UNIVERSITI PUTRA MALAYSIA

MODELING OF SALT WATER INTRUSIONS INTO LANGAT RIVER ESTUARY, MALAYSIA

NORHABINA ABD ARIS

FPAS 2012 19
MODELING OF SALT WATER INTRUSIONS INTO LANGAT RIVER ESTUARY, MALAYSIA

By

NORHABINA ABD ARIS

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

August 2012
COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

MODELING OF SALT WATER INTRUSIONS INTO LANGAT RIVER ESTUARY, MALAYSIA

By

NORHABINA ABD ARIS

August 2012

Chairman: Associate Professor Zelina Zaiton Ibrahim, PhD
Faculty: Environmental Studies

This study used one-dimensional model approach to determine salt water intrusion of Langat River. The objective of the study is to produce a methodology for rapid assessment of the impact water abstraction on the saline intrusion in the Langat River. The first step is to produce a simple model of saline intrusion in estuaries and evaluate the impact of water abstraction from river, based on resulting salinity intrusion model.

The sampling measurement has been taken during intermediate, neap and spring tide at high and low water. These observation was then applied the one dimensional saline intrusion model which has been proposed by Ippen and Harleman (1961) to predict future saline intrusion length using best fit line analysis. The study found that saline water intruded further to the upstream up to 28.29 km during spring tide at high water compare to 13.85 km during intermediate at low water. The river water stratification layer has been determined using Ippen and Harleman (1961) approach. The study revealed that the Langat River behavior ranged from partially-mixed to well-mixed estuary. There are different values of diffusion coefficients, \( D_o \) for every tide conditions which ranged from 495 to 3219. Hydrological analysis such as return period and 7-days low flow also has been carried out in this study. From this study, one dimensional model has predicted saline will intrude further upstream up to 55 km with instantaneous salinity distribution, \( s/s_o = 0.20 \) on year 2020. This model was suitable to predict saline intrusion length during intermediate tide using best fit line analysis.

This study found that the amount water left in the river for year 2020 will be less than year 2004 due to higher water demand with 259% increase in population. Rise of water abstraction from the river may affect to saline water intrude to further to the upstream and affect the quality of drinking water. Therefore the rate of salt water intrusion should also be taken into account in decision-making, particularly for water resource of water supply.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sain

MODEL PENCEROBOHAN AIR MASIN KE ATAS MUARA SUNGAI LANGAT, MALAYSIA

Oleh

NORHABINA ABD ARIS

Ogos 2012

Pengerusi: Professor Madya Zelina Zaiton Ibrahim, PhD

Fakulti: Pengajian Alam Sekitar

Kajian ini telah menggunakan pendekatan model penceroohan air masin 1-dimensi bagi Sungai Langat. Objektif kajian ini adalah untuk menghasilkan kaedah penilaian pantas ke atas impak pengambilan air terhadap penceroohan air masin di Sungai Langat. Langkah pertama adalah untuk menghasilkan model penceroohan air masin yang ringkas di muara dan menilai kesan impak pengambilan air dari sungai berdasarkan model penceroohan air masin.


Kajian mendapati jumlah minimum air dalam sungai bagi tahun 2020 akan berkurangan berbanding tahun 2004 berikut peningkatan permintaan penggunaan air selari dengan peningkatan nisbah penduduk sebanyak 259%. Peningkatan pengambilan air dari sungai akan memberi kesan terhadap kemasukan air masin lebih jauh ke hulu dan memberi
kesan ke atas kualiti air minuman. Oleh yang demikian, kadar kemasukan air masin juga perlu diambilkira dalam membuat keputusan sumber air terutamanya untuk bekalan air.
ACKNOWLEDGEMENTS

First and foremost I would like to thank Associate Professor Dr. Zelina Zaiton Ibrahim for her guidance and encouragement throughout this study. I am also thank for all my supervisory committee, Associate Professor Dr Wan Nor Azmin Sulaiman and Ir. Tuan Haji Ahmad Jamaluddin Shaaban for guidance and support.

Also thankful to the support staff who was involved directly and indirectly in this study especially during the field work at the Langat River. The related government agencies that involved in this study was the Department of Irrigation (DID) at Ampang, Department of Irrigation and Drainage (DID) at Kuala Lumpur, Department of Agriculture, Department of Environment (DOE), Majlis Daerah Kuala Langat, Pejabat Daerah Kuala Langat, Persatuan Nelayan Kawasan Kuala Selangor (PNKKS), National Hydraulic Research Institute of Malaysia (NAHRIM), Jabatan Pemetaan Malaysia (JUPEM), Puncak Niaga Sdn. Bhd., Syarikat Bekalan Air Selangor (SYABAS) and Malaysia Nature Society (MNS).

This study has been sponsored by IRPA Project with vot number: 54295, under Ministry of Science, Technology and Innovation (MOSTI). In this opportunity, I would like to thank my lovely family as a backbone and support always given to me along this study. This study cannot be done with all the support given during my study.
I certify that a Thesis Examination Committee met on 14 August 2012 to conduct the final examination of Norhabina Binti Abd Aris on her thesis entitled “Modeling of Salt Water Intrusions into Langat River Estuary, Malaysia” in accordance with the Universities and Universities 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 Master Science.

Members of Thesis Examination Committee were as follows:

Latifah binti Abd Manaf, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Ahmad Makmom bin Abdulah, Ph.D.
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Internal Examiner)

Shaharin bin Ibrahim, Ph.D.
Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Internal Examiner)

Rosnan bin Hj Yaacob, PhD
Associate Professor
Kolej Universiti Sains dan Teknologi Malaysia
Malaysia
(External Examiner)

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

Date: 23 June 2014
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 are as follows:

**Zelina Zaiton Ibrahim, PhD**  
Professor  
Faculty of Environmental Studies  
Universiti Putra Malaysia  
(Chairman)

**Wan Nor Azmin Sulaiman, PhD**  
Professor  
Faculty of Environmental Studies  
Universiti Putra Malaysia  
(Member)

**Datuk Ir. Hj. Ahmad Jamalluddin Shaaban**  
National Hydraulic Institute of Malaysia (NAHRIM)  
(Member)

---

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

Date:
DECLARATION

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other 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 2102;
- written permission must be obtained from supervisor and the office of 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.: NORHABINA BINTI ABD ARIS GS 12965
Declaration by Members of Supervisory Committee

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

Signature: __________________________  Signature: __________________________
Name of Chairman of
cSupervisory Committee: Associate Professor Zelina Zaiton Ibrahim, PhD
Name of Member of Supervisory Committee: Associate Professor Wan Nor Azmin Sulaiman, PhD

Signature: __________________________
Name of Member of Supervisory Committee: Datuk Ir. Hj Ahmad Jamalluddin Shaaban
TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>ii</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>v</td>
</tr>
<tr>
<td>APPROVAL</td>
<td>vi</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xv</td>
</tr>
<tr>
<td>LIST OF EQUATIONS</td>
<td>xvii</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>1 INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>1.1 Water Demand and Supply</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Objective of Study</td>
<td>2</td>
</tr>
<tr>
<td>1.3 Scope of Study</td>
<td>2</td>
</tr>
<tr>
<td>1.4 Significance of Study</td>
<td>2</td>
</tr>
<tr>
<td>2 LITERATURE REVIEW</td>
<td></td>
</tr>
<tr>
<td>2.1 Water Resources Management</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Water Demand and Supply</td>
<td>5</td>
</tr>
<tr>
<td>2.3 Hydrological Analysis</td>
<td>7</td>
</tr>
<tr>
<td>2.3.1 Return Period</td>
<td>7</td>
</tr>
<tr>
<td>2.3.2 7-days Low Flow</td>
<td>8</td>
</tr>
<tr>
<td>2.4 Estuaries</td>
<td>12</td>
</tr>
<tr>
<td>2.4.1 Classification of Estuaries</td>
<td>12</td>
</tr>
<tr>
<td>2.5 Saline Intrusion</td>
<td>14</td>
</tr>
<tr>
<td>2.5.1 Salinity</td>
<td>16</td>
</tr>
<tr>
<td>2.5.2 Tide Range</td>
<td>17</td>
</tr>
<tr>
<td>2.5.3 Discharge</td>
<td>17</td>
</tr>
<tr>
<td>2.6 Ecological Impact</td>
<td>18</td>
</tr>
<tr>
<td>3 METHODOLOGY</td>
<td></td>
</tr>
<tr>
<td>3.1 Study Area</td>
<td>20</td>
</tr>
<tr>
<td>3.2 Return Period Analysis</td>
<td>22</td>
</tr>
<tr>
<td>3.3 7-days Low Flow</td>
<td>24</td>
</tr>
<tr>
<td>3.4 Salinity Measurement</td>
<td>30</td>
</tr>
<tr>
<td>3.5 Classification of estuary</td>
<td>39</td>
</tr>
<tr>
<td>3.6 Saline Intrusion Model</td>
<td>41</td>
</tr>
<tr>
<td>3.7 Saline Intrusion Model by Ippen and Harleman 1961</td>
<td>42</td>
</tr>
</tbody>
</table>
3.7.1 Salinity Distribution at Low tide (Quasi-steady state) 44
3.7.2 Variation of the Diffusion Coefficient Along the channel 45
3.7.3 Instantaneous Salinity Distributions 46

4 RESULTS AND DISCUSSIONS
4.1 Estuary 48
4.2 Return Period Analysis 56
4.3 7-days Low Flow 61
4.4 Observation 63
4.5 Model Calibration and Prediction 64

5 CONCLUSION

REFERENCES 80
BIODATA OF STUDENT 83
LIST OF PUBLICATIONS 84