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Comparison of snyder synthetic unit hydrograph with measured unit hydrograph on Bionga Kayubulan

B Labdul* and A Alitu

Civil Engineering Faculty, State University of Gorontalo, Jl. Jend. Sudirman No.6,
Kota Gorontalo, Gorontalo, Indonesia

*barry.labdul@ung.ac.id

Abstract. Generally, the synthetic unit hydrograph had to be developed just like a kind of Snyder that found accord empire scientific in the United States. Determination of their parameters has been presented by various criteria, but so far, the results are still relatively deviated for watershed-watersheds in Indonesia. The study was conducted to Bionga Kayubulan sub-watershed that has properties and characteristics that need to be conducted regarding irregularities by comparing models HSS Snyder with unit hydrograph observations on sub-watershed. Hydrograph water level readings AWLR derived from a flood hydrograph, using the are discharge. to separate the base flow with runoff straight-line method is used to produce direct runoff hydrograph. From the data obtained ARR hourly rainfall records were then analyzed, using the equation effective rainfall of index Φ . Direct runoff hydrograph and rainfall effectively revealed to be the observation unit hydrograph using collins method. Based on topographic maps obtained watershed physical factors were then used to analyze HSS Snyder. Further comparison of the HSS Snyder constant adjustments made using software Microsoft Excel-Solver. Observation unit hydrograph Bionga Kayubulan sub watershed has a peak time (T_p) of 4.5 hours with a peak discharge (Q_p) of 2.81 m³/sec while Snyder HSS obtained from the analysis of T_p and Q_p of 5.15 hours of 0.33 m³/sec. The test results showed that the predicted ratio Snyder HSS HSS calibration better than Snyder before calibration. CE adjusted value is 0.11 and as adjusted to 0.93. The value of EV adjusted is 65.20% before and after adjustment to 2.70%. EQP value addition, AETR values, and values after adjusting widened AETp 0 hours.

1. Introduction

So far the design flood determination which is considered to be very accurate is the method of reducing the unit hydrograph from the measured flood hydrograph. However, the main obstacle faced was the difficulty in obtaining rain data and related observation flood hydrographs, which were caused by among others the recording equipment which was damaged, negligence of the officers, data that was corrupted so that it could not be read or lost, or indeed the recording device had not been installed. Thus, developed the hydrograph reduction method which is based on a rainy diversification into a good flow due to the influence of translational and reservoirs and are influenced by regional system streaming, known as Synthetic Unit Hydrograph [1].

Various HSS models have been developed by experts, including HSS Snyder (developed in the USA, 1938), HSS Nakayasu (developed in Japan, 1948), HSS Gama 1 (developed by Sri Harto) with research sites in 30 watersheds on the island Java, and HSS Limantara (developed in parts of Indonesia, 2006).



The models were developed based on the empirical approach. Empirical approaches are often local in nature, so to be applied elsewhere requires testing their validity [2-4].

Because the nature and characteristics of watersheds in the tropics are as varied as in the Bionga watershed, it is necessary to study the application of the Snyder HSS model and if necessary calibrate or adjust the coefficients of the parameters [5]. This is intended to get adequate calculation results and is considered to represent the characteristics of the local watershed. Thus the failure of water structures can be avoided as a result of using "blind" models [6].

2. Methods

Schematically the research process follows the flowchart as follows in figure 1.

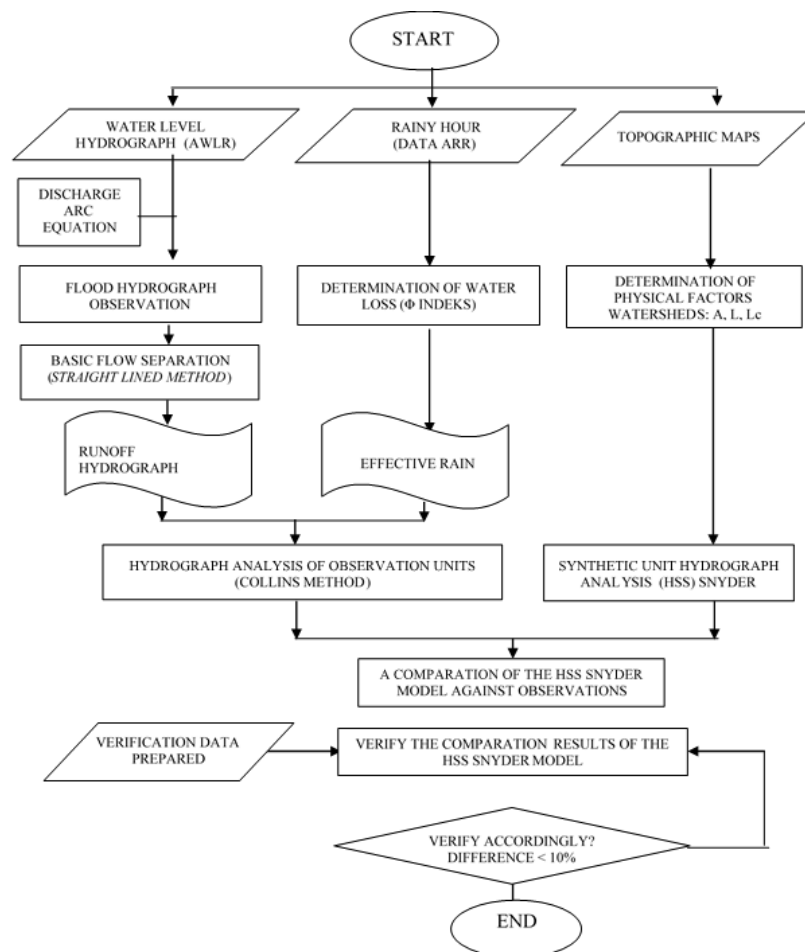


Figure 1. Research flow chart.

3. Results and discussion

Rain and flood events data used in this study are 1-2 December 2010, 6-7 December 2010, 7-8 December 2010, and 9-10 December 2010. To obtain measured hydrograph (observed) the Collins method is used [7]. Separately unit hydrograph is calculated using synthetic unit hydrograph / Snyder HSS using the Bionga watershed parameter. Next the difference between the measured unit hydrograph and unit hydrograph is calculated with results obtained using the Snyder HSS model.

Results obtained show a significant difference, so it is necessary to calibrate or adjust parameter coefficients of the Snyder HSS model. Furthermore, unused data in the calibration process is used to verify the Snyder HSS model to obtain new equations suitable for application to Bionga watershed.

Figure 2 shows the unit observation hydrograph of all events and the average unit observation hydrograph in Bionga sub-watershed Kayubulan.

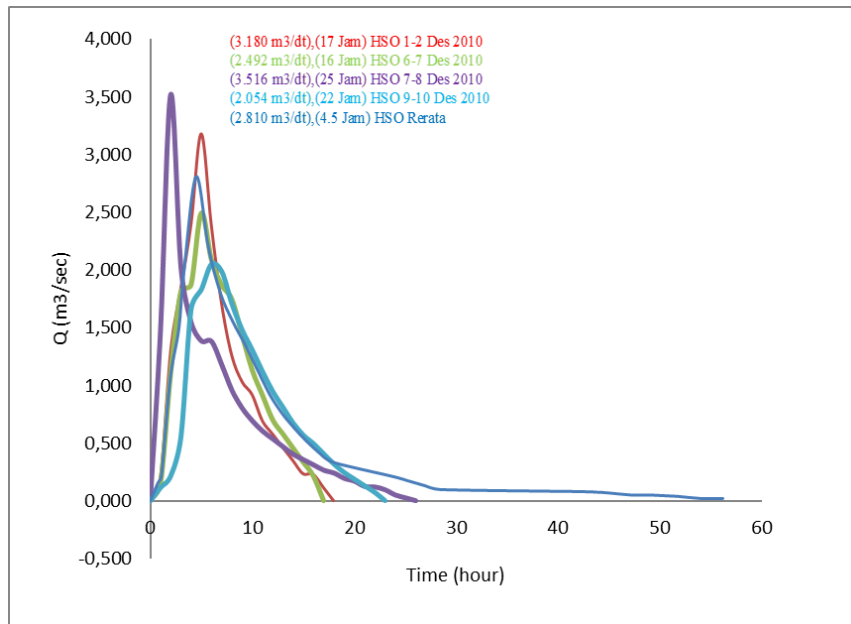


Figure 2. Observation unit hydrograph of all events and average observation unit hydrographs.

Figure 3 shows a difference in calculated hydrograph using the Snyder HSS model and observation hydrograph derived by Collins method. A significant difference was seen between outputs of Snyder HSS model and Observed HSS which tended to underestimate.

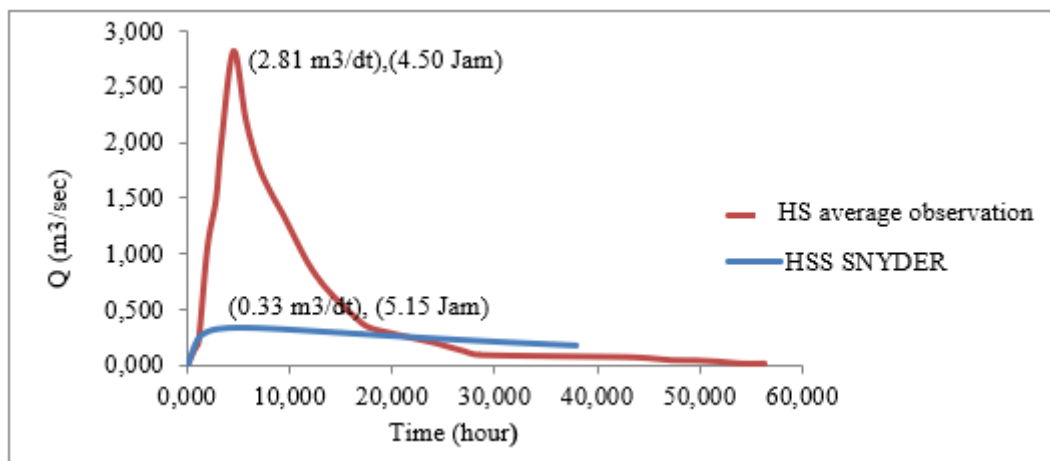


Figure 3. Hydrograph of Snyder and HSS average observation unit.

Next, by performing a calibration and verification of Snyder HSS model a new formula for Snyder HSS model will be obtained as shown in Table 1 and shown in Figure 4.

The calibration results are then verified with observed unit hydrograph data (HSO) that have not been used at the time of calibration. Verification of calibrated HSS Snyder model was carried out on observed unit hydrograph data (HSO) 1-2, which is an average of observation unit hydrograph on December 1-2, 2010 with observation unit hydrograph on December 6-7 2010. While HSO 3-4 is the average

hydrograph observation unit on 7-8 December 2010 with hydrographs of observation units on 9-10 December 2010. The results are as shown in Figure 5.

From the calibration and verification process, a new HSS Snyder model formula is suitable to be used for Bionga-Kayubulan sub-watershed and other watersheds have been obtained which have the same characteristics. The formula referred to in Table 2 with results of the compatibility test between calibration unit hydrograph and observation unit hydrograph is shown in Table 1. But when using the original HSS Snyder model formula, it is recommended that results be multiplied by multiplier factor as shown in Table 3.

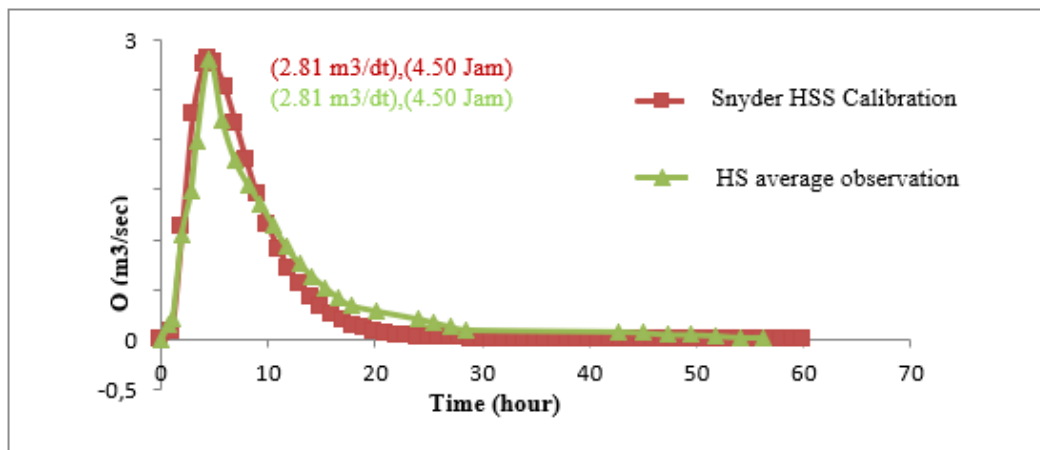


Figure 4. Snyder HSS calibration results.

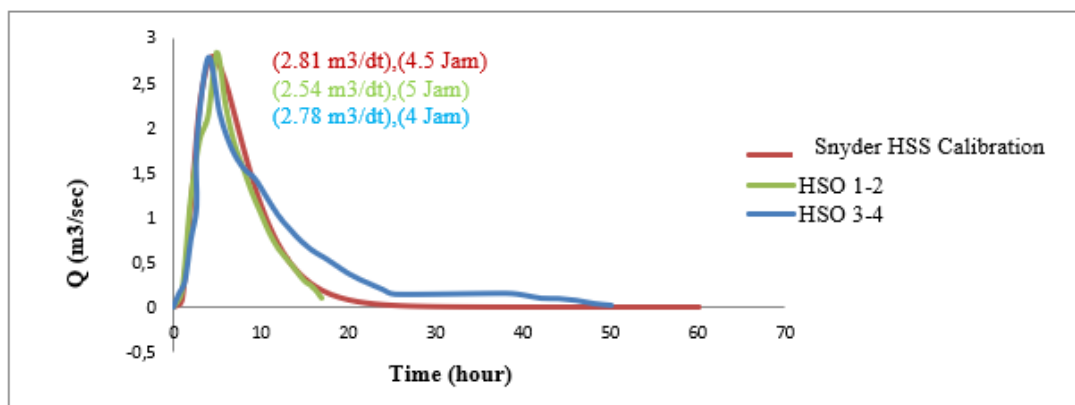


Figure 5. Comparison of HSS snyder calibration with HSO 1-2 and HSO 3-4 verification

Table 1. Test Results of Observation Unit Hydrograph Compliance with Calibrated HSS Snyder in Bionga Kayubulan Sub Watershed.

No	Parameter	Unit	
		HSS SNYDER	HSS SNYDER CALIBRATION
1	Coefficient of efficiency (CE)	0.11	0.92
2	Relative error from volume total (EV) (%)	65.20	2.70
3	Absolute error from peak discharge (AEQp) (m3/dt)	2.48	0.00
4	Relative error from peak discharge (EQp) (%)	23.09	0.00
5	Absolute error from peak time (AETp) (jam)	0.65	0.00

Table 2. HSS Snyder before and after calibrated.

No	HSS SNYDER	HSS SNYDER (calibrated)
1	$tp = Ct(L.Lc)^n$, Ct = 0,75 dan n = 0,3	$tp = 0,74506(L.Lc)^{0,27760}$
2	$te = \frac{tp}{5,5}$	$te = \frac{tp}{4,03548}$
3	$qp = 0,278 \frac{Cp}{Tp}$, Cp = 0,9	$qp = 0,278 \frac{0,669}{Tp}$
4	$a = 1,32 \lambda^2 + 0,15 \lambda + 0,045$	$a = 1,33543 \lambda^{1,96564} + 0,23186 \lambda$
5	$Q = qp * 10^{-a \frac{(1-x)^2}{x}}$, a = 0,04958	$Q = qp * 10^{-0,57719 \frac{(1-x)^2}{x}}$

Table 3. Multiplier factors of snyder HSS in Bionga Kayubulan sub watershed.

Variable	Multiplier Factor
Tp	0,87
Qp	8,52
a	11,64

4. Conclusion

Based on the results of the studies that have been carried out, it can be concluded as follows:

- Observation unit hydrograph in sub-watershed Bionga Kayubulan has a peak time (Tp) of 4.5 hours with a peak discharge (Qp) of 2.81m³ / s, whereas from HSS analysis Snyder has a Tp of 5.15 hours and QP of 0,33 m³/s.
- Comparison between HS Observation and Snyder HSS which has not been calibrated in Bionga Kayubulan watershed still shows significant differences and tends to underestimate. This can be seen from Coefficient of efficiency (CE) of 0.11, Relative error of total volume (EV) of 65.20%, Absolute error of peak discharge (AEQp) of 2.48 m³ / sec, Relative error of peak discharge (EQp) of 23.09% and Absolute error of peak time (AETp) of 0.65 hours. Thus the application of the Snyder HSS model in Bionga Kayubulan sub-watershed has not provided good predictive capabilities by following per under with nature and characteristics watershed.
- HSS Snyder calibration results on HS Observations gave quite good results, namely the value of Absolute error from peak discharge (AEQp), Relative error of peak discharge (EQp) and Absolute error from peak time (AETp) to 0.00. In addition the Relative error value of the total volume from 65.20% to 0.93%

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