UNIVERSITI PUTRA MALAYSIA

PREDICTION OF AIR POLLUTION OF AHWAZ CITY BY IMPROVING ENERGY EFFICIENCY

MAHMOUD JAVADZADEH

FPAS 2014 1

PREDICTION OF AIR POLLUTION OF AHWAZ CITY BY IMPROVING ENERGY EFFICIENCY

By

MAHMOUD JAVADZADEH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Doctor of Philosophy

July 2014

COPYRIGHT

DEDICATION

This dissertation is dedicated to all members of my family. A special dedication to my beloved wife, who I love from the bottom of my heart and to my loving sons Mahyar and Mehdi, who have been a constant source of encouragement and support to me during this study. My dear late father Ahmad, my mother, and my wife's parents dear Hassan, my dear late wife's mother (peace be upon her) and also respected and loving brothers of my wife who I love the most.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the Degree of Doctor of Philosophy

PREDICTION OF AIR POLLUTION OF AHWAZ CITY BY IMPROVING ENERGY EFFICIENCY

By

MAHMOUD JAVADZADEH

July 2014

Chairman: Associate Professor Ahmad Makmom Hj. Abdullah, PhD

Faculty: Environmental Studies

Since the development of industries, vehicles and the people in the cities and their suburban areas, carbon monoxide, sulfur dioxide, nitrogen dioxide and some other pollutants have been increasing. This study has been conducted to predict the air pollution, utilizing model of atmospheric pollutant dispersion for a large city of Ahwaz, with regard to land use, the amount of pollutants released from point, area and line sources, subsequently integrated mesoscale model was used to predict the dispersion and concentration of the air pollutants.

The main purpose of the study was to determine the dispersion factors and the meteorological condition which cause the air to be polluted over the study area. To achieve the main goal of the study, establishment of the emission inventory, meteorological simulation and (CO), (NO, NO_2) and SO_2 dispersions sources in the Ahwaz city regions by using the WRF CAMx and evaluation of the model performance were done. The mean difference between prediction and observed data was obtained by Root Mean Square Error (RMSE) and the Peak results are as follow: SO_2, 75 ppb, NO_2, 100 ppb, NO, 85 ppb and CO, 40 ppb.

A comparison of the observed peaks from the air pollution measurement stations at ground level, and the results of WRF / CAMx model show the error of the peaks is less than 30%, which this percentage indicates that input data to the model and to the real data are close to each other. Normalized error was ±20% and normalized bias was between -15% to +15%, this amount for the air pollution models are acceptable. Also, the BIAS ERROR calculates the relationship coefficient between the simulated prediction and actual data. The results showed that the Zergan Power Plant has more effect over the North East part of the Ahwaz city than the Ramin Power Plant, due to distances and the wind direction characteristics and that the pollutants concentration is equally related to emitted pollutants from their own sources. The Ahwaz city line sources have the most effect on the central city, concerning the four pollutants. It can be concluded that the concentration of SO_2 and $NO_2$are higher than the NAAQS (National Ambient Air Quality Standards) value for SO_2 (75 ppb) and NO2 (100 ppb) and other pollutants level are within the limit.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai keperluan untuk Ijazah Doktor Falsafah.

KAWALAN PENCEMARAN UDARA DI BANDAR AHWAZ DENGAN MENINGKATKAN KECEKAPAN TENAGA

Oleh

MAHMOUD JAVADZADEH

Julai 2014

Pengerusi: Profesor Madya Ahmad Makmom Hj. Abdullah, PhD

Fakulti: Pengajian Alam Sekitar

Kepesatan pembangunan industri, kenderaan dan penduduk di kawasan bandar dan luar bandar telah mencatatkan peningkatan dalam paras karbon monoksida (CO), sulfur dioksida (SO_2), nitrogen oksida (NO,NO_2) serta pencemar-pencemar lain. Kajian ini telah dijalankan adalah untuk meramal pencemaran udara disamping menggunakan model penyerakan pencemar atmosferik untuk bandar besar Ahwaz dengan merujuk kepada penggunaan tanah, jumlah pencemar yang dilepaskan dari punca, kawasan, dan punca selari yang kemudiannya menggunakan model pencantuman skalameso untuk meramal penyerakan serta kepekatan pencemar pencemar udara.

Tujuan utama kajian ini adalah untuk menentukan faktor-faktor penyerakan dan keadaan meteorologi yang menyebabkan udara di sekitar kawasan kajian dicemari. Untuk mencapai sasaran utama kajian ini, penubuhan inventori pelepasan, simulasi meteorologi dan sumber penyerakan CO, NO, NO_2, dan SO_2 di kawasan bandar Ahwaz telah dilakukan dengan menggunakan WRF-CAMx berserta penilaian kecekapan model.

Perbezaan min di antara data ramalan dan data pemerhatian diperolehi melalui Root Mean Square Error (RMSE) dan keputusan puncak adalah seperti berikut: SO_2, 75 ppb, NO_2, 100 ppb, NO, 85 ppb dan CO, 40 ppb. Perbandingan puncak yang diperhati daripada stesen pengukuran pencemaran udara di paras bumi, dan keputusan daripada model WRF/CAMx menunjukkan ralat pada puncak adalah kurang daripada 30% dimana peratusan ini menunjukkan bahawa data input dan data sebenar adalah hampir antara satu sama lain. Ralat nomal adalah ±20% dan kecondongan normal adalah antara -15% hingga +15% di mana amaun dari model pencemaran udara boleh diterima. Disamping itu, ralat kecondongan bertujuan untuk mengira hubungan pekali antara ramalan simulasi dengan data sebenar.

Keputusan menunjukkan bahawa Pusat Janakuasa Zergan memberi lebih kesan kepada bahagian Timur Laut bandar Ahwaz daripada Pusat Janakuasa Ramin disebabkan jarak, ciri-ciri arah angin dan kepekatan pencemar adalah berkadar

langsung dengan pencemar yang dilepaskan daripada sumbernya. Sumber-sumber selari di bandar Ahwaz mempunyai kesan besar kepada pusat bandar di mana empat jenis pencemar dijadikan tumpuan. Kesimpulannya, kepekatan SO_2 dan NO_2 adalah lebih tinggi berbanding Piawaian Kualiti Udara Ambien Nasional (NAAQS) iaitu nilai SO_2 (75 ppb), NO_2 (100 ppb) dan lain-lain pencemar adalah dalam lingkungan julat.

ACKNOWLEDGEMENTS

I like to thank, first and foremost, Allah and the God's messenger, our Prophet Mohammad (Peace be upon him) for the opportunity to take on his challenge. Thank the God for providing me strength, talents, tools and special people that aided me in the completion of this task.

I wish to express my sincere appreciation to my dearest supervisor, Prof. Dr. Ahmad Makmom Hj Abdullah for his assistance, guidance and encouragement through this study. Thank you for long hours that you dedicated to this script, for helping me to achieve the best. Your support is greatly respected.

I, also, would like to thank my advisory committee, Prof. Dr. Azizi Muda, Prof. Dr. Mohammad Firuz Ramli and Prof. Dr. Bahram Dabir for being very supportive and helpful during the work process of this thesis. And I would like to thank all other lecturers who have taught me during their class sessions.

I would like to appreciate the chairman, engineers Mr. Karimi , Ms. Khaksar, Zargaran, Mr. Ranjbar and all of the employees of the DOE of the Ahwaz city and engineer Mr. Gholizadeh dean of DOE of Dezful city and all of his co-workers, Police department of Ahwaz city ,all my university colleagues ,friends and all the people who helped and prayed for me to do my PhD thesis.

Last but not least, I wish to express my great appreciation to the love of my life (my wife), I remember the time I received the Offer Letter, we made a discussion together and you accepted the responsibility of our dearest sons, Mahyar and Mehdi while I am away and thank you, you did a great job on that, you have done your accepted responsibility very well, God bless you.

Therefore, my dear wife I am so thankful for your support and being so patient over years. Without the God's help, you and the people who I mentioned above, I could not complete this hard work that I have done.

I certify that a Thesis Examination Committee has met on 18 July 2014 to conduct the final examination of Mahmoud Javadzadeh on his thesis entitled "Prediction of Air Pollution of Ahwaz City by Improving Energy Efficiency" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Mohamad Pauzi bin Zakaria, PhD
Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Nor Mariah binti Adam, PhD
Associate Professor Ir.
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Luqman Chuah Abdullah, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Jao-Jia Horng, PhD
Professor
National Yunlin University of Science and Technology
Taiwan
(External Examiner)

NORITAH OMAR, PhD
Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 19 September 2014

This thesis was submitted to the Senate of the University Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Ahmad Makmom Hj Abdullah-PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Azizi bin Muda-PhD
Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Member)

Mohammad Firuz b. Ramli - PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Member)

Bahram Dabir- PhD
Professor
Faculty of Chemical Engineering
Amir Kabir University of Technology
(External Member)

_____

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

Declaration by the student

I hereby confirm that:

- this thesis is my original work
- quotations, illustrations and citations have been duly referenced
- the thesis has not been submitted previously or comcurrently for any other degree at any institutions
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be owned from supervisor and deputy vice –chancellor (Research and innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software

Signature: _____ Date: _____

Name and Matric No. : Mahmoud Javadzadeh (22276)

Declaration by Members of Supervisory committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

Signature : _____
Name of Chairman of Supervisory Committee : Ahmad Makmom Hj Abdullah-PhD

Signature : _____
Name of Member of Supervisory Committee : Azizi bin Muda-PhD

Signature : _____
Name of Member of Supervisory Committee : Mohammad Firuz b. Ramli - PhD

Signature : _____
Name of Member of Supervisory Committee : Bahram Dabir- PhD

TABLE OF CONTENTS