The analysis of correlation between Regime's River coefficient and runoff coefficient (Case study in catchment areas of sidutan and reak)

by Hasyim Hasyim

PAPER · OPEN ACCESS

The analysis of correlation between Regime's River coefficient and runoff coefficient (Case study in catchment areas of sidutan and reak)

To cite this article: L Salehudin *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **708** 012033

View the article online for updates and enhancements.

The analysis of correlation between Regime's River coefficient and runoff coefficient (Case study in catchment areas of sidutan and reak)

Salehudin ,L Wirahman W, Hasyim and Rohani

Civil Engineering Department, Faculty of Engineering, University of Mataram, Jl. Majapahit no.62, Mataram, Indonesia

Corresponding author: saleh.salehudin@unram.ac.id

Abstract. The Sidutan and Reak Watersheds have 37.77 km^2 and 23.66 km^2 basin areas, both of which are still protected forests. Along with the increase in human activities, the community's raw water needs in both watersheds can also influence the magnitude of the infiltration rate and runoff, where infiltration and runoff coefficient will affect the River Regime Coefficient (RRC). River Regime Coefficient is the magnitude of the ratio between the maximum and minimum daily discharge in a year in the river. Whereas to get runoff coefficient every year a single hydrograph and rain per hour are needed in a year. The relationship between river regime coefficients and runoff coefficients can produce a correlation equation is a linear equation. In the analysis, the runoff coefficient value in the following year in each river channel is enough to replace the value of the river regime coefficient with a linear equation. The analysis shows that the value of the River Regime Coefficient (RRC) with Runoff Coefficient in the Sidutan Watershed yields the equation $Y = -2E-05x2 + 0.0048x - 0.0539$ with a coefficient of determination $R2 = 0.6796$. River Regime Coefficient (RRC) values obtained from 2011 to 2016 were 67.69; 43.99; 188.92; 53.78; 45.01 where the value is included in the low and too high classification range. The results of the analysis indicate the watershed is in bad condition. From the analysis of runoff coefficient (C) each watershed is 0.188; 0.101; 0.229; 0.163; 0.148, shows that the level of runoff coefficient (C) of the watershed is still in good condition. From the results of the analysis of the River Regime for the Reak River Basin, the equation $Y = 0.0003x2 - 0.011x + 0.1618$ with a coefficient of determination $R2 = 0.7855$. Where the RRC Value obtained in 2011 until 2016 respectively 27.46; 29.80; 31.06; 16.96; 14,11. The results of the analysis are included in the very low classification range and to a low degree. From the results of the analysis, the Reak River Basin is still in good condition.

1. Introduction

Based on the watershed map of the Directorate of Planning and Evaluation of Watershed Management in 2011, it is known that in the West Lombok Regency it has Twenty Seven watersheds, which are included in the national priority river basin classification. One watershed which has a large catchment area river channels and water that flows throughout the year is the Sidutan and Reak watersheds located in North Lombok Regency. The increasing of of the population activities around the Reak and Sidutan watersheds, the need for water and land needs is also increasing, so that this tendency causes changes in land use, especially forests that affect the functions of the Sidutan and Reak Watersheds.

By changing the function of the land around the watershed, conservation efforts are needed to conserve the watershed and water availability in the area of North Lombok Regency.

The use of the Coefficient (C) to detect the amount of a groundwater runoff is needed to see the condition of a watershed whether the area still has a level of flood security that is moderate or very heavy. in the analysis of the Reak watershed and Sidutan watershed studies, it is necessary to observe the rainfall data points called Rainfall Station (STA) or Flood Discharge Data Observation Station called Automatic Water Level Recording (AWLR) to get the actual coefficient (C) value of the two DAS.

In addition to the C value, the watershed condition can also be known by using the River Regression Coefficient value (KRS), where the value of this KRS is a number which denotes the ratio between the maximum daily average discharge with the minimum daily discharge in a hydrological year (rainy season-dry season) with on the river fluctuation watershed conditions in the region.

2. Research sites

The research location is located on the AWLR (Automatic Water Level Recorder) Santong (D14 014) catchment area located in the Upper Sidutan basin and AWLR Sopak (watershed number 041) located on the Reak basin. Catchment area AWLR Santong has an area of 37.77 km2 with the main river is Sungai Sidutan, while the catchment area AWLR Sopak has an area of 23.66 km2 with the main river of Reak River which is administratively located in North Lombok Regency. Geographically the AWLR Santong Station is located at 8° 19 '44 "LS and 116° 17' 47" BT, and AWLR Sopak Station is at 8° 16 '29 "LS and 116° 25' 12" BT. Figure 1. Mapping of the catchment area of AWLR Santong (Sidutan Watershed) and AWLR Sopak (Reak Watershed)
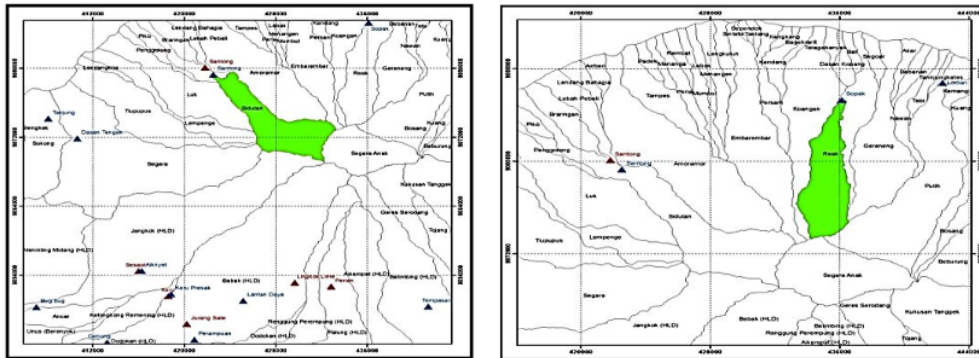

Figure 1. Sidutan watershed and reak Watershed

3 Methodology

In this study required secondary data obtained from related agencies. The data needed in this study among others: Watershed topographic maps, Hourly AWLR, and Hourly rainfall data. The steps undertaken in this study are as follows; Analyze of rainfall data, Analyze the discharge data of AWLR, Analysis of the value of runoff coefficient (C) using flood data that occurs due to rain at the same time, and Analysis of the relationship between the value of KRS with the value of C.

4. Results and discussions

The rainfall data analyzed is derived from the rainfall station data which affects the Sidutan upstream river and the Reak watershed. Where the influential rainfall station is located in the upper Sidutan watershed is Santong Station in the River Basin (DAS) and Sopak Station located in the Reak River Basin. Analysis of the data consistency test using the RAPS (Rescaled Adjusted Partial Sums) method. Based on the calculation of the statistical value and by the requirements with a 99% degree of

confidence. Indicates that rainfall data in both stations are still in a consistent limit. River Regime Coefficient Analysis (RRC), is the ratio between maximum discharge (Qmax) and minimum discharge (Qmin) in the watershed. This RRC value can indicate fluctuations between the rainy season and the dry season in a few years of observation. The RRC analysis is carried out over a hydrological year period from the beginning of the rainy season to the end of the dry season. The maximum and minimum daily discharge from each AWLR station is obtained by processing the discharge data from both the santong river and the Reak river. Reak watershed conditions analysis results still show good conditions, wherefrom the results of observations each year the average value of the PRC of 23.88 is still in the low range (20 <RRC <50), so that fluctuations in river flow are not too high during the rainy season and the season dry. Runoff Coefficient Analysis is used To get the runoff coefficient value (C), with several calculations the selection of flood and rain data per hour. In the analysis of flood and rain runoff in both watersheds, rain data and flood data are selected at the same time to get a single hydrograph.
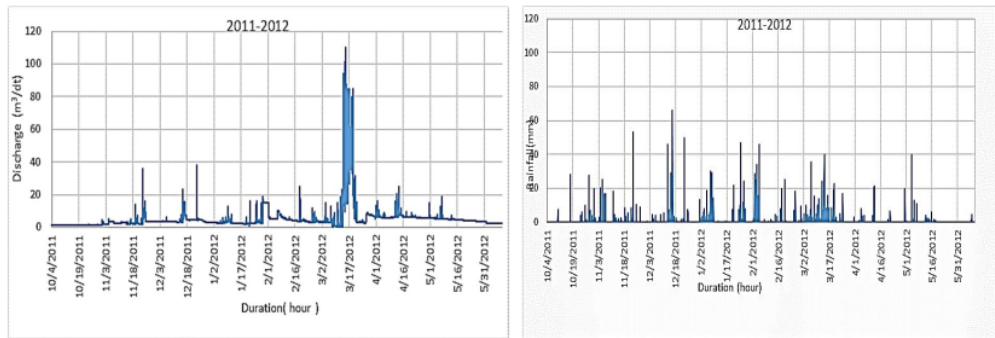

Figure 2. Chart of hourly discharge and rain from the year 2011-2012. AWLR Santong and AWLR Reak Station

Analysis of mean rainfall area, analysis means rainfall area is conducted to get the average rainfall of the area that causes flooding when the rain occurs. The Figure below shows the results of rainfall analysis from Santong and Reak stations.
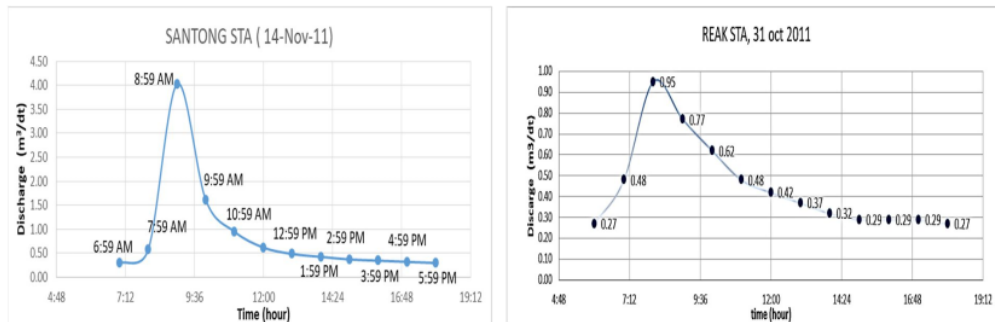

Figure 3. Chart of hydrograph discharge 31 October and 14 November (Santong and Reak Watershed)

Table 1. The hourly rainfall data of Santong and Reak Station

Santong		Reak	
Time	Rainfall (mm)	Time	Rainfall (mm)
10/31/08 8:59 PM	2.1	11/14/11 6:59 AM	0.9
10/31/08 9:59 PM	19.9	11/14/11 7:59 AM	10
10/31/08 10:59 PM	1.2	11/14/11 8:59 AM	0.7
Total	23.2	11/14/11 9:59 AM	3.3
		Total	14.9

Source : Calculation Result.

Analysis of rain volume, From the analysis of the average rainfall, the volume sum of rain that occurred in the Sidutan River Basin (DAS) was 43704 m3, while in the Rak River Basin it was obtained 24366 m3. The next result flood volume calculation on Sidutan watershed can be seen in Table 2.

Table 2. Result of calculation of Sidutan watersheds flood volume

Time	Discharge (m^3/dt)	Base flow (m^3/dt)	Flood (m^3/dt)	Flood Volume (m^3)
10/31/11 2:59 PM	1.220	1.220	0.000	0
10/31/11 3:59 PM	2.570	1.220	1.350	4860
10/31/11 4:59 PM	4.560	1.220	3.340	12024
10/31/11 5:59 PM	3.990	1.220	2.770	9972
10/31/11 6:59 PM	3.000	1.220	1.780	6408
10/31/11 7:59 PM	2.570	1.220	1.350	4860
10/31/11 8:59 PM	2.170	1.220	0.950	3420
10/31/11 9:59 PM	1.820	1.220	0.600	2160
			Total	**43704**

Source : Calculation Result.

Table 3. Result of calculation of Reak watersheds flood volume

Time	Discharge (m^3/dt)	Base flow (m^3/dt)	Flood (m^3/dt)	Flood Volume (m^3)
11/14/11 6:59 AM	0.295	0.295	0.000	0
11/14/11 7:59 AM	0.580	0.295	0.285	1024
11/14/11 8:59 AM	4.029	0.295	3.733	13440
11/14/11 9:59 AM	1.607	0.295	1.311	4720
11/14/11 10:59 AM	0.947	0.295	0.652	2347
11/14/11 11:59 AM	0.618	0.295	0.323	1163
11/14/11 12:59 PM	0.484	0.295	0.189	680
11/14/11 1:59 PM	0.425	0.295	0.129	465
11/14/11 2:59 PM	0.370	0.295	0.074	267
11/14/11 3:59 PM	0.344	0.295	0.048	174
11/14/11 4:59 PM	0.319	0.295	0.024	85
11/14/11 5:59 PM	0.295	0.295	0.000	0
			Total	**24366**

Source : Calculation Result

Analysis of runoff coefficient (C), In analyzing the flood hydrograph for one year, the runoff coefficient value is needed resulting from the analysis which results in different C values.

Table 4. The average of C value per year on Sidutan and Reak Watershed

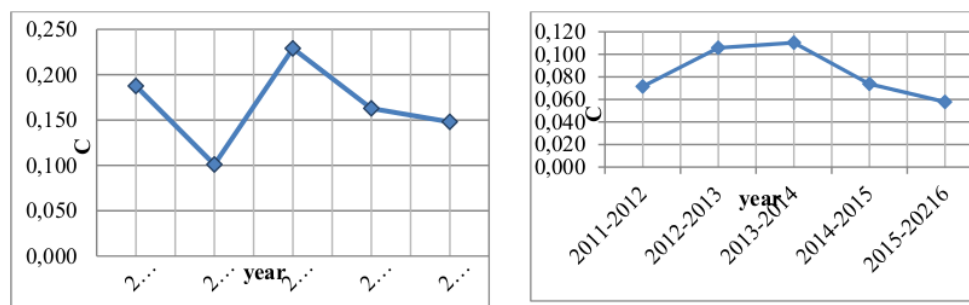| Sidutan Watershed		Reak Watershed	
Year	C	Year	C
Oct 2011-Sept 2012	0.188	Oct 2011-Sept 2012	0.071
Oct 2012-Sept 2013	0.101	Oct 2012-Sept 2013	0.106
Oct 2013-Sept 2014	0.229	Oct 2013-Sept 2014	0.110
Oct 2014-Sept 2015	0.163	Oct 2014-Sept 2015	0.074
Oct 2015-Sept 2016	0.148	Oct 2015-Sept 2016	0.058

Figure 4. Chart of C value per year on Sidutan and Reak Watershed

From the results of the analysis of both the REak Watersheds and the Sidutan River Basin, it shows that the two river basins are still in good condition, where the C value coefficient is 0.16 smaller than 0.25, while for the Reak River Basin the C coefficient value is obtained 0.12 and still below the 0.25 standard, which means that the amount of infiltrated water is higher than the amount of rainwater that becomes runoff. Thus we can conclude that the Watershed Areas for the two watersheds are still good. Analysis of Relationship of KRS with C Value, The annual average of C and RRC results for each watershed are presented in Table 5, Figure 5. Next sought the relationship between RRC value with the C value which can be seen in Figure 5.

Table 5. Recap the RRC and C values per year of Sidutan and Reak Watershed

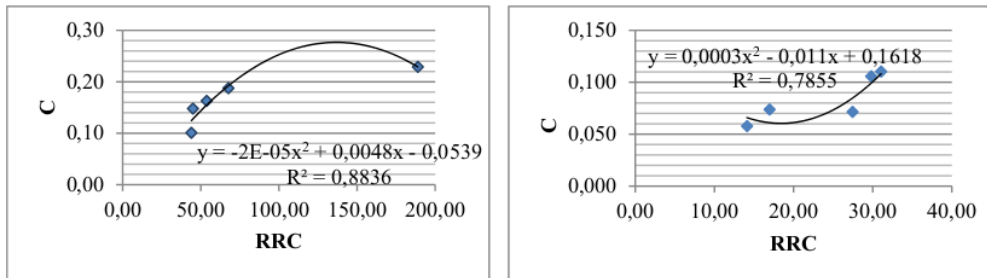| Year	Sidutan watershed				Reak Watershed			
	Mean of Daily Discharge		RRC	C	Mean of Daily Discharge		RRC	C
	Maks	Min			Maks	Min		
Oct 2011-Sept 2012	61.43	0.76	67.69	0.188	7.49	0.27	27.46	0.071
Oct 2012-Sept 2013	11.83	0.24	43.99	0.101	8.13	0.27	29.80	0.106
Oct 2013-Sept 2014	71.53	0.29	188.92	0.229	8.39	0.27	31.06	0.110
Oct 2014-Sept 2015	20.98	0.24	53.78	0.163	4.58	0.27	16.96	0.074
Oct 2015-Sept 2016	12.34	0.24	45.01	0.148	3.81	0.27	14.11	0.058

Source : *Calculation Result.*

Figure 5. the relation between RRC with C value of Sidutan and Reak Watershed

Based on the analysis shown it can be seen that almost all the RRC and C values have the same trend, C value will be followed by high RRC value. Picture 9 can be seen as the value of RRC and C value has a strong enough relationship which is viewed from the coefficient of determination (R2) that is equal to 0.8836 which is close to 1 and is 0.7855 which is close to 1 DAS Sidutan and Reak.

5. Conclussions
The result of the analysis of the relationship between the value of River Regime Coefficient (RRC) with the value of Runoff Coefficient (C) in Sidutan Watershed obtained the equation $y = -2E-05x^2 + 0.0048x - 0.0539$ with the determination coefficient (R2) = 0.8836. In the Reak Watershed the relationship between KRS value with C value, obtained the equation $y = 0.0003x^2 - 0.011x + 0.1618$ with the determination coefficient (R2) = 0.7855. The value of RRC in Sidutan watershed and the value of C shows that the watershed is in good condition every year. This can be seen from the value of RRC respectively of 67.69; 43.99; 188.92; 53.78; 45.01 is in the low to very high classification range. The result of C value shows that the watershed is in good condition every year, where the value of C respectively; 0.101; 0.229; 0.163; 0.148. The results of the RRC analysis in Das Reak and Das Sidutan still show that the conditions of the two watersheds are still in the good category. where the value of the C coefficient is very influential on fluctuations in river flow, while the value of the PRC shows the fluctuation of river discharge for one year is still quite large.

6. Suggestions
Need to conduct further research on soil conditions and other physical conditions to get more accurate data on the result of analysis with the actual condition.

References
[1]   Anonymous, 2014, Regulation of the Minister of Forestry of the Republic of Indonesia No P.60 / Menhut-II / 2014 concerning Criteria for Establishing Watershed Classification.
[2]   Asdak, C., 2014, Hydrology and Watershed Management, Gadjah Mada University Press, Yogyakarta.
[3]   Harto, S., 1993, Hydrological Analysis, Gramedia Pustaka Utama, Jakarta.
[4]   Itratip, 2008, Analysis of Water Efficiency and Loss at the Main Sago Irrigation Water Network, FST Udana.
[5]   Ramza, Sakinah, 2010, Changes in Runoff coefficient in the Ular Watershed, South Sumatra, Faculty of Engineering, University of North Sumatra.
[6]   Sarino, 2013, Runoff Analysis in Lematang Hulu Sub-watershed, South Sumatra, Faculty of Engineering, Universitas Brawijaya, Malang.
[7]   Soemarto, C.D., 1987, Technical Hydrology, National Business, Surabaya.

[8]   Soewarno, 1990, Hydrology Measurement and Data Processing of River Flow (Hydrometry), Nova, Bandung.

[9]   Sosrodarsono, S., and Takeda, K., 1983, Hydrology for Watering, Pradnya Paramitha, Jakarta.

Acknowledgement

The analysis of correlation between Regime's River coefficient and runoff coefficient (Case study in catchment areas of sidutan and reak)