THE DEVELOPMENT OF INTENSITY-DURATION-FREQUENCY CURVES FOR KUANTAN RIVER BASIN

NOR HIDAYAH BINTI ISMAIL

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

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Report submitted in partial fulfilment of requirements
for the award of the degree of
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LIST OF SYMBOL

P_i	The rainfall at neighbor stations
N_x	Annual rainfall at missing data station
N_i	Annual rainfall at neighbor station
n	The number neighbor station whose data are used
P_x	The missing precipitation
P_n	The precipitation value at *n* station
σ	Standard Deviation
μ	Mean
X_i	The variate i.e record used in the computation
N	The total number of record
$\bar{x}_i$	Mean of the sample
α_z	The scale
λ_z	Shape parameters of the gamma distribution
P_T	The frequency precipitation
K	Gumbel frequency
S	Standard deviation of *P* value
P_{ave}	The average of the maximum precipitation in a specific duration
T_d	Duration in hours
P^*_T	The frequency precipitation
S^*	Standard deviation of *P** value
K_T	The Pearson frequency factor which depends on return period (*T*) and skewness coefficient (*Cs*).
v	Degree of freedom

s	Number of parameter using fitting distribution
A^2	Anderson-Darling statistic
$F_n(x_{(i)})$	Empirical Distribution (PDF)
$x_{(i)}$	The ordered data
T	Return period (years)

LIST OF ABBREVIATION

MSMA	Manual Saliran Mesra Alam
CDF	Cumulative Density Function
PDF	Probability Density Function
KS	Kolmogorov-Smirnov Test
LP3	Log-Pearson Type III
LN	Log-Normal
IDF	Intensity-Duration-Frequency

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ABSTRACT

Kuantan is one of the flood prone areas that identified in Pahang. The main river basin is Kuantan River. This basin is responsible to drain water from the correspond catchment area to the South China Sea . Due to heavy local rainfall is often occur in the Kuantan area , Kuantan River as main river basin is cannot longer support the volume of the rainfall will causing the flood to the areas surrounding. It is getting worse year by year with heavy rainfall especially at low level area cause of clog drain, design failing, wrong estimation and other natural causes. Besides, the rainfall data in MSMA 2 has not been updated by JPS and it is not reliable to be used as a reference for any hydraulic design. In MSMA 2, only one station which is Sg.Lembing P.C.C.L Mill represent Kuantan district and its intensity parameter will be used for the development project along the Kuantan River Basin. That way may affect the value of intensity should be used for that location area. Thus, the purpose of this study is to develop intensity-duration-frequency (IDF) curve for all 10 station along the Kuantan River Basin based on historical data. Also, to analyse the appropriate frequency analysis in developing IDF curve for Kuantan River Basin and also to compare the rainfall intensity values between MSMA and appropriate frequency analysis for IDF curves. The rainfall data that required for construction of IDF curve is from the Department of Irrigation and Drainage (DID). The data period of 5 minutes to 7200 minutes starting on year 1971 to year 2015. To designing IDF curve, process involved are find the value of mean, standard deviation, frequency factor, rainfall depth and intensity value for 2, 5, 10 ,20, 50 and 100 years return period for both methods Gumbel and Log-Pearson Type III. The range percent of difference intensity between MSMA and new IDF curve is (0.0493%-98.1556%). It is cause by the location of new station either far away or near with the station Sg.Lembing P.C.C.L Mill. Gumbel and Log-Pearson Type III method is used to compare whether it is appropriate to be used for construction of IDF curve for Kuantan River Basin. So, in order to test the accuracy of both methods, Kolmogorov Smirnov (KS) was be used for fitting distribution. Based on the result, mostly Log-Pearson Type III test which is 0/120 test was rejected while Gumbel Distribution showed to fit the graph than Log-Pearson Type III by that accept 120/120 test. So, Gumbel is accepted 100% from all test in Gumbel that can be acceptable compared to LPT III.

ABSTRACT

Kuantan adalah salah satu kawasan berisiko untuk banjir yang dikenalpasti dalam Pahang. Lembangan sungai utama ialah Sungai Kuantan. Lembangan ini bertanggungjawab untuk mengalirkan air dari kawasan tadahan ke Laut China Selatan. Oleh kerana hujan tempatan yang lebat sering berlaku di kawasan Kuantan, Sungai Kuantan sebagai lembangan sungai utama tidak boleh lagi menampung jumlah hujan yang akan menyebabkan banjir di kawasan sekitar. Ia menjadi teruk menjelang tahun ke tahun kerana hujan yang sangat lebat terutama pada kawasan yang lebih rendah menyebabkan kawasan longkang tersumbat, kegagalan reka bentuk, serta anggaran yamg salah. Selain itu, data hujan dalam Manual Saliran Mesra Alam 2 (MSMA 2) tidak dikemaskini oleh JPS dan ia tidak relevan untuk digunakan sebagai rujukan bagi apa-apa reka bentuk hidraulik. Dalam Manual Saliran Mesra Alam 2, hanya satu stesen iaitu Sg.Lembing P.C.C.L Mill yang mewakili daerah Kuantan dan parameter intensiti akan digunakan untuk projek pembangunan di sepanjang Lembangan Sungai Kuantan. Dengan cara itu, ia boleh memberi kesan kepada nilai keamatan yang akan digunakan ditempat itu. Oleh itu, tujuan kajian ini adalah untuk membina lengkung keamatan-tempoh-kekerapan (IDF) untuk semua 10 stesen di sepanjang Lembangan Sungai Kuantan berdasarkan data mentah. Juga, untuk menganalisis analisis kekerapan yang sesuai dalam membangunkan IDF lengkung untuk Sungai Kuantan .Selain itu, perlu membandingkan nilai keamatan hujan pada MSMA 2 dan nilai keamatan hujan yang baru untuk lengkung IDF. Data hujan yang diperlukan untuk pembinaan lengkung IDF adalah daripada Jabatan Pengairan dan Saliran (JPS). Tempoh data selama 5 minit hingga 7200 minit bermula pada tahun 1971 hingga tahun 2015. Untuk menghasilkan lengkung IDF, proses yang terlibat adalah mencari nilai purata, sisihan piawai, faktor kekerapan, kedalaman hujan dan nilai keamatan untuk 2, 5, 10, 20 , 50 dan 100 tahun kembali tempoh untuk kedua-dua kaedah Gumbel dan Log-Pearson Jenis III. Gumbel dan Log-Pearson Jenis III kaedah yang digunakan dalam project ini untuk membandingkan sama ada kaedah itu sesuai digunakan bagi pembinaan lengkung IDF untuk lembangan Sg.Kuantan. Jadi, untuk menguji ketepatan kedua-dua kaedah, Kolmogorov Smirnov (KS) telah digunakan. Berdasarkan kepada keputusan, kebanyakannya Log Pearson ujian Jenis III yang 0/120 ujian telah ditolak manakala kaedah Gumbel pula menunjukkan 120/120 ujian telah diterima. Jadi, kaedah Gumbel telah diterima 100% daripada semua ujian yang menjadikan kaedah ini lebih sesuai digunakan untuk pembangunan lengkung IDF di Sungai Kuantan berbanding LPT III.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Malaysia's climate is hot and humid throughout the year since it is situated near the equator. According to the Malaysian Meterological Department, Malaysia experience a rainy season almost every year neither lightly nor heavy rainfall. The average annual rainfall is estimated at 3000 mm In Malaysia , the weather can be divided into two monsoon which is southwest that occur late May to September while the other monsoon is Northeast monsoon usually start from November to March. The transition period in between the monsoon is known as intermonsoon period (MMD, 2015).

The seasonal wind flow pattern is to determine the rainfall distribution patterns over the country . During the northeast monsoon season occur, the exposed areas like east coast of Peninsular Malaysia, Western Sarawak and the northeast coast of Sabah will experience heavy rain spells. On the other hand, areas are sheltered by mountain ranges are free from its influence . It is best to describe the rainfall distribution of country according to season . Rainfall is the amount of precipitation that fallen within a specific period of time.The rainfall processes has always been determined which include the estimation of the rainfall distribution and identification of wet or dry events on a particular day. The rainfall are often related with changes of climate. Rainfall distribution pattern will change due to type of monsoon wind that blowing at different times in a year (MMD, 2015).

This situation of rainfall will cause the variety pattern of rainfall that fallen to the ground. The data of rainfall at the certain location are needed for design drainage system. So data of rainfall that have been collected will be used in the design formula or using various of software in order to achieve the parameters and the expected result in water system design. From this data finally will produce the intensity duration frequency (IDF) relationship curve . In these curves are presented three important parameters of the rainfall, such as rainfall intensity, duration and frequency. These type of parameters are very important and sometimes very crucial in the work design.

The two type of monsoon winds which are blowing moist air from different directions depending on the season will give neither lightly nor heavy rainfall . When heavy rainfall occur , the basin receives large amount of rainfall that will result for flash flood to the areas surrounding . North-East Monsoon that occur between November until February bringing heavy rain often causing floods for the east coast of Peninsular Malaysia including Pahang , Kelantan and Terengganu (MMD, 2015).

Kuantan is one of the flood prone areas that identified in Pahang . It covers area up to 2025 km^2. The location is in the state of Pahang and the main river basin is Kuantan River . This basin is responsible to drain water from the correspond catchment area to the South China Sea . Due to heavy local rainfall is often occur in the Kuantan area , Kuantan River as main river basin is cannot longer support the volume of the rainfall making will causing the flood occur . The way to prevent flood from happen is construction of the rainfall intensity-duration-frequency (IDF) relationship curve. This type of relationship is the 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 establishment of such relationships were done as early as in 1932 (Bernard, 1932).

1.2 PROBLEM STATEMENT

In the every year, part of the Pahang state have been affected by problem related to flooding. Kuantan is one of the parts in Pahang experienced severe flooding. The main river basin is Kuantan River. The flooding occurs because of heavily rainfall in the area of the Kuantan River Basin. The heavily rainfall cause the basin receives a large amount of rainfall which the basin longer cannot support that will result the flood to the areas surrounding. The effects of flooding is people in Kuantan area were dislocation from their place or home and also the government and private sector properties have been damaged that cause a big impact on our country economy due to poor design of drainage system and flooding management system in Malaysia.

Manual Saliran Mesra Alam (MSMA) has been published by Jabatan Pengairan and Saliran. The IDF curve becomes a reference for hydraulic design method. Based on MSMA, we can obtain the existing data for Sg Kuantan which is station Sg.Lembing P.C.C.L Mill IDF curve between 1980 until 2009. So that means, there is data from year 2011 until 2015 that has not been updated by JPS. So it is not reliable as a reference for engineer to design drainage system due to climate change.

Besides that, not all stations in Pahang stated in MSMA 2. For Kuantan, the construction of IDF curve only in station Sg.Lembing. So, in pursuing development today where many areas began to build, there is difficulty if the development area doesn't state in MSMA 2. For station along the Kuantan River Basin that not covered in MSMA 2 need to use station Sg.Lembing P.C.C.L Mill intensity parameter as the nearest station to calculate intensity for design drainage. That way may affect the value of intensity should be used for that location area and design drainage for that location.