Synthetic Analysis of Hidrograf Units using the Method of HSS Nakayasu, Snyder And Limantara *(Study in DAS Way Sulan)*

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Abstract. DAS Way Sulan located in East Lampung Regency of Lampung Province. DAS Way Sulan this was the area of review in the research of the preparation of this thesis. Flood-prone areas in the planning area includes the rea of the estuary's Way Home, flood plains and alluvial plain especially along the Way Sulan. Factors cause flooding include the high rainfall, the closure of land upstream capacity and reduced flow of the rivers especially in areas of lower reduced due to sedimentation and topographic area. Flood hazards/safeguards for potential flooding in River Way Sulan can do planning safeguards against a flood with a building plan that aims to reduce the damage that occurs due to the flood levels most minimum. Building planning in the field of water resources can be done well if rainfall data at each station the rain can be known and calculated using the debitnya method of the HSS. *Key Words: Synthetic Unit Hidrograf.*

1. Introduction

1.1 Background

In Lampung there are 3 (three) units of river basin *(SWS)* SWS Mesuji bones, onions, White-Compatriot and SWS watermelon. A third of this Way Sulan SWS is a tributary of the Way his Compatriot yng DAS 500 km2, Way less than a River empties into Sulan Way with Compatriot River 62 Km in length and with an area of 217 Km2, DAS Way Sulan is part of the WS Way Compatriot more river for the fulfillment of the needs of the community of South Lampung district compared to other rivers.

This is because the availability of water, the topography which allows for farming wetlands, Center leaning more economic growth exist the River region which is followed by population growth and growth the industry. Way Sulan had important function as a source of water for irrigation and also needs water to surrounding communities, but the River could potentially flood every year that could damage agricultural.

1.2 The intent of this Research.

Research is to know the magnitude of the design flood discharge and which method is most effective and approaching the magnitude of flood discharge design in DAS Way Sulan to the planning needs of the floods on the river way Sulan keter who experience limitations in the data, it needs to be done the calculation by using the method of Synthetic Unit Hidrograf, analysis, calculation of Design Flood Discharge of rainfall Maximum Year.

1.3 Limitation Issue.

1.DAS used small Watershed *(DAS with extents ≤ 500 km ²).*
2. The maximum daily rainfall Data for 20 years Starting from the 3.
3. Frequency analysis using a Log Pearson III.
4. The method used is the HSS comparison method HSS Nakayasu, Limantara and Snyder.
5. A time plan is Q 2, 5,10,20 and 25 year.

1.4 The benefits of Research.

With the research is expected to provide information and considerations about the use of methods of HSS Nakayasu Snyder and Limantara in the analysis of flood discharge plan in DAS Way Sulan.

2. The Cornerstone Of The Theory

Sri Soeharto *(1993)* defines the Watershed *(DAS)* is the area where all the water drains into a river that was intended. This area generally bounded by topographic boundaries, meaning set forth is based on air-surface flow, and not assigned based on underground water due to surface soil water always changed according to the.

2.1 Frequency Analysis

Frequency analysis is not to determine the magnitude of the discharge flow of the River at one time, but it is more appropriate to estimate whether the river flow discharge will exceed a certain price equals/example for 10 years, 20 years and beyond that will come. In hydrology, the analysis used to determine the magnitude of rain and flood discharge design *(design flood)* with a certain birthday.

2.2 Analysis Of The Quality Of The Data

Outlier Data Test Data is an outlier data deviate too high or too low of a set of data for analysis, so it is good to use. Outlier data test has three conditions name:

1) If log >, Cs Cs 0.4 high outlier test then data correction, outlier test is low, the correction of data.

2) If Cs Cs 0.4 then log <: low outlier test, correction data, test the high outlier, correction of data.

3) If-0.4 0.4 Cslog < then; outlier test high or low, the correction of data. The formula used:

By:

Cs = coefficient Log = raw Byway Slog Log X = K Kn (taken from the outlier test K value) depending on the amount of data in the analysis. Lox XH = high Outlier Log Xl = low Outlier

Analysis Of Rainfall.

To get the average rainfall of the measurement results of rain in several measurements can be used method of Thiessen Polygon :

$R\ A1R1+A2R2+\cdots.Anrn\ A1+A2+\cdots.An$ ……………........(1)

With:

R = rainfall regions R1, R2, ...,

Rn = rainfall in each point observations and n is the number of observation points

A1, A2, ..., An = extensive areas that represent each of the observation station.

Statistical parameter in the analysis of hydrological data required numerical measurements that characterize the data. The parameters used in the analysis of the arrangement of the data from a variable called parameter statistics *(Triatmodjo, 2008)*. The statistical parameters used in the analysis of hydrological data are: average count, By way *(standard deviation)*, the coefficient of variation, the (the coefficient of skewness) and kurtosis coefficients. The function of distribution opportunities that are used are: Gumbel distribution, Normal distribution, Normal distribution, the distribution Log Pearson III.

2.3 The test match

Is the test match is intended to assess whether certain types of frequency distribution curve can describe/represent the distribution of observation data. The test match is the test done with the Kolmogorov-Smirnov *(Triatmodjo, 2008)*.

2.4 Debit flood Plan.

Flood plan is the largest discharge that may occur on the River in question. There are several methods for maintaining flood discharge. The method used at a location determined by the availability of more data. A common method used is the hidrograf method of the flood and the rational method. *(Suripin, 2003)*.

2.5 Hidrograf Synthetic Nakayasu Units

The required parameters in the analysis using Hidrograf Synthetic Unit Nakayasu, among others:

1. The period from the beginning of rain until the peak of hidrograf *(Time to Peak Magitude)*
2. Grace period from the point to the point of heavy rains heavy hidrograf *(Time Lag)*
3. Hidrograf grace period *(the Time Base of the Hydrograph)*
4. Area stream *(Catchment Area)*
5. The length of the longest major rivers flow *(the Length of The Longest Channel)*
6. The coefficient stream (Run off's) Peak Flood Discharge:

Discharge of flood peaks:

$$Qp = \frac{CA.Ro}{3,6(0,3Tp + T_{0,3})} \text{ ....(2)}$$

By :
Qp = peak flood discharge (m3/dt)
Ro = rain unit (mm)
Tp = time lag from the beginning of rain until the peak of the floods (HR).
T0, 3 = time needed by a decrease in discharge, from a peak of up to 30% of the peak discharge (HR)
CA = area stream to o utlet (km2)
To determine the Tp and T0, 3 use the following formul.
Approach :
Tp = tg + 0,8 tr …………..(3)
T0,3 = α tg ………..…(4)
Tr = 0,5 tg get to tg

2.6 Hidrograf Synthetic unit

Of Snyder Snyder developed the model with empirical coefficients linking elements hidrograf unit with characteristics of the Watershed. It is based on the idea that rain into the flow of good translation or influence can be explained is influenced by his WATERSHED system *(Sri Soeharto, 1993).* The hidrograf elements associated with A = stream area (km²) L = length of main flow (km) LC = the distance between the point of weight by the release stream area (outlet) measured along the mainstream. With these elements Snyder make as follows:

$$Qp = 2,78\frac{Cp - .A}{T_p} \text{ ....(6)}$$

2.7 Hidrograf Synthetic Unit Limantara

In addition to the HSS Limantara, there is also a synthetic unit of Hidrograf (HSS) Limantara found by Montarcih Lily Limantara, year 2006. Research on location of parts of Indonesia namely in Java, Bali, Lombok and Kalimantan Timur. Due to the location of the research done on the DAS in Indonesia so that it has a characteristic DAS Indonesia. Parameters used in HSS Limantara among others: broad DAS (A), the main river Length (L), the length of the river is measured to the nearest point by point the weight of the DAS (Lc), the slope of the River (S), the coefficient of roughness (n)
Peak Discharge equation Qp=0,042.A0,451.L0,497.Lc0,356.S-0,131.n0,168 …...(7)
with
QP = peak discharge flood hidrograf unit (m3/dt/mm)
A = wide DAS (km2)
L = length of main river (km)
Lc = length of the River from the outlet to the point closest to the point of severe DAS (km)
S = the slope of the river roughness coefficient
n = main DAS
0.042 = coefficient for k onversi satuan (m0,25/dt).
The Equation Of The Curve Rises.
Qn=Qp.[(t/Tp)]1,107 …………………....(8)
With:
Qn = discharge on the equation of the curve rises (m3/dt/mm)
Qp = peak discharge hidrograf unit (m3/dt/mm)
t = hidrograf time (hours)
Tp = ride hidrograf time or time reach the Summit of hidrograf (HR) the equation of the curve down:
Qt = Qp.100,175(Tp – t) ………………………..(9)
With :
Qt = discharge on the equation of the curve down (m3/dt/mm)

Qp = peak discharge hidrograf unit (m3/dt/mm) Tp = ride hidrograf time or time reach the Summit of hidrograf (HR)
t = hidrograf time (hours) = 0.175
coefficient for unit conversion (dt-1)
Analysis Of Flood
Peak Discharge Equation Dimensions
(Qp)Qp = 0,042.A0,451.L0,497.Lc0,356.S
0,131.n0,168……………………………………………..(10)
analysis of the dimensions are as follows:
[L]2 [T]-1 = [L]0,25 [T]-1 [L 2]0,451 [L]0,492 [L]0,356
[L]2 [T]-1 = [L]0,25 [T]-1 [L]0,902 [L]0,492 [L]0,356
[L]2 [T]-1 = [L]0,25 + 0,902 + 492 +0,356 [T]-1
[L]2 [T]-1 = [L]2 [T]-1
The Equation Of The Curve Rises (Qn)
Qn=Qp.[(t/Tp)]1,107…………………………….(11)
analysis of the dimensions are as follows:
[L]2 [T]-1 = [L]2 [T]-1 { [T]-1 / [T]-1 }1,107
[L]2 [T]-1 = [L]2 [T]-1 x 1
[L]2 [T]-1 = [L]2 [T]-1
The Equation Of The Curve Down (Qt)
Qt=Qp.e0,175(Tp – t) ………………………… (12)
analysis of the dimensions are as follows:
ln Qt = 0,175 (Tp – t) x ln Qp…………….(13)
ln [L]2 [T]-1 = [T]-1 [T]1 x ln [L]2 [T]-1
ln [L]2 [T]-1 = 1 x ln [L]2 [T]-1
[L]2 [T]-1 = [L]2 [T]-1

2.8 Limantara HSS specifications.

Can be applied to other Watersheds has a similarity of characteristics with DAS on site research. HSS Limantara engineering specifications are presented in the following table.

Table 1. Specifications Techniques HSS Limantara.

Nott	Unit	Ranges
A	km^2	0,325 – 1667,500
L	km	1,16 – 62,48
Lc	km	0,50 – 29,386
S	-	0,00040 – 0,14700
N	-	0,035 – 0,070
Af	%	0,00 - 100

3. Analysis

3.1 The Analysis of Precipitation

Data plan maximum daily rainfall used in this analysis are sourced from Hydrological Unit BBWS Mesuji Compatriot with period 1995-note pen until 2016. Observation station used was three stations located in the DAS Way Sulan used namely Tanjung Bintang Station, station, station a new Gutter Humpback.

3.2 The Selection Of The Type Of Distribution Based On Statistical Parameter.

The parameter data that was used to be able to determine the exact type of distribution is divided 5 large measurements: measurements of central tendency (mean) or median count, Byway of baku *(standard deviation),* the coefficient of skewness), the coefficient variations, and keruncingan coefficient *(coefficient, kurtosis).* The determination of the appropriate distribution type with data done by the statistical parameter compatibility with the terms of each type of distribution.

Table 2. Review The Suitability Of The Type Of Distribution Based On Statistical Parameter

Type	Requirements	Results
Normal	$C_s \approx 0$ $C_k \approx 3$	$C_s = 1,2642$ $C_k = 4,6823$
Log Normal	$C_s = Cv^3 + 3Cv = 0,2874$ $C_k = Cv^8 + 6Cv^6 + 15Cv$	$C_s = 0,3855$ $C_k = 2,6708$
Gumbel	$C_s \approx 1,14$ $C_k \approx 5,4$	$C_s = 1,2642$ $C_k = 4,6823$
Log Pearson III	Apart from the	$C_s = 0,3855$ $C_k = 2,6708$

Based on the results of the review of the statistical parameters of observation data did not meet against the boundary parameter statistics, then try using data graphics. The Selection Of The Type Of Distribution By Way Of Graphics. The selection of the appropriate type of distribution with the distribution of observation data is done by making the line frequency curves based on mathematical equations for each type of distribution. The expected outcome is the formation of the curve based on the frequency of the reference points of the theoretical values by using mathematical equations curves the frequency distribution types that can represent the distribution of observation data. The representations made on probability paper. Its the test Method used is the Kolmogorov-Smirnov method. Kolmogorov-Smirnov test is carried out with the greatest chances of deviation between see observation data with the theoretical data.

Table 3. Test The Fit Of The Data Distribution Again.

The Type	The Differ	**Smirnov-Kolmogo**	
Normal	0,169	$D \leq 0,29$	fulfilling
Gumbel	0,130	$D \leq 0,29$	fulfillingi
Log-	0,149	$D \leq 0,29$	fulfillinghi
Log-Pearson III	0,124	$D \leq 0,29$	fulfilling

Thus all types leverage qualified test Kolmogorov-Smirnov. However, to calculate the flood discharge plan used type a mem-give value Dmax, in this case is the type of the distribution Log Pearson III. Then retrieved rain plan air-based method of Log Pearson III with a particular anniversary period, as in the following table.

Table 4. Rain Plan method a Log Pearson III with a period Certain Anniversary

Reset (Years)	Log Pearson Tipe III (mm)
2	92.1454
5	110.3846
10	121.5284
20	132.2610
25	134.5186

3.3 Analysis of Flood Discharge Plan

In calculating discharge flood plans to use three methods, namely Synthetic Unit Hidrograf (HSS) Nakayasu, Snyder and Limantara.

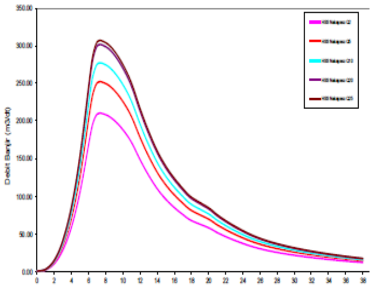

Figure 1. Hidrograf Synthetic Nakayasu Units.

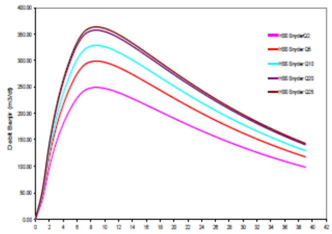

Figure 2. Hidrograf Synthetic Unit Of Snyder

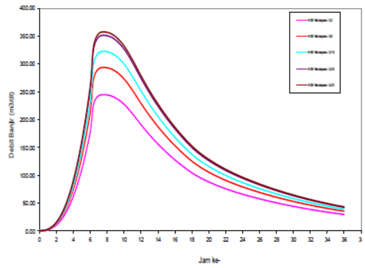

Figure 3. Hidrograf Synthetic Unit Of Limantara

Table 5. Debit Flood Plan Nakayasu For Various Restart Period

Num	Reset (Years)	Flood Discharge (m^3/det)
1	1.01	140.77
2	2	209.15
3	5	250.59
4	10	275.35
5	20	299.82
6	25	304.97

Table 6. Debit Flood Plan Snyder For Various Period Restarted

Num	Reset (Years)	Flood Discharge (m^3/det)
2	2	249.31
3	5	298.60
4	10	328.72
5	20	357.72
6	25	363.82

Table 7. Debit Flood Plan HSS Limantara For Various Restart Period

Num	Reset (Years)	Flood Discharge (m^3/det)
1	1.01	164.72
2	2	244.76
3	5	293.25
4	10	322.23
5	20	350.88
6	25	356.90

4. Conclusions And Suggestions

4.1 Conclusions

Based on the results of the Analysis of three methods of synthetic Unit Hidrograf using a maximum annual rainfall data obtained a conclusion that is as follows:

a. That the Synthetic Hidrograf of units that can be applied for the purposes of the calculations and planning the building of water in Watersheds Way Sulan Hidrograf is a synthetic unit of Snyder, because from the analysis results obtained that HSS Snyder resulted most debit flood plan compared to the two Other HSS 363.82 m³/sec .

b. Limantara HSS Time rise = 6.39, down Time = 36.36 hours.

c. HSS Snyder Time rise = 6.89, down Time = 116.03 hours.

d. Nakayasu HSS Time rise = 6.39, down Time = 26.37 hours.

e. To peak flood discharge HSS Limantara and HS S Snyder has almost the same magnitude of flood discharge, while HSS Nakayasu have discharge flood.

f. Smaller than 4 parameters DAS used in this method is the most dominant at the height of its influence on flood discharge, namely the length of the River, Broad river ,DAS koofisien roughness and long river in measure to the toughest point of the DAS.

4.2 Suggestion

Advice based on the results of the research associated with the verification results and benefits of this research at the recommend is as follows:

a. In accordance with the results of the research that has been done the slope of koofisien River, roughness and long rivers measure up to the heaviest point of DAS is the dominant factor in the creation of a synthetic unit of Hidrograf comparison, therefore it is necessary to return the third parameter of the study method of the HSS.

b.Considering the difficulty in making HSS model in determining the equation of peak discharge, the equation of the curve rises and curves down a really accurate, it needs to be equipped with AWLR and ARR respectively each DAS.

c. The calibration has to be done in order not to occur irregularities- against the analysis of HSS.

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