Experimental Study of Estimation Model for Direct Run-off Volume with Soil Conservation Service (SCS) Model

(Case Study of Bantimurung Catchment Area in Maros Regency of South Sulawesi)

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***Abstract*-- Hydrology modelling has developed and this useful for water resources management basic data. This study intends to predicate direct runoff. Method which is used is one that has been developed by U.S. Soil Conservation Service, now (Natural Resources Conservation Service, NRCS). The SCS method calculates physical condition of Catchment Area as an input in hydrology analysis. Parameter used in this method is land cover and soil type, then the physical condition to be translated into index reflecting direct run off potential called curve number. The result of this study indicates that applied Soil Conservation Service (SCS) model in the Bantimurung Catchment area to predicate the volume of direct run-off become over estimate with amount of 22.92 % in predicting maximum discharge.**

***Index Term*-- Hydrograph Model, Volume of Run-off, Soil Conservation Service Model (SCS)**

I. INTRODUCTION

One of the management planning program of Catchment Area is necessary known the first local hydrology condition . However, hydrology data in a large part of Catchment area that will be planned their Catchment Area management is not sufficient available yet, to solve this problem an approach to be needed by using appropriate modelling hydrology with the Catchment Area condition, the result of the modelling is expected can be applied in the Catchment Area that has resemblance of that condition. With appropriate hydrology modelling existence, then characteristic and evaluation of sub Catchment area/Catchment area can be easily conducted.

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Method to calculate volume of direct run-off correlating some physical characters of Catchment area is method developed by U.S. Soil Conservation Service (now Natural Resources Conservation Service, NRCS). SCS method calculates physical condition out of Catchment Area as input in hydrology analysis. Physical condition of Catchment area applied in this method is land cover and soil type. The land cover and soil type is then translated into index reflecting direct run off potential. The index is called curve number.

The useful of the hydrology data analysis result is more experienced at the present time, even it is always needed as a basic data for activity concerning water resources management of Catchment area. In general there are three stages in hydrology analyses that are started with measuring phenomenon hydrology, making correlation between examined variable, and making prediction [5]. A regression analysis and correlation is often used to make a modelling hydrology. This modelling is tried as simple as possible in the sense of the modelling to be easy applied, without ignoring carefulness aspect, and modelling resulted is predictive.

After taking note of hydrology processes in a Catchment Area, it can be concluded that rainfall distribution become direct stream-flow is besides affected by surface physical characters of Catchment Area, it is also affected by rain characters. In view of that rain occurred in wet tropical climate area has a large enough variation in accordance with space and time, the study of correlation of rain and run off and how their effect toward respond a Catchment Area is very needed, in view of measuring hydrology phenomenon in particular in areas that there is no their hydrology data recording either due to budget limitation or their human resources, it is needed a correlation model between variable, so that the existence a model, then the directly hydrology phenomenon measurement can be reduced.

In preparation of model is required a complete and accurate data, so the result of the model can be appied in area having resemblance of condition of biophysical or their economical social. In this study will be exmined only on empirical model forming one of part from deterministic model. This model in

general presenting correlation between two hydrology factors or more based on observation result in laboratory or in the field. The empirical model has usually shape of mathematics equation based on information obtained from the research result.

The objective of this study is to predict run-off volume using SCS model on Bantimurung Catchment Area.

II. Literature Review

Run off is part of rainfall running on the soil surface going into the river, lake and sea. The run off occurred when the rain velocity is bigger than infiltration [7]. The important run off value for requirement of evaluation Catchment Area is run off volume condition occuring before and after the existance an activity/project.

Direct run off analysis using physiographic factor as parameter is method of SCS curve number. The method was Developed by U.S.SCS or it is now well known

Due to rain, land cover and soil type their characteristics have variation toward Smadi (1998) that this type model has more complex and difficult calculation step. A model considering spatially hydrologi parameter so will produce the more accurate output (Smadi, 1998). Spatial hydrology analysis or many complex data..The complex process can be facilitated by existance of Geography Information System (Prandey et, 2003).

Daily run off analysis with curve number developed by USDA NRCS (Natural Resources Conservation Service) is based on retention parameter (S), Initial is based on retntention parameter (S), Initial Abstractions (Ia), and daily rain (Rs). In general, initial parameter (Ia) is parameter relating with soil type and land cover, initial abstraction ration (ג) curve number method suggested is 0,20 (USDA SCS, 2005).

The surface runoff occurs when rain velocity is bigger than inflitration and equation of runoff is always developed that condition (USDA, 2005). The runoff will flow through channel or small ditch and finally enter into the river. In fact that before runoff, a part of rain becoms Initial abstraction (Ia). This abstraction is lost before run off comprising inundated water in the surface, water intercepted by vegetation, evaporation, and infiltration (USDA NRCS, 2005). So the rain (Pd), having cotribution to surface run off (Qd) is reduced by Initial abstraction that is complex variable but in general (USDA NRCS, 2005), that can be approximated by related soil and land cover, as for the equation as follows:

$$Ia = 0{,}2\ S \qquad \ldots\ldots\ldots\ldots (1)$$

The equation of 0,2 is initial abstraction ration and stated with symbol of symbol ג (lamda). This variable always chages from rain to other ones and from place to other places . With this variable must be calibrated on order to get optimal result in one area and given time. To calculate daily surface runoff, the following equation is applied :

$$Qd = \frac{(Pd - \lambda S)^2}{(Pd\ \lambda S + S)} \qquad \ldots\ldots\ldots\ldots (2)$$

With equation of (2) above, the surface runoff will occur when Pd is bigger than Ia. Retention parameter (S) is dependent variable on hte soil type, land use system and moist soil. The equation applied to decide S according to (USDA NRCS, 2005) is the following as :

$$S = \left(\frac{25400}{CN} - 254\right) \qquad \ldots\ldots\ldots\ldots (3)$$

In determining a CN value should be also taken notice of previous Antecedent Soil Moist Condition (AMC). Soil with water saturation condition will produce large direct run off potentiala and soil with dry condition will produce small diect run off potential.

By trying-out toward characteristic of rainfall infiltration that fallen down in various different soil types. The U.S. Soil Conservation Service [1] has developed a estimation method of total run off volume with using available rain data, thas is well known as SCS method. As for the affecting characteristic of the soil infiltration to support this method, among others are soil hydrology group, land cover type, condition of hydrologic and the first soil moist, and agriculture practise (land cultivation system) [6]

III. Study Methodology

A. Location and Area

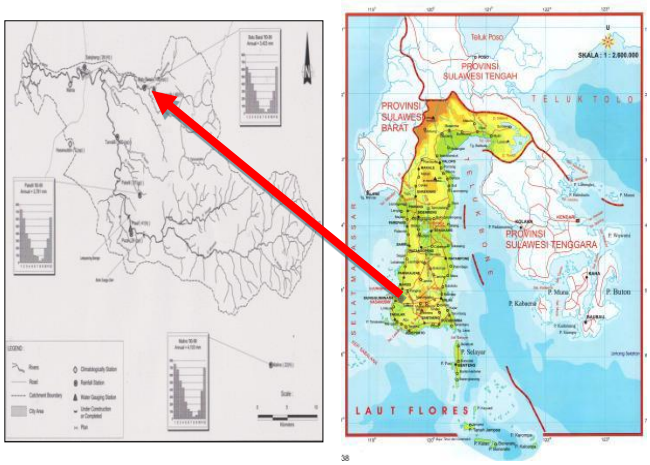

Fig. 1. Location and Area Bantimurung

Geographically Bantimurung catchment area is located in position 05° 01' 14,55'' 0f South Latitude and 119° 40' 32,3 " of East Longitude with area of 20.25 Km^2 with elevation between 100 to 500 m above Sea Mean Level. This catchment area includes National Park area is under Control of Forestry Service and Tourist Service of Maros Regency. The condition of Bantimurung Catchment Area is located in Bulusaraung mountain line with stony mountain condition that too steep and there ara some kinds of the best butterfly in the world, so that it is necessary kept their conservation.

The shape of the Bantimurung catchment area is more like bird fur with outlet dimension in Bantimurung Station (Automatic Water Level Record).The length of Bantimurung River from upstream to location of AWLR (outlet) is 6.22 km

with average of river slope is 0.0523, depth is 7.0 meter and the average of wide is 14 meter

B. Soil Type and Land Use System

The existing soil type Bantimurung Catchment area is Inceptisol and Mollisol. Distribution of soil type in this area there are soil types they are Tropaquepts, Dystropepts, and Rendolls. Aluvial is soil type of the Tropaquepts and dystropepts is a soil type including into Inceptisol ordo. Formely, this soil included Alluvi, Regosol, Gleyhumus, and Latosol solils. Soil type of Rendosol included one entering into ordo Mollisol.

The existing Land Use System in Bantimurung catchment area based on observation (June,2012) can be given in Table I.

Table I
Land Use Percentage in Bantimurung Catchment Area

Soil Group	Infiltration Velocity (mm/hour)	Texture
A	8-12	Sand, clay sand and sandy clay
B	4-8	Silty clay, clay
C	1-4	Loamy sand clay
D	0-1	Loamy clay, loamy silt clay, sandy loam, silty loam, loam

C. Material and Equipment

The material required to support this study is as follow as :

(1) Land use map with scale of 1:50.000, geology map with scale of 1:500,000, soil map with scale of 1: 100.000, and Indonesia Globe map with scale of 1: 50,000.

(2) Landsat Image

The used equipment for this study consisting of :

1) Observation station of AWLR
2) Rain Observation station
3) Computer
4) Software SPSS

D. Data Collection

The collected data comprises : hydrology parameter to support the run off volume estimation with SCS method that is soil hydrology group, land cover type, condition of hydrology and the first land moist, and practise agriculture method (land cultivation system).

E. Data Process and Analysis

The run off volume estimation with SCS method namely :

$$Q = (p-0{,}2s)^2/(p+0{,}8s) \quad \text{..... (1)}$$

$$S = (25400/CN - 254) \quad \text{..... (2)}$$

Where:

Q = Run off (mm)
P = A moment rainfall (mm)
S = Diffrent between rainfall and run off (mm)
CN = Run off Curve Number

The curve number has variaton from 0 to 100 affected by hydrolic soil group condition. As for the hydrolic soil group (differed on A,B,C and D). They are given in Table II.

Table II
Hydrolic Soil Group

No	Land Use	Area (Ha)	Percentage (%)
1	Upright stone mountain/medium forest	1900	93.83
2	Stony land	10	0.49
3	Grassy sorjoun land	5	0.22
4	Pavement Road	10	0.49
5	House,Stall,School, Mousque,etc	10	0.49
6	Rice cultivation	90	4.44
	Total	2025	100.00

Resource : McCuen (1989) and US SCS (1972)

Fig. 2. Model Catchment Area Bantimurung at Laboratory

IV. RESULT AND DISCUSSION

Run off Volume Estimation with SCS Model.

The calculation for each factor SCS Model is as following;

a) The Curve Number factor is given in Table III.

Table III.
The curve number calculation of Bantimurung Catchment Area

No.	Catchment **Area (Ha)**	Soil Group	Land use type,Treatment,Soil Condition	Curve Number	Weigthed Curve Number
1	1900	D	Uprigth stone mountain/medium forest	89	169100
2	10	D	Stony land	91	910
3	5	C	Grassy sorjoun land	80	400
4	10	D	Pavement Road	91	910
5	10	D	House,stall, school,mousque,etc	86	670
6	90	D	Plantation	87	7830
	2025				180020
Weigthed Curve Number = 88.90					

b) Different between rainfall and run off (s)

The amount of different between rainfall and run off is correlation with run off curve number = 31.71

c) Run off Volume = 91,72 mm
d) Total run off volume during maximum rain is of 123 mm =1.857.411 m^3

The result of total run off volume was predicated in Bantimurung Catchment Area on the maximum rain is of 123 mm, their value is of 1,857,411 m^3, to be compared with actual value obtained from the result of hydrology observation is of 2,409,750 m^3, so that there is difference of 552,339m^3 (22.92%). This indicates that applied method in the Bantimurung Catchment Area become over estimate in predicting run off.

V. CONCLUSION

1. Soil Conservation Service (SCS) method become over estimate amount of 22,92 % in predicting run off volume in the Bantimurung Catchment Area with the actual value obtained from hydrology observation result (outlet).
2. It is suggested that study is necessary carried out anymore in other location having various different Catchment Area wide.

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