THE DEVELOPMENT OF FITTING CONSTANT FOR INTENSITY DURATION FREQUENCY (IDF) CURVE IN KLANG VALLEY

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We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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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

Lembah Klang adalah salah satu kawasan banjir di mana banjir kilat sering melanda beberapa kawasan di Lembah Klang berikutan hujan lebat. Oleh kerana perubahan iklim yang tidak dijangka, ia mungkin akan menyebabkan peningkatan keamatan dan kekerapan hujan lebat yang melampau di kebanyakan wilayah pada masa akan datang. Hubungan antara Keamatan Tempoh Kekerapan (IDF) adalah salah satu kaedah yang paling biasa digunakan dalam kejuruteraan sumber air, sama ada untuk merancang, mereka bentuk dan mengendalikan projek sumber air, atau untuk pelbagai projek kejuruteraan terhadap banjir. Data IDF di dalam Manual Saliran Mesra Alam Edisi ke-2 (MSMA 2) tidak konsisten untuk setiap tahun kerana iklim Malaysia sentiasa berubah. Selain itu, sistem saliran di bandar selalunya tidak dapat menampung apabila hujan yang hebat terjadi. Data di dalam MSMA2 hanya mewakili bandar-bandar utama sahaja. Ini bermakna bahawa terdapat potensi ralat yang besar dalam ekstrapolasi dijangka masa yang panjang seperti 100 tahun. Oleh itu, lengkung IDF yang baru dan dikemaskini diperlukan sebagai rujukan kepada reka bentuk perparitan dan pengurusan air. Tujuan kajian ini adalah untuk membangunkan pemalar kelengkapan berdasarkan kekerapan tempoh intensiti (IDF) menggunakan analisis kekerapan seperti kaedah Gumbel dan Log-Normal di Lembah Klang. Rumusan empirikal yang digunakan untuk menganggarkan pemalar yang sesuai dengan lengkung IDF ialah Persamaan Sherman. Di samping itu, ia juga untuk menganalisis nilai pemalar keamatan hujan di antara MSMA2 dan anggaran pemalar lengkung IDF di Lembah Klang menggunakan Persamaan Sherman. Persamaan Sherman digunakan untuk menghitung pemalar kawasan iaitu pemalar a, b dan c. Peratusan perbezaan keseluruhan diantara Persamaan Sherman dan MSMA 2 menggunakan kaedah Gumbel adalah dari 0% hingga 3200% manakala peratusan Persamaan Sherman dan MSMA 2 menggunakan kaedah Log Normal adalah dari 0% hingga 1000%. Berdasarkan hasilnya, kaedah Log Normal lebih sesuai dan boleh dipercayai untuk Lembah Klang apabila dibandingkan dengan kaedah Gumbel kerana beza peratusan dari Persamaan Sherman dan MSMA 2 untuk kaedah Log Normal adalah lebih kecil daripada kaedah Gumbel.

ABSTRACT

Klang Valley is one of the flood prone areas where flash floods often hit several areas in Klang Valley following the heavy downpour. Due to the unexpected climate change, it will likely result in an increase in the intensity and frequency of extreme precipitation events in most regions in the future. The rainfall Intensity-Duration-Frequency (IDF) relationship is one of the most commonly used tools in water resources engineering, either for planning, designing and operating of water resource projects, or for various engineering projects against floods. The data in IDF curve is not consistence for every year because of Malaysia climate always change. Besides, urban drainage systems often cannot cope with intense convective rainfall events. Other than that, in MSMA2 the data only represent for major towns. This means that there is a large potential error in extrapolating to long ARI such as 100 years. Thus a new and updated IDF curve is needed to make as a reference to design drainage and storm water management. The purpose of this study is to develop the fittings constants based on the intensity duration frequency (IDF) using frequency analysis such as Gumbel distribution and Log-Normal distribution in Klang Valley. The empirical formula that is used to estimate the fitting constant of IDF curve is Sherman Equation. Besides, it is to analyze the rainfall intensity values between MSMA2 and estimated fitting constants of IDF curve in Klang Valley using Sherman Equation. The Sherman Equation is used to computed the locality constants which are a,b and c. The overall percentage different of Sherman Equation and MSMA 2 for Gumbel distribution function is from 0% until 3200% while the percentage different of Sherman Equation and MSMA 2 for Log Normal distribution function is from 0% until 1000%. Based on the results, Log Normal distribution is more suitable and reliable for Klang Valley when compared to Gumbel distribution as the percentage different of Sherman Equation and MSMA 2 for Log Normal distribution is smaller than Gumbel distribution.

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LIST OF SYMBOLS

P_T	The Frequency Precipitation
K	Gumbel Frequency Factor
S	Standard Deviation of P value
P_{ave}	The Average of The Maximum Precipitation in a Specific Duration
P_i	The Individual Extreme Value of Rainfall
n	The Number of Events of Years of Record
T_d	Duration
I_T	Rainfall Intensity
P*	Logarithm of Precipitation
P_T*	The Frequency Precipitation
S*	Standard Deviation of P* Value
P^*_{ave}	The Average of The Maximum Precipitation in a Specific Duration
K_T	The Pearson Frequency Factor Which Depends on Return Period (T) and Skewness Coefficient (Cs)
Cs	Skewness Coefficient
ξ	The Location Parameter
α	The Scale Parameter
k	The Shape Parameter
m	Rank of Recorded Years
c	Gumbel Correction Factor Which Depend on (m/N) Values
$\bar{y}_n$	Reduced Mean
S_n	Reduced Standard Deviation

LIST OF ABBREVIATIONS

IDF	Intensity Duration Frequency
ARI	Average Recurrence Interval
MSMA	Manual Saliran Mesra Alam
DID	Drainage of Irrigation and Drainage
AMS	Annual Maximum Series
AEP	Annual Exceedance Probability
PDS	Partial Duration Series
GEV	Gumbel Extreme Value
TRMM	Tropical Rainfall Measuring Mission
CDF	Cumulative Density Function
PDF	Probability Density Function
GPD	Generalized Pareto Distribution

CHAPTER 1

INTRODUCTION

1.1 Background Study

A key requirement for efficient solutions of many water related problems in urban areas needed a detailed understanding of rainfall processes. The heterogeneity of rainfall means that a systematic study is necessary, especially in the tropical region where abundant rainfall often causes severe urban flash floods (Nordila, 2008). Malaysia is one of the countries located at Southeast Asia, close to the equator which is categorised as equatorial, being hot and humid throughout the year (Climatestotravel.com, 2018).

The area of Malaysia at equator zone gives Malaysia experience tropical atmosphere with two sort of monsoon season which are the northeast and southwest through the year. Northeast happen amid November to May bring moisture and more rainfall. Where southwest give wind blowing monsoon inside of May to September (Nur Salbiah Shamsudin, 2016). The climates of the Peninsula and the East differ, as the climate on the peninsula is directly affected by wind from the mainland, as opposed to the more maritime weather of the East. These outcomes give average rainfall in Malaysia in 2500 mm with normal temperature 27^{o}C a year.

In Malaysia, flash flood events occur frequently in urban areas such as the Klang Valley. These events occur mainly during raining season. Flash flood caused an increase in damages and losses in the area. The storms of convective origin are generally known to be responsible for much of flash flood events in Malaysia.

From the rainfall pattern, the data will be utilized to develop rainfall intensity duration frequency (IDF) curves. Intensity duration frequency (IDF) curves are used in many hydrologic designs for the purpose of water managements and flood preventions.

The IDF curves available in Malaysia are those obtained from univariate analysis approach which only considers the intensity of rainfalls at fixed time intervals (Ariff, Jemain, Ibrahim, & Wan Zin, 2012). IDF curves can be obtained based on historical data and are usually employed to evaluate the extreme values of precipitation in urban drainage systems. IDF curves can be defined as mathematical tools that express the relation between intensity, duration, and average recurrence interval (ARI) of precipitation. Rainfall IDF ought to be up and coming in accordance with the progressions of rainfall pattern due to worldwide temperature alteration impact and temperature changes.

1.2 Problem Statement

Manual Saliran Mesra Alam (MSMA), is an abbreviation from Malay Language translation of Urban Stormwater Management Manual, it has been widely accepted and use by the engineers as a guideline to make design. The data of IDF curves in MSMA 2 was updated until 2009 only. The data in IDF curve is not consistence for every year because of Malaysia climate always change. Climate change will likely result in an increase in the intensity and frequency of extreme precipitation events in most regions in the future. As a result, IDF values will optimally need to be updated more frequently than in the past and climate change scenarios might eventually be drawn upon in order to inform IDF calculations.

As the change of climate effect the data, a new data is needed. It is very important to keep the efficiency of the drainage for a long time as the ARI is for about 100 years. Besides, rapid urbanization might modify the hydrological processes of a catchment. It is responsible for many water related problems in urban areas, especially in the tropical regions. Urban drainage systems, often cannot cope with intense convective rainfall events. Therefore, the updated data is needed to make as a reference to design drainage and storm water management.

Besides that, there are not all stations in Klang Valley stated in MSMA 2 because in MSMA 2 the data only represent for major towns. This means that there is a large potential error in extrapolating to long ARI such as 100 years. Data of the nearest district area are used to design the area that is not stated in the MSMA 2. Since the

place is different, the data of the nearest area is not very efficient to design the drainage system.

1.3 Objectives

The objectives of this study are;

- To develop IDF curves using frequency analysis such as Gumbel distribution and Log-Normal distribution in Klang Valley.
- To estimate the fitting constant of Intensity Duration Frequency curve in Klang Valley using Sherman Equation.
- To analyze the rainfall intensity values between MSMA 2 and estimated fitting constants of Intensity Duration Frequency curve in Klang Valley using Sherman Equation.

1.4 Scope of Study

This study involved only some part of the Klang valley as there is no official designation of the boundaries that make up Klang Valley but it is often assumed to comprise the following areas and their corresponding local authorities which are Federal Territory of Kuala Lumpur, Selangor district of Petaling, Selangor district of Klang, Selangor district of Gombak, Selangor district of Hulu Langat.

The data collections are from Department of Irrigation and Drainage (DID) where Klang Valley area is using Annual Maximum Series (AMS) rainfall data from year 1995 to 2016 to develop IDF curves. The duration of IDF curves from 5, 10, 15, 30, 60, 180, 360, 720, 1440, 2880, 4320 and 7200 minutes and the ARI including 2, 5, 10, 20, 50 and 100 years.

To construct the IDF curve, there are two methods that are used. The method was Gumbel Distribution and Log Normal Distribution Function. The empirical formula used to determine the IDF curve fitting constants is Sherman Equation. The different percentage of rainfall intensity between MSMA 2 and the estimated fitting constants of Intensity Duration Frequency curve in Klang Valley using Sherman Equation has been analysed.

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