THE DEVELOPMENT OF ISOHYET MAP FOR PAHANG STATE USING KRINGING METHOD

ATHIRAH BINTI ZULKIFLI

B.ENG (HONS.) CIVIL ENGINEERING
UNIVERSITI MALAYSIA PAHANG
UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS / UNDERGRADUATE PROJECT PAPER AND COPYRIGHT

Author’s full name: ATHIRAH BINTI ZULKIFLI
Date of birth: 12th MAY 1992
Title: THE DEVELOPMENT OF ISOHYET MAP FOR PAHANG STATE USING KRIGING METHOD
Academic Session: 2015/2016

I declare that this thesis is classified as:

☐ CONFIDENTIAL (Contains confidential information under the Official Secret Act 1972)*
☐ RESTRICTED (Contains restricted information as specified by the organization where research was done)*
✅ OPEN ACCESS I agree that my thesis to be published as online open access (full text)

I acknowledged that University Malaysia Pahang reserves the right as follows:

1. The thesis is the property of University Malaysia Pahang.
2. The Library of University Malaysia Pahang has the right to make copies for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

_________________________  ______________________________
(SIGNATURE)  (SIGNATURE OF SUPERVISOR)

(920512-06-5484)  (NORASMAN BIN OTHMAN)

Date: JUNE 2016  Date: JUNE 2016

NOTES:  *If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or Restriction
THE DEVELOPMENT OF ISOHYET MAP FOR PAHANG STATE USING KRIGING METHOD

ATHIRAH BINTI ZULKIFLI

Thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor (Hons.) of Civil Engineering

Faculty of Civil Engineering and Earth Resource
UNIVERSITI MALAYSIA PAHANG

JUNE 2016
SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor (Hons.) of Civil Engineering.

Signature :  
Name of Supervisor : EN. NORASMAN BIN OTHMAN
Position : LECTURER
Date : JUNE 2016

Signature :  
Name of Co-Supervisor : PN. SHAIRUL ROHAZIAWATI BINTI SAMAT
Position : LECTURER
Date : JUNE 2016
STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award for other degree.

Signature: ________________________________
Name: ATHIRAH BINTI ZULKIFLI
ID Number: AA12216
Date: JUNE 2016
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPERVISOR’S DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>STUDENT’S DECLARATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vii</td>
</tr>
<tr>
<td>TABLE OF CONTENT</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xiii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiv</td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td>xvi</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xviii</td>
</tr>
</tbody>
</table>

## CHAPTER 1       INTRODUCTION

1.1 General 1
1.2 Problem Statement 3
1.3 Objective of the Study 4
1.4 Scope of Study 4
1.5 Significant of study 4
CHAPTER 2 LITERATURE REVIEW

2.1 Introduction 6

2.2 Hydrological Cycle 7

2.3 Forms of Precipitation 8

2.4 Type of Precipitation 9
   2.4.1 Cyclonic Precipitation 9
   2.4.2 Convective Precipitation 11
   2.4.3 Orographic Precipitation 11

2.5 Types of Raingauges 12
   2.5.1 Non-recording Gage 12
   2.5.2 Recording or Automatic Raingauge 13

2.6 Estimating Missing Data 16
   2.6.1 Simple Arithmetic Average 17
   2.6.2 Normal Ratio Method 17
   2.6.3 Modified Normal Ratio Method 17
   2.6.4 Inverse Distance Method 18

2.7 Estimating of Mean Areal Rainfall 18
   2.7.1 Arithmetic Average Method 19
   2.7.2 Thiessen Polygon Method 19
   2.7.3 Isohyetal Method 20
2.8 Methods to Develop Isohyet Map

2.8.1 Inverse Distance Weighting (IDW)  
2.8.2 Natural-neighbor 
2.8.3 Nearest-neighbor 
2.8.4 Kriging 
2.8.5 Radial Basis 
2.8.6 Modified Shepard 
2.8.7 Triangulation with Linear Interpolation 
2.8.8 Minimum Curvature 
2.8.9 Local Polynomial 

2.9 Software 

2.9.1 ArcGIS 10.2 
2.9.2 Surfer 8 
2.9.3 AutoCAD Map 3D 
2.9.4 Didger 3 

2.10 Related Studies Using Kriging Method for Isohyet Map 

2.10.1 Spatial Analysis of Daily Rainfall Intensity and Concentration Index in Peninsular Malaysia 

2.10.2 Rainfall Distribution and its Impact on Penang’s Water Resource 

2.10.3 Spatial Interpolation on Rainfall Data Over Peninsular Malaysia Using Ordinary Kriging Method.
CHAPTER 3 METHODOLOGY

3.1 Introduction 36
3.2 Flow Chart of the Study 37
3.3 Study Area 38
3.4 Data Collection 38
   3.4.1 Rainfall Data 39
   3.4.2 Map 39
3.5 Software 39
3.6 Kriging method 40

CHAPTER 4 RESULT AND DISCUSSION

4.1 Introduction 42
4.3 Isohyet Maps of Average Annual Rainfall (2001-2015) 55
4.4 Summary 56

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1 Introduction 57
5.2 Conclusion 57
5.3 Recommendation 58
REFERENCES 60
APPENDICES 62
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Average monthly rainfall for Bentong (2001-2015)</td>
<td>63</td>
</tr>
<tr>
<td>A2</td>
<td>Average monthly rainfall for Bera (2001-2015)</td>
<td>64</td>
</tr>
<tr>
<td>A3</td>
<td>Average monthly rainfall for Kuantan (2001-2015)</td>
<td>64</td>
</tr>
<tr>
<td>A4</td>
<td>Average monthly rainfall for Rompin (2001-2015)</td>
<td>65</td>
</tr>
<tr>
<td>A5</td>
<td>Average monthly rainfall for Temerloh (2001-2015)</td>
<td>66</td>
</tr>
<tr>
<td>A6</td>
<td>Average monthly rainfall for Raub (2001-2015)</td>
<td>66</td>
</tr>
<tr>
<td>A7</td>
<td>Average monthly rainfall for Pekan (2001-2015)</td>
<td>67</td>
</tr>
<tr>
<td>A8</td>
<td>Average monthly rainfall for Cameron highland (2001-2015)</td>
<td>69</td>
</tr>
<tr>
<td>A9</td>
<td>Average monthly rainfall for Jerantut (2001-2015)</td>
<td>70</td>
</tr>
<tr>
<td>A10</td>
<td>Average monthly rainfall for Lipis (2001-2015)</td>
<td>71</td>
</tr>
<tr>
<td>B1</td>
<td>Average annually rainfall (2001-2015)</td>
<td>74</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Hydrologic cycle</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Warm Front</td>
<td>9</td>
</tr>
<tr>
<td>2.3</td>
<td>Cold Front</td>
<td>10</td>
</tr>
<tr>
<td>2.4</td>
<td>Occluded Front</td>
<td>10</td>
</tr>
<tr>
<td>2.5</td>
<td>Thunderstorm</td>
<td>11</td>
</tr>
<tr>
<td>2.6</td>
<td>Orographic Precipitation</td>
<td>12</td>
</tr>
<tr>
<td>2.7</td>
<td>Symon’s Raingage</td>
<td>13</td>
</tr>
<tr>
<td>2.8</td>
<td>Weighing bucket type rain gauge</td>
<td>14</td>
</tr>
<tr>
<td>2.9</td>
<td>Tipping bucket type raingage</td>
<td>15</td>
</tr>
<tr>
<td>2.10</td>
<td>Siphon type automatic rainfall recorder</td>
<td>16</td>
</tr>
<tr>
<td>2.11</td>
<td>IDW as surface plot</td>
<td>22</td>
</tr>
<tr>
<td>2.12</td>
<td>Contour plots</td>
<td>23</td>
</tr>
<tr>
<td>2.13</td>
<td>Contour plots</td>
<td>24</td>
</tr>
<tr>
<td>2.14</td>
<td>Contour plots</td>
<td>25</td>
</tr>
<tr>
<td>2.15</td>
<td>Contour plots</td>
<td>26</td>
</tr>
<tr>
<td>2.16</td>
<td>Contour plots</td>
<td>27</td>
</tr>
<tr>
<td>2.17</td>
<td>Contour plots</td>
<td>28</td>
</tr>
<tr>
<td>2.18</td>
<td>Contour plots</td>
<td>29</td>
</tr>
<tr>
<td>2.19</td>
<td>Contour plots</td>
<td>30</td>
</tr>
<tr>
<td>2.20</td>
<td>A GIS as a layer cake</td>
<td>31</td>
</tr>
</tbody>
</table>
2.21 Surfer easily creates a multitude of map types to visualize data

2.22 Surface and point cloud tools

3.1 Chart of the Study

3.2 Map of district in Pahang, Malaysia

4.1 Average monthly rainfall for January (2001-2015)

4.2 Average monthly rainfall for February (2001-2015)

4.3 Average monthly rainfall for March (2001-2015)

4.4 Average monthly rainfall for April (2001-2015)

4.5 Average monthly rainfall for May (2001-2015)

4.6 Average monthly rainfall for June (2001-2015)

4.7 Average monthly rainfall for July (2001-2015)

4.8 Average monthly rainfall for August (2001-2015)

4.9 Average monthly rainfall for September (2001-2015)

4.10 Average monthly rainfall for October (2001-2015)

4.11 Average monthly rainfall for November (2001-2015)

4.12 Average monthly rainfall for December (2001-2015)

4.13 Average annually rainfall (2001-2015)
LIST OF SYMBOLS

\( P_X \) Missing annual precipitation
\( m \) Missing station
\( P_m \) Annual precipitation value
\( N_X \) Normal annual precipitation
\( x \) Station
\( i \) Index station
\( n \) Number of index station
\( b \) Constant distance weighted
\( r_x \) Rainfall station
\( D \) Distance weighted
\( \bar{p} \) Average precipitation
\( n \) Number of stations
\( A \) Total area of the watershed
\( A_i \) Area of each polygon
\( j \) Data point
\( \alpha \) Distance
\( K_j \) Adjustment
\( Z_j \) Z-value for location
\( d_{ij} \) Adjusted distance
\( \text{Km}^2 \) Square kilometer
\( \text{mm} \) Millimetre
<table>
<thead>
<tr>
<th>Cm</th>
<th>Centimetre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Km/h</td>
<td>Kilometres per hour</td>
</tr>
</tbody>
</table>
## LIST OF ABBREVIATION

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMO</td>
<td>World Meteorology Organization</td>
</tr>
<tr>
<td>DID</td>
<td>Department of Drainage and Irrigation</td>
</tr>
<tr>
<td>JUPEM</td>
<td>Jabatan Ukur dan Pemetaan</td>
</tr>
<tr>
<td>IDW</td>
<td>Inverse Distance Weighting</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Drafting</td>
</tr>
</tbody>
</table>