THE DEVELOPMENT OF ISOHYET MAP FOR PAHANG STATE USING KRIGING METHOD

ATHIRAH BINTI ZULKIFLI

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

UNIVERSITI MALAYSIA PAHANG

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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

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Signature : .....

Name of Supervisor : EN. NORASMAN BIN OTHMAN

Position : LECTURER

Date : JUNE 2016

Signature : .....

Name of Co-Supervisor : PN. SHAIRUL ROHAZIAWATI BINTI SAMAT

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Name : ATHIRAH BINTI ZULKIFLI

ID Number :AA12216

Date :JUNE 2016

TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 3 METHODOLOGY

CHAPTER 4 RESULT AND DISCUSSION

CHAPTER 5 CONCLUSION AND RECOMMENDATION

LIST OF TABLES

LIST OF FIGURES

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
$\overline{P}$	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
Km^2	Square kilometer
mm	Millimetre

Cm	Centimetre
Km/h	Kilometres per hour

LIST OF ABBREVIATION

WMO	World Meteorology Organization
DID	Department of Drainage and Irrigation
JUPEM	Jabatan Ukur dan Pemetaan
IDW	Inverse Distance Weighting
GIS	Geographical Information System
CAD	Computer Aided Drafting

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ABSTRACT

Peninsular Malaysia has uneven topographical and geographical landscapes hence giving it uneven distribution of monthly rainfall quantity throughout the country. Pahang is one of the states in the Peninsular Malaysia where the total rainfall for every month was different and subjected to regular monsoon season especially the North East Monsoon. The aim goal of this study is to produce the isohyets maps of rainfall pattern and intensity of 11 districts in Pahang via software called ArcGIS 10.2 using Kriging method. The rainfall data was collected from various rainfall stations that were set up by the Department of Irrigation and Drainage Malaysia (DID) from 2001 until 2015. From the stimulated isohyets map, the maximum and minimum rainfalls for 11 districts in Pahang were analyzed as well as seasonal and regional trends revealed three major regions in Pahang that is high-elevated, inland, and coastal region. The seasonal and regional trends of rainfall pattern have been examined. The seasonal distribution of rainfall shows that from November to March is higher which may due to the Northeast monsoon effect over Pahang. Meanwhile, for regional distribution, the highest average value occurence of rainfall are over coastal areas compared to inland areas. From the monthly isohyet maps for duration 15 years, it showed that the highest average rainfall for monthly was recorded in the eastern area, which is at Rompin area (442.48 mm) in December. Meanwhile, the western region at Temerloh area (51.44 mm) displayed low average rainfall, in February. For the annual average rainfall showed that the highest annual average rainfall was recorded at Rompin area (2340.38 mm) and the lowest annual average rainfall was detected at Temerloh area (1364.39 mm). Overall, from the analysis, the changes of rainfall pattern in Pahang state influenced by monsoon winds, weather climate, and topography & geology.

ABSTRAK

Semenanjung Malaysia mempunyai lanskap topografi dan geografi yang tidak rata, justeru itu ia menyebabkan pengagihan kuantiti hujan bulanan yang tidak sekata di seluruh negara. Pahang merupakan salah satu daripada negeri-negeri di semenanjung Malaysia di mana jumlah hujan bagi setiap bulan adalah berbeza dan tertumpu kepada musim monsun yang kerap terjadi terutamanya musim monsun Timur Laut. Matlamat utama kajian ini adalah untuk menghasilkan peta isohyet bagi melihat pola taburan hujan di 11 daerah di negeri Pahang melalui aplikasi perisian ArcGIS 10.2 menggunakan kaedah 'Kriging'. Rekod taburan hujan telah dikumpulkan dan dianalisis dari pelbagai stesen hujan yang telah ditetapkan oleh Jabatan Pengairan dan Saliran Malaysia (JPS) dari tahun 2001 hingga 2015. Daripada peta isohyet yang dihasilkan, jumlah maksimum dan minimum hujan untuk 11 daerah di negeri Pahang dianalisis berserta dengan aliran bermusim dan aliran serantau yang mengambarkan tiga rantau utama di Pahang yang terdiri daripada kawasan tinggi, kawasan pedalaman, dan kawasan pantai. Taburan hujan bermusim menunjukkan bahawa dari bulan November hingga Mac adalah lebih tinggi yang mungkin disebabkan oleh kesan musim monsun Timur Laut di Pahang. Sementara itu, bagi pengagihan serantau, nilai purata hujan yang tertinggi berlaku di kawasan pantai berbanding kawasan pedalaman. Daripada peta isohyet bulanan untuk tempoh 15 tahun, menunjukkan nilai purata hujan yang tertinggi telah dicatatkan di bahagian kawasan timur, iaitu kawasan Rompin (442.48 mm) dalam bulan Disember. Sementara itu, daerah Barat di kawasan Temerloh (51.44 mm) mencatatkan nilai purata hujan yang terendah dalam bulan Februari. Untuk purata hujan tahunan menunjukkan nilai purata hujan yang tertinggi telah dicatatkan di kawasan Rompin (2340.38 mm) dan nilai purata hujan yang terendah telah dikesan dibahagian kawasan Temerloh (1364.39 mm). Secara keseluruhan, daripada analisis, perubahan pola taburan hujan di negeri Pahang dipengaruhi oleh angin monsun,cuaca,dan topografi dan geologi.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The geography of Malaysia deals with the tropical climate of Malaysia, a country located in southeast Asia. There are two distinct parts to this country being peninsular Malaysia to the West and East Malaysia to the East. Peninsular Malaysia is located south of Thailand, North of Singapore and East of the Indonesian island of Sumatra. East Malaysia comprises most of the northern part of Borneo and shares borders with Brunei and Indonesia.

Malaysia has an equatorial climate with uniformly high temperatures, high humidity, relatively light winds, and abundant rainfall throughout the year. Malaysia faces two monsoon winds seasons, the Southwest Monsoon from April to September, and the Northeast Monsoon from November to February. The Northeast Monsoon brings in more rainfall compared to the Southwest Monsoon, originating in China and the north pacific. Malaysia is located near the coast, land and sea breezes can affect wind flow pattern.

Precipitation is high in most part of Malaysia. Kuala Lumpur has receives over 2400 mm per year, Penang over 2700 mm per year, Kuching in Sarawak over 3900 mm per year, and Labuan in Sabah over 3500 mm per year of percipitation. During the northeast monsoon, western Sarawak and the northeast coast of Sabah experience heavy

rain. In the state of the East Coast, the wettest months was November, December, and January. Meanwhile, the driest months was June and July. Most of the rest of the peninsula has peaks of high rainfall (October through November and April through May) followed by periods of lower rainfall (January through February and June through July). On average Kuala Lumpur receives 195 days and Penang receives 154 days of rain each year.

Pahang basin receives high total rainfall during the northeast monsoon period amounting to almost 40% of Pahang's total annual rainfall. The consequence of the extreme rainfall has an impact on Pahang river where it results in higher river flow and water level and finally contributing to serious flood event along the river in the basin. It is the longest river in peninsular Malaysia with a length of 459 km. The upstream of this river is located at the Titiwangsa Main Range. Pahang river starts with two rivers, namely the Tembeling and Jelai rivers which meet at a confluence in Kuala Tembeling located 300 km away from the estuary of Pahang river. The river meanders though townships such as Jerantut, Temerloh, Maran, Bera, as well as Pekan and lastly flows into the South China Sea which is located on the east coast of Peninsular Malaysia.

The isohyetal method is used to estimate the mean precipitation across an area by drawing line of equal precipitation. The method uses topographic and other data to yield reliable estimates. Based on McCuen (1998) the isohyetal method allow the hydrologist to consider factor, such as topography, that can affect the catch at the gage. Isohyets are contours of equal precipitation analogous to contour lines on a topographic map. In the isohyetal method, precipitation values are plotted at their respective stations on a suitable base map, and isohyets are drawn to create an isohyetal map. Isohyetal lines are based on interpolation between rain gauge stations. While constructing isohyets, it is assumed that rainfall between two stations varies linearly, unless abrupt changes in topography indicate otherwise.

Effective and good rainfall data is vital in many human system. It is importance in hydrological analysis and also in the management of water resources. In malaysia, an important issue with regards to the rainfall data records is the absence of rain gauge stations in particular regions. This is an important issue in hydrology because

hydrologist utilizes the rainfall data as the input in most of their researches. Due to high cost and too many procedures that have been listed by World Meteorological Organization (WMO) in constructing rain gauge stations, it is quite impossible to solve this problem by constructing them in the regions involved in the research. Thus, it is important to estimate rainfall data in those unsampled locations. In order to estimate those data, spatial interpolation method is utilized. One of the spatial interpolation methods is Kriging.

Kriging technique is preferable because most of the researches identified that kriging can give a more accurate results for interpolation of daily rainfall data. Based on Antonic (2008) results indicate that grid and line isohyets data obtained by the Kriging method are much more representative. There are many advantages of applying kriging technique. The benefits include it provide some measures of the certainty or accuracy of the predictions data, and also be able to produce a prediction surface. Based on ESRI (2009) Kriging is a multistep process, it includes exploratory statistical analysis of the data, variogram modelling, creating the surface, and exploring a variance surface. By using kriging method, the capability of obtaining high efficiency estimation in rainfall data is highly possible to be achieved.

1.2 PROBLEM STATEMENT

Rainfall pattern in Malaysia are variable and effected by Monsoon winds. Therefore, rainfall that are not same in every area are suitable to be investigate to know what will happen in the future. It is also difficult to draw a consistent picture of changes in the tropics and subtropics, where many areas are not analyzed and data are not readily available. The study including analysis of rainfall pattern for all 11 districts in Pahang.

Isohyets maps can help the hydrologist to design the drainage and to predict flood may be happen at certain place in particular time. To draw isohyets maps, it needs a complete rainfall data especially for topography with a very large area but there are missing data in the rainfall data collected. Because of that, a systematic data management and planning are needed to produces a map that are more interesting and effective. All the data need to be analyzed to get the best result because most of the data