UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF AN EXPERT SYSTEM FOR PREDICTING THE EFFECTS OF ECONOMIC ACTIVITIES ON GROUNDWATER QUALITY

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By

MONGKON TA-OUN

Thesis Submitted in Fulfilment of the Requirement for
the Degree of Doctor of Philosophy in the Faculty of Engineering
Universiti Putra Malaysia

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I dedicate this work to my parents and my family
with great appreciation for their understanding and encouragement
which have been a constant source of inspiration to me

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

DEVELOPMENT OF AN EXPERT SYSTEM FOR PREDICTING THE EFFECTS OF ECONOMIC ACTIVITIES ON GROUNDWATER QUALITY

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July 2000

Chairman: **Associate Professor Mohamed Daud, Ph. D., P. Eng.**

Faculty: **Engineering**

Presently, groundwater conservation has become a very important issue in the world. The attention has been given to groundwater pollution problems. The application of Information Technology (IT) in the form of an expert system namely GWPES (Groundwater Pollution Expert System) will be able to help in information retrieval and decision support when dealing with groundwater pollution and protection. The rule base and Graphic User Interface (GUI) of GWPES was developed using wxCLIPS version 1.62 for Personal Computer (PC), version 1.49 for Local Area Network (LAN) system and Authorware 3.5 for developing graphic presentation files. These application softwares also supported the GWPES for the interpretation of some knowledge data bases. The wxCLIPS expert system shell was originally designed by NASA (National Aeronautics and Space Administration). The rules were developed according to the comprehensive groundwater pollution information and Environmental Impact Assessment (EIA) procedure. The main menu of GWPES consists of six main parts as follows; Introduction, EIA Procedure, Concept,

Prediction, Mitigation and Monitoring. The first three parts help all interested people related to EIA to understand groundwater pollution information and EIA procedure. The next three main parts have been incorporated into an expert system to predict future situation of groundwater [Pollution Vulnerability, Nitrogen Fertiliser Impact and Project Activities Impact], and to propose possible mitigation measures as well as to approach groundwater quality-monitoring plan. Knowledge bases for GWPES have been elicited from domain experts (2 geologists, 1 hydrologist, 1 civil engineering majoring in groundwater, 2 soil scientists and 1 soil & water engineering expert) through interviews, existing established literature, EIA reports and field study. The GWPES has friendly graphical user interface that has been accepted satisfactorily by external domain experts and end-users.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi syarat keperluan untuk ijazah Doktor Falsafah

PEMBENTUKAN SATU SISTEM PAKAR UNTUK MERAMAL KESAN AKTIVITI EKONOMI TERHADAP KUALITI AIR BAWAH TANAH

Oleh

MONGKON TA-OUN

Julai 2000

Pengerusi: **Profesor Madya Mohamed Daud, Ph. D., P.Eng.**
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Pada masa ini, pemulihanan air tanah telah menjadi satu isu penting di dunia. Perhatian telah diberikepada masalah pencemaran air tanah. Aplikasi teknologi maklumat (TM) dalam bentuk sistem kepakaran seperti GWPES a berkebolehan membantu pengurusan semula maklumat dan menampung daya keputusan apabila menyentuh perihal pencemaran air bawah tanah. Asas-asas pergetahuan dan penggunaan GUI di dalam GWPES telah dibangunkan dengan menggunakan wxCLIPS versi 1.62 bagi komputer peribadi; versi 1.49 bagi sistem LAN dan Authouwde 3.5; di mana fail dipaparkan secara grafik bagi menampung sistem berkenaan untuk menginterpretasi sesetengah pengetahuan asas di dalam sistem kepakaran wxCLIPS (rekabentuk oleh NASA). Peraturan-peraturan dibentuk berdasarkan kefahaman maklumat pencemaran air bawah tanah dan prosedur EIA. Enam faktor yang ditekankan di dalam GWPES adalah: Pengenalan, Prosedur EIA, Konsep, Ramalan, Mitigasi dan Pemantauan. Tiga fakta pertama membantu mereka yang berminat mengenai EIA bagi memahami prosedur EIA dan maklumat

pencemaran air bawah tanah. Tiga fakta selepasnya akan digabungkan ke dalam sistem kepakaran untuk: 1. meramal situasi air bawah tanah pada masa hadapan; 2. mencadang ukuran mitigasi yang berkemungkinan, dan 3 untuk pendekatan plan kualiti air bawah tanah. Asas pengetahuan GWPES diambil dari pakar-pakar bidang (2 ahli geologi, 1 ahli hidrologi, 1 jurutera civil major air bawah tanah, 2 saintis tanah dan 1 jurutera air dan tanah) melalui temubual, kajian bahan bertulis sedia ada, laporan EIA dan kajian ujian di lapangan. Oleh kerana GWPES dilengkapi dengan GUI bersifat mesraguna, ramai di antara pakar bidang luaran dan pengguna terkini berpuas hati dengan sistem berkenaan.

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I certify that an Examination Committee met on 25th July 2000, to conduct the final examination of Mongkon Ta-oun, on his Doctor of Philosophy thesis entitled "Development of an Expert System for Predicting the Effects of Economic Activities on Groundwater Quality" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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Date: 15 AUG 2000

This thesis was submitted to the Senate of Universiti Putra Malaysia and was accepted as fulfilment of the requirements for degree of Doctor of Philosophy.

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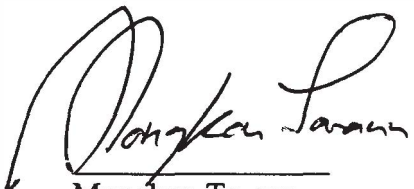
I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



Mongkon Ta-oun

Date: 15/8/2000

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