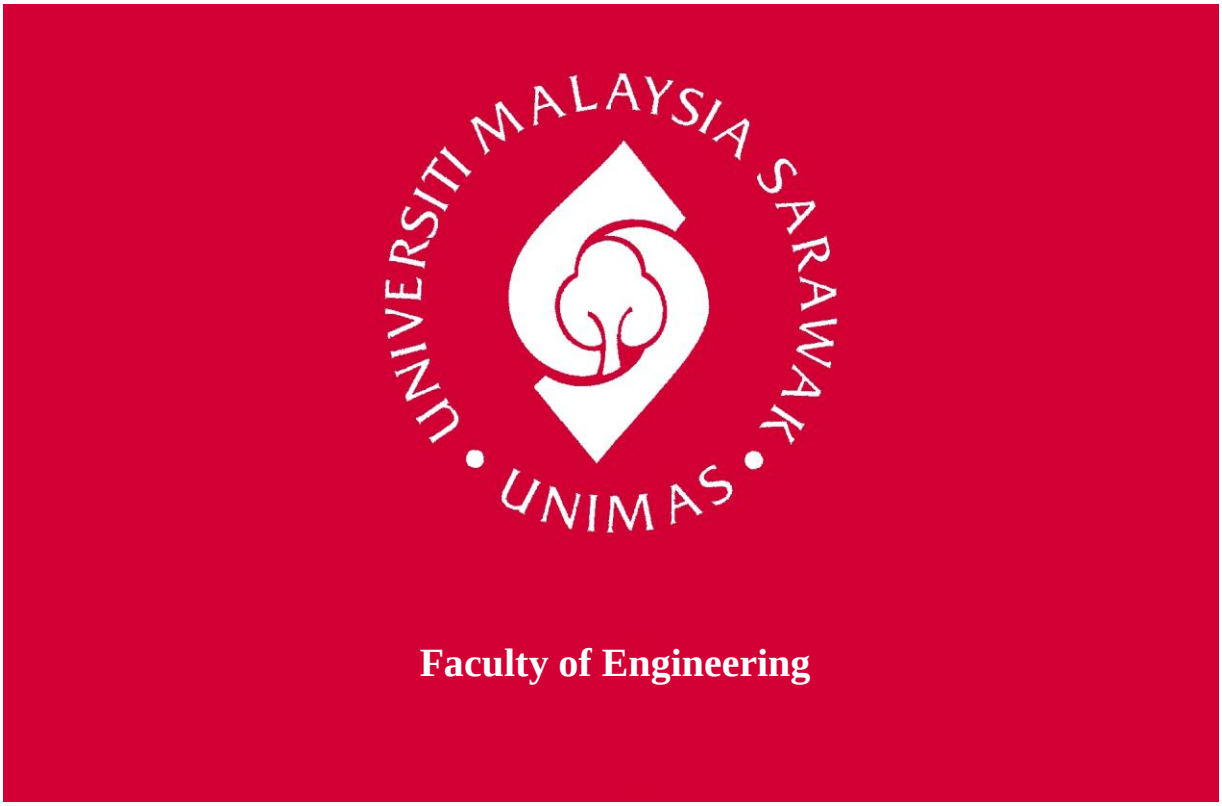

DEVELOPMENT OF TEMPORAL RAINFALL PATTERNS FOR SARAWAK

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DEVELOPMENT OF TEMPORAL RAINFALL PATTERN FOR SARAWAK

JULIAN LESLIE ANYIE

This project is submitted in partial fulfillment of
the requirements for the Degree of Bachelor of Engineering with
Honours (Civil Engineering)

Dedicated to

My beloved parent and siblings

All my friends, lecturers and course mates

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Praise to the Lord, for being with me all the time in the completion of this thesis.

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ABSTRAK

Dalam kajian mengenai taburan hujan, maklumat mengenai tempoh masa hujan, purata keamatan hujan dan corak hujan '*temporal'* adalah amat penting. Projek ini adalah untuk membangunkan corak hujan '*temporal'* bagi Sarawak memandangkan buat masa kini Sarawak masih belum menpunyai corak hujan '*temporal*' di dalam *Hydrological procedure No.1*. Manual Saliran Mesra Alam Malaysia (MASMA) telah membangunkan corak hujan '*temporal'* untuk Semenanjung Malaysia dan corak hujan '*temporal*' bagi kawasan Pantai Timur Semenanjung Malaysia telah diaplikasikan untuk Sarawak buat masa kini. Corak hujan '*temporal'* memainkan peranan penting dalam anggaran aktiviti kebanjiran yang banyak mempunyai kegunaan dalam bidang kejuruteraan seperti rekabentuk struktur hidrologi, pengurusan kawasan banjir, kajian ekologi sungai dan kajian insurans kebanjiran. Seperti yanf dinyatakan dalam MASMA, teknik yang dicadangkan oleh *Australian Rainfall and Runoff (AR&R)* yang dikenali sebagai *'Method of Average Variability'* dan cara dalam *Hydrological Procedure No.1-1982* telah diaplikasikan untuk membangunkan corak hujan '*temporal'* bagi Sarawak. Data hujan selang 5 minit dari tahun 1998 hingga 2006 bagi 10 stesen kaji hujan terpilih telah diperoleh daripada Jabatan Pengaliran dan Saliran (JPS) Sarawak untuk projek ini. Corak hujan '*temporal'* yang dibangunkan adalah untuk tempoh masa 10 minit, 15 minit, 30 minit, 60 minit, 120 minit, 180 minit dan 360 minit. Setelah mendapat corak hujan '*temporal'* bagi Sarawak, corak tersebut dibanding dengan corak bagi kawasan Pantai Timur Semenanjung Malaysia. Corak hujan '*temporal'* yang dibangunkan diharapkan dapat memberi sumbangan kepada penyelidikan hidrologi Sarawak.

ABSTRACT

In the study of the design rainfall, the information on rainfall duration, average rainfall intensity and temporal rainfall pattern is important. This project is to develop of temporal rainfall pattern for Sarawak since temporal pattern for Sarawak is still not available Hydrological Procedure No. 1 (HP-No.1). Urban Stormwater Management Manual for Malaysia (MASMA) had developed the temporal pattern for design storms in Peninsular Malaysia and the temporal rainfall pattern for East Coast of Peninsular Malaysia were adopted for Sarawak. Temporal rainfall pattern is important in flood estimation which is useful in engineering practice such as design of hydrologic structures, flood plain management, river ecology studies and flood insurance studies. As mentioned in MASMA, the recommended technique by the Australian Rainfall and Runoff (AR&R) known as the 'Method of Average Variability' and method in Hydrological Procedure No.1-1982 are used to develop temporal rainfall patterns. 5 minutes rainfall data from year 1998 to year 2006 for 10 selected rainfall stations in Sarawak is obtained from Department of Irrigation and Drainage (DID) Sarawak to conduct this project. The temporal rainfall patterns developed are for 10 minutes,15 minutes, 30 minutes, 60 minutes, 120 minutes, 180 minutes and 360 minutes duration. After obtaining the temporal rainfall patterns, the patterns are to be compared to the patterns for East Coast of Peninsular Malaysia. It is expected that the design temporal rainfall pattern obtained can contribute to Sarawak hydrological research.

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LIST OF ABBREVIATIONS AND NOTATIONS

A	Area of watershed
ARI	Average Recurrence Interval
AR&R	Australian Rainfall and Runoff
AVM	Average Variability Method
C	Runoff coefficient
DID	Department of Irrigation and Drainage
ha	Hectare
HP	Hydrological Procedure
hr	Hour
I	Intensity of rainfall
IDF	Intensity-Duration-Frequency
MASMA	Manual Saliran Mesra Alam Malaysia
min	Minute
mm	Millimeters
n	Number of gauges
P	Rainfall depth
P_{av}	Average depth of precipitation
Q_{peak}	Peak discharge
r	Ratio of storm peak to storm duration
T	Design return period
$\bar{t}$	Mean of rainfall distribution

t_c	Equilibrium time for rainfall occurring at the most remote portion of the basin to contribute flow to the outlet
t_d	Duration of the storm
%	Percent

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Rainfall is the main factor for all stormwater studies and designs. Understanding the designs and mathematical studies of rainfall processes and significance of the data is necessary as it describes and guide through the modeling of the rainfall patterns. (MASMA, 2000)

Rainfall event can be characterized by the rainfall duration, average rainfall intensity of a particular average recurrence interval (ARI) and rainfall temporal pattern. A temporal rainfall pattern is the distribution of total rainfall depth over certain time interval within a given rainfall duration. (A. Rahman, 2005)

Temporal rainfall pattern are used to represent the typical variation of rainfall intensities during a typical storm period. The rainfall temporal patterns give the standard design procedures to be use in the stormwater flow calculation as well as to design storms. It is the important factor that affects the runoff volume, the magnitude and timing of the peak discharge. Temporal Rainfall Pattern can be obtained by making realistic estimates analysis of local rainfall data from recording rain gauge.

The analysis has to be done for several times with wide varying storm durations to cover various types of storms at rainfall stations. (MASMA, 2000)

1.2 Present Malaysian Practice

Malaysia is part of the South East Asian community. It occupies a total area of approximately 330,000 square kilometer and is divided by the South China Sea into West Malaysia (Peninsular) and East Malaysia (Sabah and Sarawak), about 1000 km apart. Being located between longitudes 1° - 7° North and latitudes 100° - 120° East, Malaysia is influenced by the equatorial environment and is well outside volcanic, tornado, and severe drought belts. Strategically, the country is located central to various international air and sea transport and communication routes. Malaysia is warm and humid throughout the year, as characterised by the equatorial climate. It has an average annual rainfall of more than 2500 mm with monthly variations for selected cities and towns (MASMA, 2000)

In Manual Mesra Alam Malaysia (MASMA) Chapter 13, Design Rainfall, it indicates that the 1982 of Hydrological Procedure No. 1 (HP 1) gave recommendations on temporal patterns to be adopted for design storms in Peninsular Malaysia. The patterns were prepared for six standard durations which are 0.5, 3, 6, 12, 24 and 72 hours from nine rainfall stations located in different part of Peninsular Malaysia. Nine rainfall stations located in different parts of Peninsular Malaysia were used in this analysis which covered nine years of rainfall data from July 1970 to June 1979.

For Sarawak and Sabah, no rainfall temporal pattern data is available in HP 1-1982. According to MASMA 2000, the temporal patterns for Sabah and Sarawak were adopted from the patterns for the East Coast of Peninsular Malaysia for preliminary study since the climatic conditions are more comparable rather than West Coast of Peninsular Malaysia. Hydrological Procedure No. 26 (HP 26), 1983 produced by Department of Irrigation and Drainage (DID), meanwhile did provide the estimation of design rainstorm in Sabah and Sarawak.

Sarawak, with an average annual rainfall of 3830 mm according to Department of Irrigation and Drainage (DID), experiences two monsoonal changes. Sarawak is a tropical country with an equatorial climate. It is hot and humid throughout the year with mean daily temperature ranging from 23°C during the early hours of the morning to 32°C during the day. It experiences two monsoonal changes. The West Coast East Monsoon, which usually occurs between November to February, brings with it heavy rainfall. The South West Monsoon is usually less wet. Except for monsoonal changes, the climate remains fairly stable throughout the year. Annual rainfall varies between 330 cm to 460 cm for the greater part of the country. (Wijnen B.V., 2008)

1.2 Objectives

The objective for this study is to develop standard Temporal Rainfall Patterns for Sarawak since that Temporal Rainfall Patterns for Sabah and Sarawak are not available in Hydrological Procedure No. 1. Besides, this studies also to compare the

standard of temporal rainfall patterns of Sarawak developed with temporal rainfall patterns of East Coast of Peninsular Malaysia.

1.3 Layout of the Thesis

Chapter 1 This chapter is the introduction on the background and rainfall events of Sarawak. Also included in this chapter are the objectives of the studies.

Chapter 2 Literature review highlight on topics related to rainfall such as hydrological cycle, types of rainfall, rainfall measurement and rainfall analysis is carried out. Understanding on temporal patterns at Peninsular Malaysia is essential as it is a guideline to develop temporal rainfall patterns for Sarawak. Studies of different methods used to develop the temporal rainfall pattern from other regions are also vital to achieve the objective of this thesis.

Chapter 3 This chapter focuses on description of the study area and data required to develop temporal rainfall patterns for Sarawak. The method selected and its procedures to develop temporal rainfall pattern for Sarawak is explained in detail. Flow chart on the work procedure to develop temporal rainfall patterns for Sarawak also illustrated in this chapter. Also included are the expected constraint and obstacle that occur during this study.

Chapter 4 The presentation of the result and analysis in form of tables and graphs. Comparison between temporal patterns of Sarawak and East coast of Malaysia is carried out. The results of comparison are then discussed in this chapter.

Chapter 5 This chapter concludes the entire outcome from this study. Some recommendations are stated here to explain further studies need to be carried out to develop the standard temporal rainfall pattern for Sarawak.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Precipitation can come in many forms such as rain, snow, sleet, hail and mist. For hydrological design, precipitations are important especially in rainfall forms as the analysis and measurement guide to the flood estimation in engineering practice (McCuen R.H., 1989). For Malaysia, rainfall is the driving force for hydrological designs since there are no snowing event ever happens in Malaysia.

Rain is a product of the condensation of atmospheric water vapor that is released on the Earth's surface. It forms when separate drops of water fall to the Earth from clouds but all rain reaches the surface where some of it evaporates while falling through dry air. Rain is the primary source of fresh water for most areas of the world, providing suitable conditions for diverse ecosystems, as well as water for hydroelectric power plants and crop irrigation. Rain plays a role in the hydrologic cycle in which moisture from the oceans evaporates, condenses into drops, falling precipitates from the sky, and eventually returns to the ocean via rivers and streams to repeat the cycle again. (Wikipedia, 2008)