THE DEVELOPMENT OF INTENSITY DURATION FREQUENCY (IDF) CURVES IN GOMBAK

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STUDENT'S DECLARATION

I hereby declare that the work in this 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 Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Perubahan iklim merupakan salah satu faktor yang memberi kesan kepada sumber air kerana ia boleh menjejaskan kitaran hidrologi keseluruhan dan seterusnya menyebabkan perbezaan kepada kuantiti hujan, tempoh dan kekerapan hujan. Kajian ini menerangkan tentang lengkungan Lengkung Keamatan Tempoh Frekuansi di Gombak. Lengkungan Keamatan Tempoh Frekuansi merupakan salah satu alat yang biasa digunakan untuk merancang, mereka bentuk dan mengendalikan projek sumber air oleh jurutera, kontraktor dan pemaju. Lengkungan Keamatan Tempoh Frekuansi di dalam Manual Saliran Mesra Alam edisi kedua hanya dikemaskini sehingga tahun 2012 dan merangkumi kawasan yang terhad sahaja. Objecktif kajian ini adalah untuk menghasilkan lengkung Keamatan Tempoh Frekuansi berserta dan tidak berserta data terasing menggunakan Taburan Lognormal and Taburan Gumbel di Gombak. Data hujan Siri Maksimum Tahunan (AMS) diambil dari Jabatan Pengairan dan Saliran. Terdapat sebelas stesen hujan dalam kajian ini. Kaedah yang digunakan bagi menentukan lengkung Keamatan Tempoh Frekuansi adalah U.S. Water Resource Council (1981) dan Interquartile Range (IQR). Melaluai kajian ini, ia dapat membuktikan bahawa Interquartile Range mempunyai nilai data terasing yang lebih tinggi berbanding U.S. Water Resource Council (1981) disebabkan oleh percanggahan di antara 75 dan 25 peratus bagi mengukur penyebaran kajian statistik. Taburan Lognormal and Taburan Gumbel merupakan kaedah yang digunakan bagi menghasilkan lengkung Keamatan Tempoh Frekuansi. Berdasarkan analisa kajian, peratusan perbezaan di antara lengkung Keamatan Tempoh Frekuansi yang baru berserta dan tidak berserta data terasing bagi kaedah Taburan Lognormal adalah sebanyak 0% sehingga 21.6% manakala bagi kaedah Taburan Gumbel sebanyak 0% sehingga 24.7%. Peratusan perbezaan (%) di antara lengkung Keamatan Tempoh Frekuansi berserta dan tidak berserta data terasing dengan menggunakan kaedah Taburan Gumbel adalah lebih tinggi berbanding Taburan Lognormal. Ini membuktikan semakin banyak data terasing yang dibuang, semakin tinggi peratusan perbezaan (%).

ABSTRACT

Changing in climate is one of the main parameter that affecting the water resources as it affects the whole hydrologic cycle thus causes variation in rainfall intensity, duration and frequency of precipitation. The study is about development of Intensity Duration Frequency (IDF) curves in Gombak. IDF curve is one of the most commonly used all engineers, developers and contractors to design storm, hydraulic and hydrology structure. The IDF curves in Manual Saliran Mesra Alam (MSMA 2) only updated until year 2012 and covered limited location only. The aim of this study is to developed IDF curves with and without outlier by using Lognormal distribution and Gumbel distribution in Gombak. The Annual Maximum Series (AMS) of rainfall data were collected from Department of Irrigation and Drainage (DID). It consists of eleven rainfall stations. The methods that were used to determine the outlier of IDF curves are U.S. Water Resource Council (1981) and Interquartile Range (IQR). It is clearly shows the greater removal of outliers for Annual Maximum Series (AMS) rainfall data was by using Interquartile Range rather than U.S. Water Resource Council (1981) due to discrepancies between 75th and 25th percentiles that measure the dispersion of statistical study. Lognormal distribution and Gumbel distribution are the methods that were used to develop IDF curves. Based on the analysis, the percentage difference between IDF curves with and without outlier for Lognormal distribution are within 0% to 21.6% while for Gumbel distribution are within 0% to 24.7%. It can be concluded that the percentage of difference between IDF curves with and without outlier using Gumbel distribution is greater than using Lognormal distribution. According to the output, it shows the greater removal of outliers will produce higher percentage of difference (%).

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LIST OF SYMBOLS

N	Sample Size
K_N	10% significance level K values
y	High/Low outlier threshold in log units
s_y	Standard Deviation
$\bar{y}$	Mean logarithm of variate
$G_ϱ$	Grubbs' statistics for highest value
$X_ϱ$	Highest value
X	Mean value
P_{ave}	Average maximum precipitation corresponding to specific duration
σ	Standard deviation of the log data
I	Intensity, I (in mm/hr) for Return Period,T
K	Gumbel Frequency factor
SD	Standard Deviation
$\overline{X}$	Mean of the log data rainfall
K_T	Frequency factor
Pt	Frequency precipitation Pt (in mm) for each P duration with a specific Return Period,T
X	Value of Intensity Before Removal of Outlier
Y	Value of Intensity After Removal of Outlier
T_γ	Average Recurrence Interval, ARI (year)
P	Annual Exceedance Probability, AEP (%)

LIST OF ABBREVIATIONS

DID	Department of Irrigation Drainage
IDF	Intensity Duration Frequency
MSMA	Urban Stormwater Management Manual for Malaysia
IQR	Interquartile Range
ARI	Average Recurrence Interval
AMS	Annual Maximum Series
GEV	Generalized Extreme Value
SUDS	Sustainable Urban Drainage Systems
HP1	Hydrological Procedure 1
USWB	United States Weather Bureau
GPD	Gear Pump Distributor
EVI	Enhanced Vegetation Index
ARF	Areal Reduction Factor
CCF	Common Cause Failures
NOAA	National Oceanic and Atmospheric Administration’s
NAHRIM	National Hydraulic Research Institute of Malaysia
NWS	National Weather Service

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Malaysia has an equatorial type of climate which is high temperature, humid and rainy throughout the year. The climate in Malaysia can be considered influenced by the northeast and southwest monsoon. Formation of rain is due to the winds that come from the southeast monsoon which occur on April until September. In Malaysia, between the middle of October until March the climate of the eastern part of peninsular is affected by the monsoon season or rainy season. During this monsoon season, certain area will experience heavy rainfall (Walter *et al.*, 1975).

Rainfall apparently is the driving force behind all storm water studies and designs. An understanding of rainfall developments and the implication of the rainfall design data is an essential criterion for designed drainage and storm water management projects. Inadequate drainage in many urban areas also enhances the effects of heavy rain. The frequency and intensity of rainfall in Malaysia is much higher than in most countries, especially those with temperate climates. Rainfall design method which has been developed in other countries may not always be suitable for application in Malaysia. Thunderstorms, high tide phenomena and heavy rain are the most influencing factors for flood hazards (Booth, D. B *et al.,* 2002).

Flood is the most devastating natural disaster experienced in Malaysia which happened nearly every year during the monsoon season. Flood occurs when the rainfall is greater than the outflow of the water. Flood usually cause by the heavy rainfall when the natural water channel does not have sufficient capacity to carry the excessive water. There are many flood prone areas in Malaysia. These areas usually located near the seaside. Figure 1.1 and Figure 1.2 shows the location of the flood prone area in Peninsular Malaysia, Sabah and Sarawak respectively.

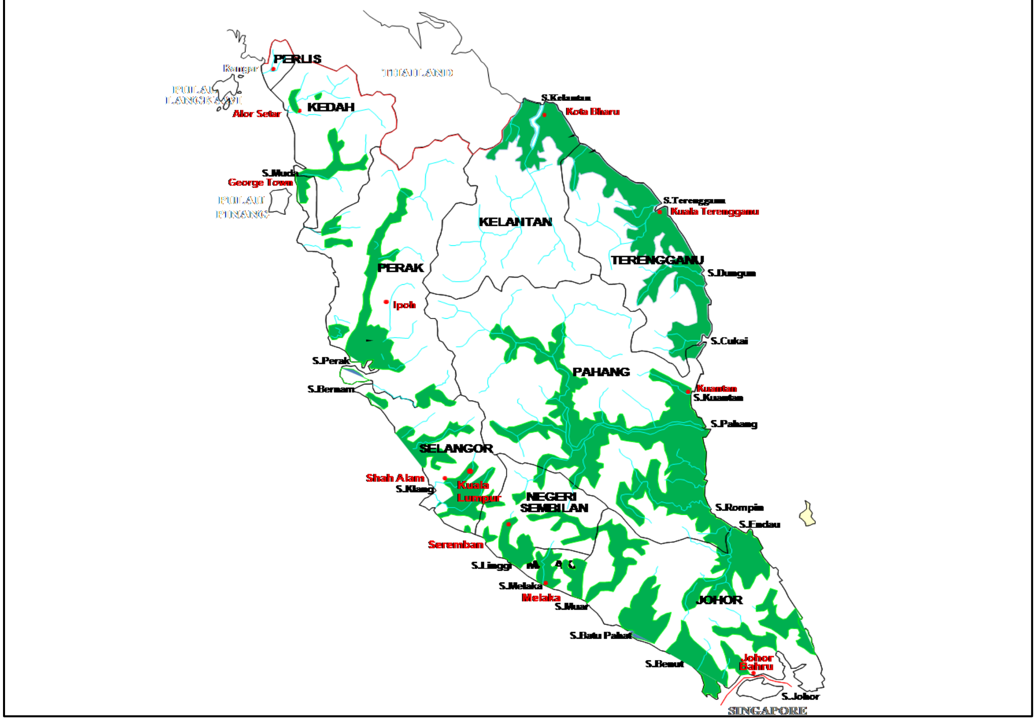

Figure 1.1 Flood Prone Areas in Peninsular Malaysia

Source: Department of Irrigation Drainage (DID, 2009)

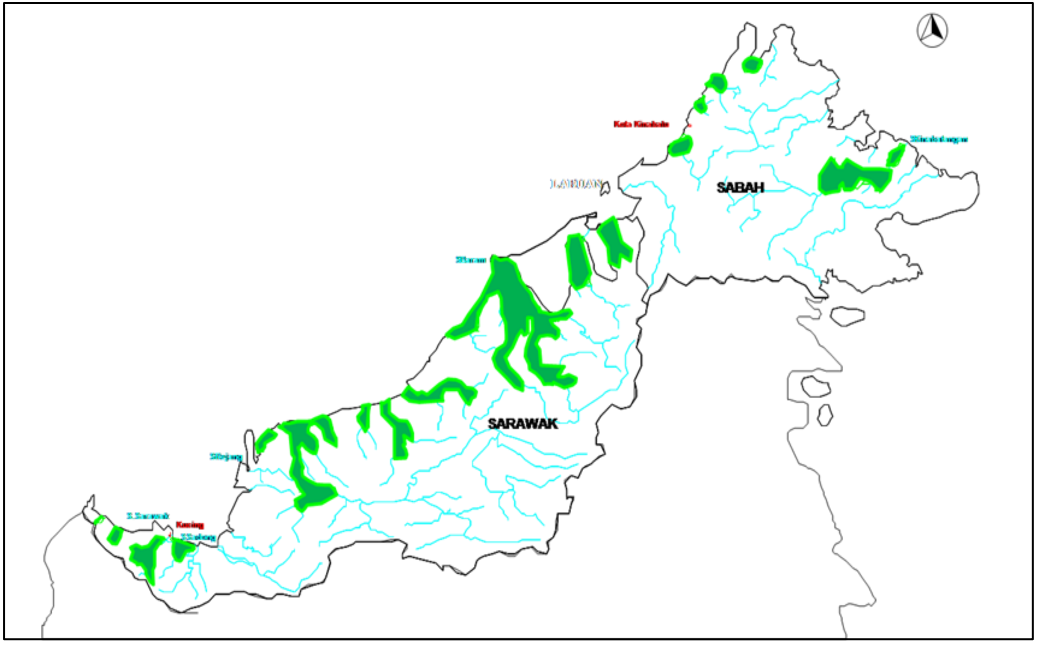

Figure 1.2 Flood Prone Areas in Sabah And Sarawak

Source: Department of Irrigation Drainage (DID, 2009)

According to Jabatan Meteorologi Malaysia (MetMalaysia) updated 2016, the region of North east Monsoon is Pahang, Kelantan, Terengganu and South of Sarawak. From this rainfall pattern, data and evaluation of extreme rainfall data are significant in water resources development and management for design purposes in construction of sewerage and storm system, determination of the essential discharge capability of channels, and capability of pumping stations. So they are important in order to prevent flooding, insurance of water damage, and evaluation of dangerous weather. Studies on the rainfall IDF relationship have acknowledged much attention in past few years.

An Intensity Duration Frequency (IDF) curve is a graphical representation of the probability that a given average rainfall intensity will occur. It is a form design rainfall data required for estimation peak discharges. IDF curve is used as tools in water resources engineering for planning, design and operation of water resources project by engineers. An IDF curve is created with long term rainfall records collected at a rainfall monitoring station. It helps the engineer designing the drainage works safe and economically. In the study, the attempt has been made to find the difference between the observed data and derived data by taking the rainfall data available for 15 minutes of time interval (Zameer Ahmed, 2012).

1.2 Problem Statement

Urban Stormwater Management Manual Second Edition (MSMA 2) was used by all regulators, planners, engineers, designers, developers and contractors who were involve in stormwater management that provides all the guidelines to design storm, hydraulic and hydrology. The data of IDF curves in MSMA 2 only updated until year 2012. The data of IDF curves in MSMA 2 are not same for every year due to the climate change in Malaysia.

A new data is needed as change of climate that affects the data. It is very significant to retain the proficiency of the drainage for a long time as the ARI is about 100 years. Besides, the providing data in MSMA 2 is already outdated due to the change of climate in Malaysia. Records during the year of 2012 until 2018, anything can occur during the period that will transform the uniformity of the data such as the

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