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Submission date: 03-Oct-2019 06:38AM (UTC+0700)

Submission ID: 1184874756

File name: Estimation_of_Composite_Curve_Number.....pdf (1.62M)

Word count: 2414

Character count: 12616

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ESTIMATION OF COMPOSITE CURVE NUMBER ($CN_{COMPOSITE}$) IN UNDA RIVER BASIN

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ABSTRACT

The hydrological response of a river basin to rain to be transformed into discharge is influenced by the physical-climatic characteristics of the river basin and its land use. The approach in estimating the transformation of rain into discharge is an approach called the Soil Conservation Service run-off curve number (SCS-CN) model, which is a rain-discharge transformation model using an index of run-off curve number (CN).The Unda River Basin is one of the potential river basins in Bali Province that crosses Bangli Regency in the Upper, Karangasem Regency in the middle and Klungkung Regency in the downstream. The purpose of this research to evaluate the hydrological conditions in the river basin based on the CNcomposite of each sub-catchment in Unda River Basin.The steps of making CNcomposite value analysis begin with the preparation of the boundary map data, the Unda sub-catchment map, the land type shapefile data, the land use shapefile data. Then proceed with the classification of each parameter, then overlay the map, then the results are calculated to calculate the CN value for each type of land and land use. Then to find the CNcomposite value calculated using the CNcomposite formula. From the calculation, the CN composite value for Kaun sub-catchment is 51.76, Masin sub-catchment 51.24, Nyuling sub-catchment 51.48, Tanah sub-catchment is 52.86, Telagawaja sub-catchment is 48.58 and Undasub-catchment is 54.70. The biggest value is in the Unda sub-catchment and the smallest is in the Telagawaja sub-catchment. The smaller the CNcomposite value indicates the better hydrological conditions. So from the map of land use overlay results and soil types in the Unda river basin the best hydrological conditions are in the Telagawaja sub-catchment and the unfavorable ones are in the Unda sub-catchment.

Keywords:
CN number, soil type, land use, river basin.

INTRODUCTION

Maintaining and improving the hydrological function of a River basin is the concern of stakeholders in the region, especially the local government. For this reason, there are tools and indicators that can be used to assess whether or not the hydrological function of a river basin is very important. One way to assess river basin conditions is to use a hydrological model. A hydrological model which is an imitation of a hydrological system becomes very complex because there are many components and processes involved. Knight [1] in his writing mentions that there are four main groups that influence the response of hydrological functions: climate, physical shape of the landscape, area indicators and land use.

The hydrological response of a river basin to rain to be transformed into discharge is influenced by the physical-climatic characteristics of the river basin and its land use. The approach in estimating the transformation of rain into discharge is an approach called the Soil Conservation Service run-off curve number (SCS-CN) model, which is a rain-discharge transformation model using an index of run-off curve number (CN). The curve number (CN) states the ability of land use under certain soil hydrological

ISSN: 2456-9348
Vol (03) _Issue (10)
Impact Factor: 4.520

International Journal of Engineering Technology Research & Management

conditions in transforming rain into rainwater that is retained by land and which becomes surface runoff. The curve number value is influenced by the type of soil and land cover [2, 3].

The Unda River Basin is one of the potential river basins in Bali Province that crosses Bangli Regency in the Upper, Karangasem Regency in the middle and Klungkung Regency in the downstream. Undariver basin is a type of Perennial river flow and a total area of 230.91 km^2. This river basin is widely used as the fulfillment of raw water in the Karangasem and Klungkung regions and also as a supply of irrigation water supply in Karangasem and Klungkung Regencies.

To maintain the sustainability of the potential water available in the Undariver basin, it is necessary to conduct an evaluation of the hydrological conditions in the river basin. Nowadays the use of geographic information systems can help make it easier to find out information and can be used as material in hydrological modeling.

In this research CNcomposite values will be obtained from the overlay of land use maps and soil type maps in the Undariver basin for later CNcomposite distribution maps in each sub-catchment to determine the hydrological conditions of each sub-catchment so that later management strategies can be identified.

RESEARCH METHODS

Research Location

The Unda River Basin covers 3 districts, that are Karangasem Regency (208,092 km^2), Klungkung Regency (11.701 km^2) and Bangli Regency (11.122 km^2) with a total river basin area of 230.91 km^2.

Fig. 1: Research Location [4]

Research Tools and Materials

a. Research Tools

The tool used in data processing in this study is Microsoft Excel 2013 and Arcview 10.6.1.

b. Research Materials

The data needed in this CN distribution map is in the form of two vector digital maps, namely digital maps of soil types in the Undariver basin and land use maps in the Undariver basin with georeference WGS_1984_UTM_Zone_50S.

Vol (03) _Issue (10)
ISSN: 2456-9348
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Table 1: Research Data

No	Data Type	Data Source
1.	Unda sub-catchment map	Bali-Penida River Basin Bureau
2.	River BasinBoundary Map	Bali-Penida River Basin Bureau
3.	Soil Type Shapefile Data	Bali Regional Development Planning Agency
4.	Land Use Shapefile Data	Bali-Penida River Basin Bureau

Step of Map Making

The steps of making CNcomposite value analysis begin with the preparation of the boundary map data, the Unda sub-catchment map, the land type shapefile data, the land use shapefile data. Then proceed with the classification of each parameter, then overlay the map, then the results are calculated to calculate the CN value for each type of land and land use. Then to find the CNcomposite value calculated using the CNcomposite formula.

$$CN_{composite} = \frac{\sum A_i CN_i}{\sum A_i} \quad \text{Eq. 1}$$

Where:
CN*composite* : Composite curve number
A_i : Area each land use
CN_i : Curve Number each the land use

RESULT AND DISCUSSION

General Overview of Research Location

The Unda River Basin covers 3 regencies, that are Karangasem Regency (208,092 km^2), Klungkung Regency (11.701 km^2) and Bangli Regency (11.122 km^2) with a total area of 230.91 km^{2}river basin. Undariver basin is small because it is less than 5,000 km^2. Undariver basin is divided into six sub catchment that are Kaun sub catchment, Masin sub catchment, Nyuling sub catchment, Tanah sub catchment, Telagawaja sub catchment and Undasub catchment as shown in Figure 2 [5].

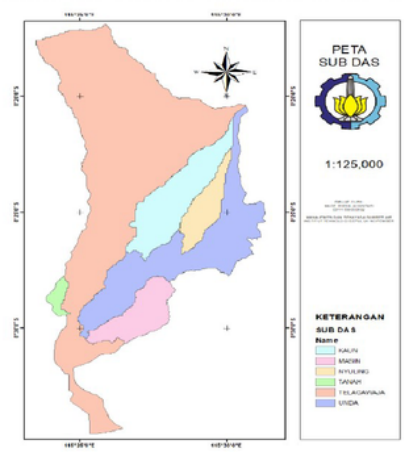

Fig. 2: Sub Catchment inUnda River Basin

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Estimated Curve Number (CN)

The value of the curve number (CN) in the SCS-CN method is determined based on a combination of land use, soil, and previous soil moisture conditions (AMC). Estimation of CN value can be started by determining the type of soil group. SCS develops soil classification systems based on soil properties, detailed soil maps, or soil infiltration rates [6]. Classification of soil groups in Table 2.

Table 2: Land Group Classification [7]

Land class	Soil Characteristics	Infiltration rate (cm / hour)
A	Deep sand, deep loess, aggregate dust	0.78-1.14
B	Loess shallow, sandy loam	0.38-0.78
C	Diamond loam, shallow sandy clay, low organic matter content and high clay content	0.13-0.38
D	Soils that expand significantly, if wet are heavy clays, and certain saline soils	< 0.13

UndaRiver Basin Soil Classification

Undariver basin is dominated by gray regosol soil as much as 57.84% of Undariver basin area, followed by 15.31% yellowish brown regosol, reddish brown latosol and litosol 14.76%, and 12,09% habitable regosol.

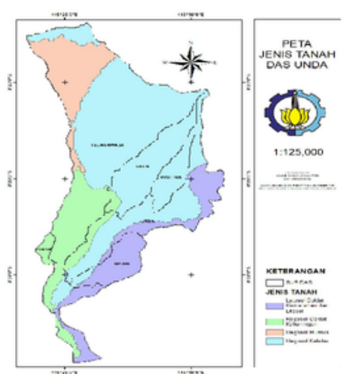

Fig. 4: Unda River Sub Basin Soil Type

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Table 3: Soil type each Sub Catchment Unda River Basin

Sub Catchment	Type of soil	Land Class	Area (km^2)	Percentage
Kaun	Yellowish Regosol Brown	A	22.23	94.2%
	Gray Regosol	A	1.36	5.8%
Masin	Reddish Brown Latosol and Litosol	A	12.35	89.9%
	Gray Regosol	A	1.38	10.1%
Nyuling	Reddish Brown Latosol and Litosol	A	10.06	99.992%
	Gray Regosol	A	0.00	0.008%
Tanah	Yellowish Regosol Brown	A	2.34	100%
Telagawaja	Yellowish Regosol Brown	A	69.13	54.1%
	Reddish Brown Latosol and Litosol	A	26.24	20.5%
	Regosol Topsoil	A	25.78	20.2%
	Gray Regosol	A	6.73	5.3%
Unda	Yellowish Regosol Brown	A	25.01	58.8%
	Reddish Brown Latosol and Litosol	A	13.24	31.1%
	Gray Regosol	A	4.29	10.1%

Classification of Land Use Parameters

For land use parameters, land use is divided into fresh water, forests, gardens / plantations, settlements, grass / vacant land, irrigated paddy fields, bush / shrub, rocky land, buildings and fields.

Overall the land use of Undariver basin is dominated by land cover in the form of gardens / plantations by 30.71%, then forests by 21.38% and fields by 16.40% and irrigated fields by 16.16%.

Table 4: Curve Number (CN) for each Land Use Type

Type of Land Use	Land Class			
	A	B	C	D
forests	30	55	70	77
Settlements	57	72	81	86
irrigated paddy fields	63	74	82	85
fresh water	100	100	100	100
gardens / plantations	45	66	77	83
grass / vacant land	49	69	79	84
bush / shrub	68	79	86	89
fields	62	78	88	81
buildings	57	72	81	86
rocky land	76	85	89	91

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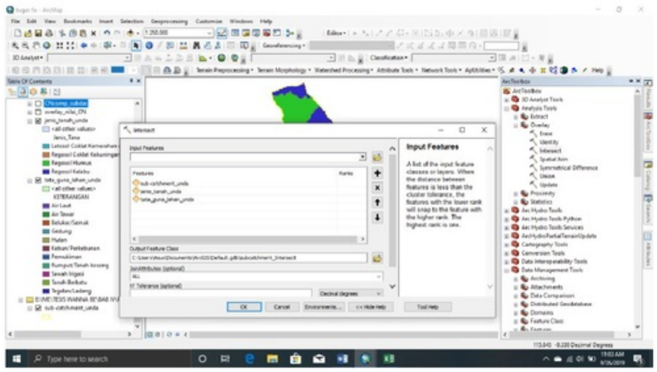

Fig. 5: Land Use Overlay, Land Type with Sub catchment to get CN value

The results of overlaying soil types, land use and sub catchments are then made into a new column in the attribute table on the overlay shapefile according to Table 4.

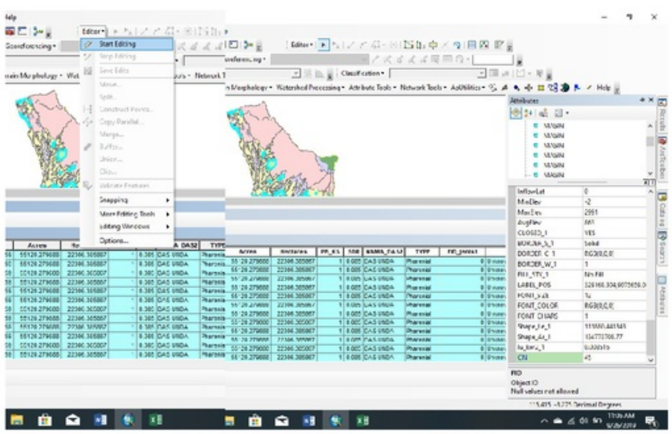

Fig. 6: Providing CN Value for each Land Use

After filling in the CN value for each land use, a CNcomposit calculation for each sub-catchment is calculated with equation 1 using Microsoft Excel.

ISSN: 2456-9348
Vol (03) _Issue (10) Impact Factor: 4.520

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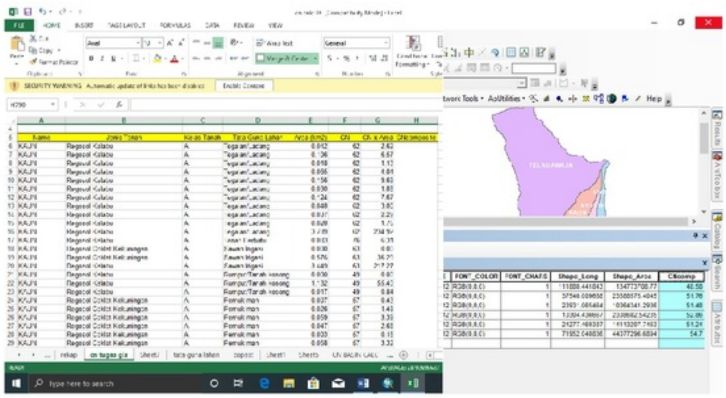

Fig. 7: Calculation and Filling in the CNcomposite Value of each sub-catchment

Table 5: CNcomposite Calculation Results for Each Sub Catchment in the UndaRiver Basin

Sub Catchment	CNcomposite
Kaun	51.76
Masin	51.24
Nyuling	51.48
Tanah	52.86
Telagawaja	48.58
Unda	54.70

CNcomposite derived from the CN value of each land use and soil type are multiplied by the extent of each and then averaged. From the calculation, the CNcomposite value for Kaun sub-catchment is 51.76, Masin sub-catchment 51.24, Nyuling sub-catchment 51.48, Tanah sub-catchment is 52.86, Telagawaja sub-catchment is 48.58 and Undasub-catchment is 54.70. The greatest value is in the Undasub-catchment and the smallest is in the Telagawaja sub-catchment.

The smaller the CNcomposite value indicates the better hydrological conditions. So from the map of land use overlay results and soil types in the Undariver basin the best hydrological conditions are in the Telagawaja sub catchment and the unfavorable ones are in the Undasub-catchment. The value of 48.58 can be interpreted that when there is rain falling into the area 48.58% of the water flows and 51.42% is absorbed and held in the ground. So the greater the value of the CNcomposite, the surface water flowing directly (surface runoff) will be even greater. With the increasing surface runoff, the possibility of flooding during the rainy season and drought in the dry season will increase.

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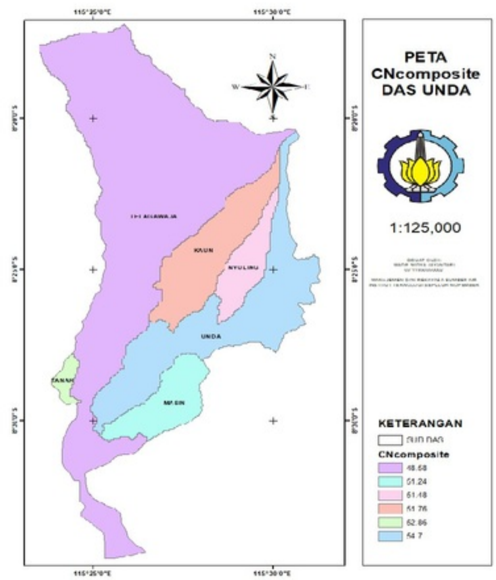

Fig. 8: CNcomposite for each Sub-Catchment in Unda River Basin

CONCLUSION

Based on the analysis there are some things that can be summarized as follows.

1. To obtain an estimated curve number (CN) map for each sub-catchment in the Undariver basin, it can be done by overlaying digital map data in vector format, namely shapefile maps of soil types, land use maps and sub-catchment maps in the Undariver basin.
2. From the calculation, the CN composite value for Kaun sub-catchment is 51.76, Masin sub-catchment 51.24, Nyuling sub-catchment 51.48, Tanah sub-catchment is 52.86, Telagawaja sub-catchment is 48.58 and Undasub-catchment is 54.70. The biggest value is in the Unda sub-catchment and the smallest is in the Telagawaja sub-catchment. The smaller the CNcomposite value indicates the better hydrological conditions. So from the map of land use overlay results and soil types in the Undariver basin the best hydrological conditions are in the Telagawaja sub-catchment and the unfavorable ones are in the Unda sub-catchment.

ACKNOWLEDGEMENTS

Acknowledgments submitted to the Warmadewa University who have supported the completion of this paper.

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