sulfur dioxide was well below the guideline recommended by DOE (0.14ppmv).

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai keperluan untuk ijazah Master Sains

RAMALAN PENYEBARAN SULFUR DIOKSIDA DARI BERBILANG SUMBER PERLEPASAN DI BANDAR-BANDAR UTAMA SEKITAR LEMBAH KLANG, MALAYSIA DENGAN MENGGUNAKAN SISTEM INTEGRASI MODEL MM5-SMOKE-CMAQ.

Oleh

CHNG LOI KOK

Mac 2011

Pengerusi : Profesor Madya Ahmad Makmom Hj. Abdullah, PhD

Fakulti : Pengajian Alam Sekitar

Perlepasan sulfur dioksida yang meningkat seiring dengan perindustrian dan urbanisasi telah menjadi perhatian utama di kalangan masyarakat. Ia juga dikenali sebagai punca utama kepada pembentukan hujan asid yang akan membawa impak negatif kepada alam sekitar dan kesihatan manusia. Peramalan punca perlepasan sulfur dioksida adalah sangat penting untuk merangka strategik bagi tujuan mitigasi. Oleh itu, peramalan punca perlepasan dan penilaian kualiti udara dengan menggunakan pemodelan kualiti udara menjadi sangat penting dalam pembentukan pelan kualiti udara. Walaubagaimanapun, inventori punca pelepasan yang beresolusi tinggi masih tidak didapati di Malaysia. Kajian lepas yang berkenaan dengan inventori punca pelepasan mempunyai resolusi yang rendah dan tidak dapat digunaakan dalam kajian peyebaran sulfur dioksida. Kajian ini akan fokus dalam perhubungan antara perubahan pelepasan pencemar dan keadaan meteorologi maka mempengaruhi kualiti udara di sekitar tempat kajian. Objektif utama kajian ini adalah untuk menyediakan satu inventori punca pelepasan dari pelbagai sumber di

Lembah Klang; bagi meramal keadaan meteorologi dan penyebaran sulfur dioksida di sekitar Lembah Klang dengan menggunakan integrasi model MM5-SMOKE-CMAQ; dan menilai prestasi model tersebut. Data Meteorologi data dari MM5 dan pelepasan data dari SMOKE telah digunakan bagi meramal penyebaran sulfur dioxide dengan menggunakan CMAQ. Penilaian CMAQ model menunjukan model tersebut beroperasi baik dengan data purata 12 jam. Penilai tersebut memberi nilai tinggi dalam kolerasi iaitu 0.87 dan RMSE yang rendah iaitu 1.87E-03 ppmv. Hasil kajian ini menunjukan integrasi model MM5-SMOKE-CMAQ adalah sesuai digunakan di Lembah Klang yang mempunyai dataran dan guna tanah yang kompleks. Model ini menunjukkan bahawa tahap maksima sulfur dioksida (0.041ppmv) berada di kawasan industri Shah Alam diikuti dengan kawasan industri Klang, manakala Kajang, Petaling, Gombak dan Cheras menunjukkan tahap sulfur dioksida yang rendah. Model ini juga menunjukkan bahawa tahap sulfur dioksida di sekitar Lembah Klang adalah dibawah tahap yang ditetapkan oleh Jabatan Alam Sekitar iaitu 0.14ppmv.

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I certify that an Examination Committee has met on 24 Mac 2011 to conduct the final examination of Chng Loi Kok on his thesis entitled "Predicting Sulphur Dioxide Dispersion from Multiple Sources in Major Cities in Klang Valley, Malaysia using Integrated MM5-SMOKE-CMAQ Model System" in accordance with Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the candidate be awarded the Master of Science.
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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Master of Science**. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotation and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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CHNG LOI KOK

Date: 24 March 2011

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