THESIS

RAINFALL TIME-DISTRIBUTION ANALYSIS FOR FLOOD DESIGN COMPUTATION CASE STUDY UPPER CIKAPUNDUNG RIVER BASIN

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PERNYATAAN

Saya yang bertandatangan di bawah ini,

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Dengan ini menyatakan bahwa skripsi saya yang berjudul: "**RAINFALL TIME-DISTRIBUTION ANALYSIS FOR FLOOD DESIGN COMPUTATION CASE STUDY UPPER CIKAPUNDUNG RIVER BASIN"** adalah karya ilmiah yang bebas plagiat. Jika di kemudian hari terdapat plagiat dalam skripsi ini, maka saya bersedia menerima sanksi sesuai dengan peraturan perundang-undangan yang berlaku.

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ABSTRACT

Flood discharge computation plays an important role in predicting flood occurrence in certain areas, especially areas which have relatively heavy storm events throughout the years, such as upper Cikapundung watershed. The analysis process requires data input of storm design which have its hourly distribution. The rainfall time-distribution can be obtained if there's an hourly rainfall recording station. Problems occur when no hourly rainfall data is available; therefore the storm design can't be distributed hourly. But, as an alternative, the rainfall time-distribution can use the ones that have been developed in other areas. To obtain the alternative rainfall time-distribution, the mass curve and outflow hydrograph result in upper Cikapundung watershed model is compared between the one using rainfall time-distribution from real-time data (in this case from Station Bandung) and the one using other rainfall time-distributions. Rainfall time-distribution for Bandung has an 8-hour duration which is selected based on the most often occurrence of rainfall throughout the years. The calibrated model results in similar mass curve and outflow hydrograph by using SCS type III rainfall time-distribution with 8-hour duration as well. This time-distribution therefore can be applied as an alternative to represent rainfall hourly distribution for upper Cikapundung watershed.

Keywords: Flood discharge computation, hourly distribution, rainfall time-distribution, mass curve, outflow hydrograph

ANALISIS POLA DISTRIBUSI HUJAN TERHADAP PERHITUNGAN DEBIT BANJIR DAS CIKAPUNDUNG HULU

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ABSTRAK

Analisis debit banjir memegang peranan yang penting dalam memprediksi besarnya limpasan yang terjadi dalam suatu daerah, terutama daerah yang memiliki curah hujan tahunan besar seperti DAS Cikapundung hulu. Perhitungan debit banjr memerlukan data masukan berupa curah hujan rencana yang terdistribusi jam-jaman. Pola distribusi hujan dapat diperoleh apabila terdapat stasiun pencatatan hujan jam-jaman. Apabila tidak tersedia data curah hujan jam-jaman, maka sebagai alternatif dapat menggunakan pola distribusi hujan yang sudah dikembangkan di wilayah lain. Untuk menguji kecocokan pola distribusi pada DAS Cikapundung, simulasi model dilakukan serta dibandingkan hasil hidrograf banjir dengan menggunakan pola distribusi hujan sesuai data (dari Stasiun Bandung) dan dengan menggunakan pola distribusi hujan yang lain. Pola distribusi hujan Bandung memiliki durasi hujan 8 jam, dimana durasi tersebut merupakan durasi hujan yang paling sering terjadi selama tahun-tahun pengamatan. Hasil model yang sudah terkalibrasi mengindikasikan kecocokan kurva massa dan hidrograf banjir apabila menggunakan pola distribusi hujan SCS tipe III dengan durasi hujan 8 jam. Pola distribusi hujan ini dapat digunakan sebagai alternatif untuk merepresentasikan pola distribusi hujan DAS Cikapundung hulu.

Kata Kunci : Analisis debit banjir, distribusi jam-jaman, pola distribusi hujan

PREFACE

This thesis is made as a completion of the bachelor education in Civil Engineering from Faculty of Engineering Parahyangan Catholic University. Praise and thank the presence of God for the abundance of grace so that I am able to finish thesis "RAINFALL TIME-DISTRIBUTION ANALYSIS FOR FLOOD DESIGN COMPUTATION CASE STUDY UPPER CIKAPUNDUNG RIVER BASIN".

Several persons have contributed academically, practically, and with support to this thesis. I would therefore like to express my gratitude to:

1. My advisor Doddi Yudianto, Ph.D. and co-advisor Steven Reinaldo Rusli, S.T., M.T., M.Sc. for their time, valuable input, and support throughout the entire process of completing this thesis.
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6. All my other friends and colleagues who can't be mentioned one by one who have given their support

I realize that this thesis is far from perfection, therefore I really hope for critiques and suggestions so that I can improve this thesis. Finally, I wish that this thesis is not only useful for me, but also it can be favorable for students or anybody else who read.

Bandung, 25th June 2018

Kevin Christian
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TABLE OF CONTENTS

ANNOTATIONS

A_i	:	Gage Weight Factor
CN	:	*Curve Number*
Cs	:	Skew Coefficient
CV	:	Coefficient of Variation
Ft	:	Stability Value
Ia	:	Initial Abstraction (mm)
k	:	Frequency Distribution Parameter
Kn	:	Outlier Test Constant
L	:	Hydraulic Length of Watershed (m)
n	:	Manning's Roughness Coefficient
P	:	Wetted Perimeter
$P_{(X)}$	:	Probability of Event X
q	:	Lateral Inflow
Q	:	Flow Rate (m^3/s)
$\overline{R}$	:	Regional Rainfall
R_i	:	Rainfall Depth Data
R_{sp}	:	Spearman's Rank-correlation Coefficient
s	:	Standard Deviation
S_{tr}	:	Standard Deviation of Variant Value
S_o	:	Channel Slope
T	:	Return Period
$Tlag$	:	*Lag Time* (menit)
x	:	Observed data
$\bar{x}$	:	Population Mean Value
$\bar{y}$	:	Mean Value of Data
Y	:	Average Land Slope
$Y_{H,L}$	:	Threshold of Upper and Lower Outlier (in logarithmic)
Yn	:	Mean Value of Reduced Variant
Δt	:	Time Step
Δx	:	Distance Step
α	:	Concentration Parameter
β	:	Location Parameter
Γ	:	Gamma function

LIST OF FIGURE

LIST OF TABLE

APPENDIX

CHAPTER 1
INTRODUCTION

1.1 Background

Indonesia is a nation with a large amount of annual rainfall, around 2000-3000 mm/year according to the rainfall record by Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). The occurrence of every rainfall isn't equally distributed throughout the entire region of Indonesia. West region of Indonesia tends to have bigger rainfall depth compared to the east region of Indonesia. This is caused by the difference in geographical location and climate change that the distribution of rainfall isn't equal in a scale of space, time, and amount. Problems occur when dealing with large amount of rainfall depth and random distribution of rainfall, such as abundance of water in some regions. Therefore, flood control design is needed to prevent such problems especially in the west region of Indonesia.

Cikapundung River is a river located in West Java Province with a length of 28 km. This river's upstream is in Bukit Tunggul Mountain and it flows south across Bandung until it empties into Citarum River. The river creates Cikapundung catchment area of 434.43 km^2 which covers regions of Kabupaten Bandung Barat, Kabupaten Bandung, and Kota Bandung. Throughout the river flows, especially in downstream region, many people utilize the water for domestic, commercial, industrial, and agricultural use. The water in this river becomes heavily polluted recently, which cause not only quality problem but also quantity problems. Due to the amount of solid waste being irresponsibly thrown away to the river, floods often occur throughout this region, especially in the event of heavy rainstorms. Aside from dealing with this social and water quality problems, flood control design is needed to tackle the occurrence of heavy rainfalls.

Flood control design analysis requires input data of rainfall design with an hourly distribution. Time distribution of rainfall can be obtained if there is an hourly

rainfall recording from an automatic rainfall station. However, not all regions in West Java have this automatic rainfall station. Hence, a time distribution of rainfall to represent this area is needed in doing analysis.

An alternative way to determine time distribution of rainfall is by following patterns that have been developed in certain areas, such as time distribution of rainfall developed by Wanny, Tadashi Tanimoto, SCS, Huff, and PSA 005. Wanny developed an hourly rainfall distribution for West Java region; in accordance Tadashi Tanimoto (1969) developed one for the entire Java Island. Soil Conservation Service (SCS, 1972) developed a synthetic time distribution in flood design to represent the actual rainstorm. PSA 005 time distribution of rainfall is developed by Ministry of Public Works in Guideline for Design Floods document. Huff (1967) developed a time distribution of heavy rainstorm on an area over 400 mi^2 in Illinois. From these available time distribution, flood design modelling can be done to determine which time distribution is applicable for West Java region.

Based on those issues, this research is meant to do study towards a time distribution of rainfall which can represent West Java region. Assessment to the suitability of the time distribution is determined by flood design analysis based on available data.

1.2 Key Problems

Hourly rainfall data recording in West Java region is limited. Consequently, a time distribution of rainfall which can represent this region is needed so that flood design analysis can be done for a specific location in West Java using that time distribution. The quality and quantity of hourly rainfall recording should be increased to overcome the limitation of data. Aside from that, analysis on time distribution of rainfall using the developed time distributions can be done to replace the actual time distribution.

1.3 Study Objectives

This study is basically aimed to determine the time distribution of rainfall which can represent West Java region based on the available hourly rainfall data. The detailed objectives are as follows:

1. Produce model of Cikapundung catchment area for flood design purpose;
2. Compute time distribution of rainfall according to the available hourly rainfall data;
3. Identify the changes of runoff hydrograph by using different time distributions;
4. Determine the most suitable time distribution of rainfall.

1.4 Scope of Study

To prevent the extent of problems analysis, this research will only discuss about the time distribution of rainfall in West Java region, specifically in Cikapundung catchment area. The time distribution is applicable only for a relatively small catchment area and return period under fifty year. Flood design modelling of Cikapundung catchment area uses software HEC-HMS.

1.5 Research Metodology

This study basically consists of series of analysis, starting from rainfall data analysis, time distribution analysis, and flood discharge analysis. Rainfall data screening and frequency analysis are done for further use to estimate design storm and flood discharge using return period of 2, 5, 10, and 25 years. The hourly rainfall data is analyzed to produce a time distribution rainfall. Modelling on Cikapundung catchment area uses mathematic model Hydrology Engineering Center – Hydrology Modelling System (HEC-HMS) by using gage weight method for regional rainfall and SCS method for transformation of rainfall-runoff. The calibrated model in which a time distribution based on real-time data is then compared to different time distributions from the developed ones (PSA 005, Huff, SCS, etc.) applied to the

calibrated model. The time distribution that produces the least changes on runoff hydrograph can be selected as the one represents West Java region. Figure 1.1 shows the flow chart of research methodology.

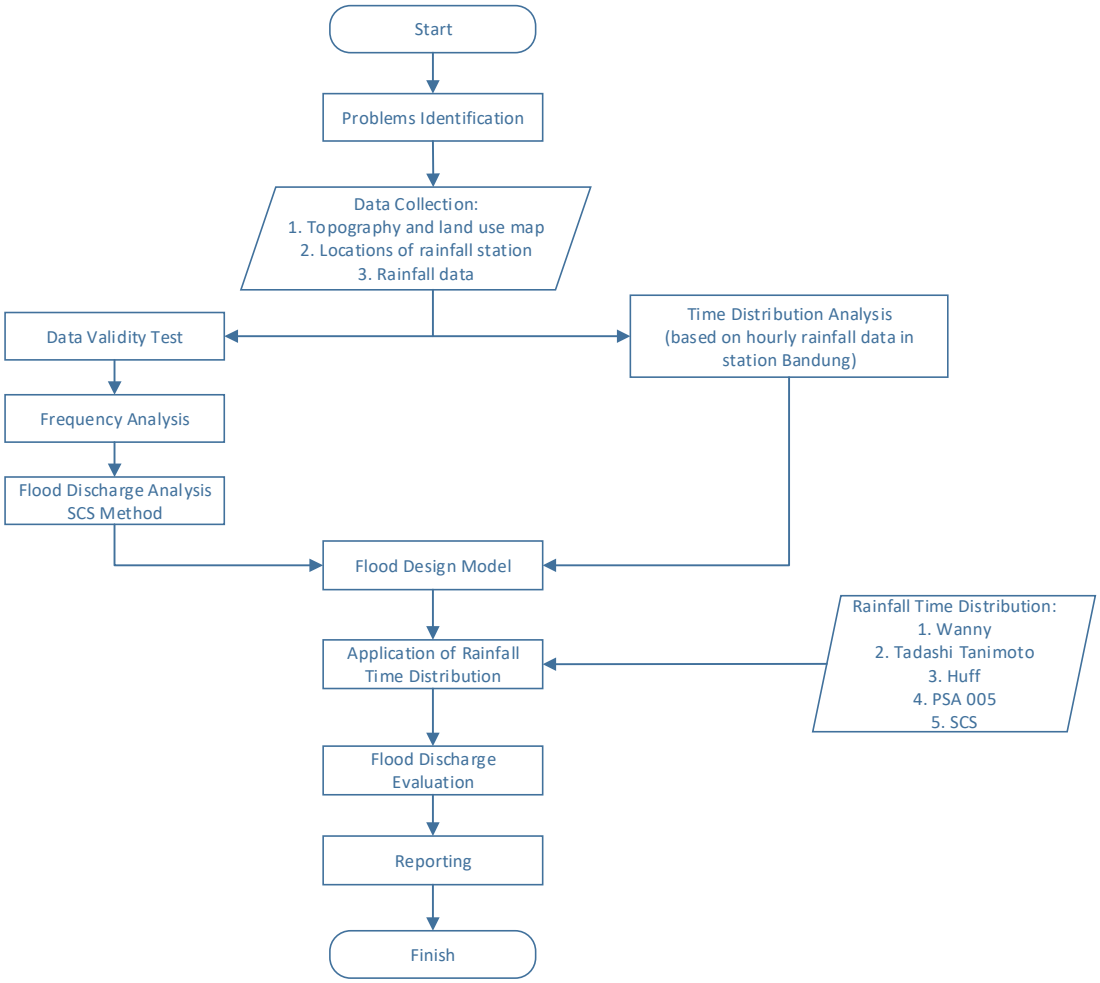

Figure 1.1 Research Methodology Flow Chart