Description of the biophysical characteristic and relation with discharge of Je'ne Rakikang Catchment Area

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Abstract. This study aims (1) to determine the biophysical characteristics and discharge on Je'ne Rakikang Catchment Area, (2) the relationship between the biophysical characteristics and discharge on Jene Rakikang Catchment Area. This research was conducted at Jene Rakikang Catchment Area. The data were collected in the form of primary and secondary data. Primary data were determined by measuring the discharge and precipitation, during 31 days of observation and secondary data collected from government agencies or related institutions such as land cover collected the data from the Institute for Balai Pemantapan Kawasan Hutan Wil. VII Makassar, rainfall data from the Global weather (2004-2013), geological data from Ujung Pandang GRDC Sheets of 1982, the data from Aster DEM slope, soil type data from RePP Prot 1987 and the data obtained from the calculation as well as visually. The data were analyzed using the quantitative descriptive method. The results showed that the discharge fluctuations of Je'ne Rakikang Catchment Area very varied. Biophysical characteristics of the Je'ne Rakikang Catchment Area consist of geology, topography, soil type, orientation, area, shape, drainage density, stream gradient, flow pattern, land cover and rainfall could potentially influence the behavior of discharge. The different of biophysical characteristics of Jene Rakikang Catchment Area provide a response to discharge in the event of rain with short time.

1. Introduction

Water as the main output in a watershed (DAS) ecosystem, has an important role for living things on earth. Therefore, the presence of water in a watershed ecosystem must remain available in a balanced...
condition both in terms of quality, quantity, and availability from time to time for present and future life.

Damage to the watershed ecosystem at this time, which is reflected by the decline in water quality, quantity and availability has been seen everywhere. Drought and difficulty obtaining water during the dry season and abundant water during the rainy season are characteristics of the damage to a watershed such as that which occurred in the Saddang and Jeneberang watersheds. According to the Decree of the Minister of Forestry in 2009, the number of priority watersheds has increased to 108 and Jeneberang watershed ranks 71 in these priority watersheds.

The Jeneberang watershed is one of the priority watersheds. This indicates that the watershed has decreased in quality. The deterioration in quality can be seen from the difference between the minimum and maximum discharge, erosion and sedimentation [1]. Even though the Je'neberang watershed is a priority, there are still several sub-watersheds and water catchments (DTA) which can be said to have been in good condition when seen from their land cover conditions. One of them is the Catchment Area (DTA) which is still dominated by forest vegetation is the Je’ne Rakikang catchment area. One of the parameter to determine the quality of the watershed is the fluctuation of the river discharge with different rainfall conditions.

River flow fluctuations are highly dependent on the biophysical characteristics of the watershed. Watershed biophysical characteristics include watershed morphology, morphometry, land cover and rainfall that pass through a watershed [2]. Biophysical characteristic factors such as rainfall, land cover, density, watershed shape, flow pattern, soil type, river gradient, and topography affect river discharge conditions. Therefore, this study aims to determine the biophysical characteristics and river discharge in the Je'ne Rakikang Catchment Area and the relationship between biophysical characteristics and discharge in the Je'ne Rakikang Catchment Area.

2. Material and methods

2.1. Research location
This research was conducted from February to March 2015 in Je’ne Rakikang catchment area.

2.2. Tools and materials
The tools used are GPS, roll meter, neat rope, scaled stick, Mappangaja Improvised Current Meter, calculators, computer devices, digital cameras, and writing instruments. Meanwhile, the materials used are the Rupa Bumi Map (RBI) with a scale of 1: 50,000, land cover maps (2013) from the Forest Area Consolidation Center (BPKH) Wil. VII Makassar, slope map from Aster DEM, soil type map from RePPProTT 1987, geological map from the Center for Geological Research and Development (Puslitbang) Ujung Pandang Sheet Geology 1982 and rainfall data for the last 10 years from Global Weather (2004-2013).

2.3. Research procedure
The research procedure consisted of preparation of location research and data collection both primary and secondary data. Primary data are river cross section measurements, river discharge measurements every morning (08.00), noon (12.00), and evening (16.00) at a depth of 20%, 60%, and 80%. Sosrodarsono and Takeda, 1999 using Mappangaja Improvised Current Meter, and rainfall measurements [3]. The cross-sectional measurement of the river is calculated by [4]:

\[ A = L_1 \cdot D_1 + L_2 \cdot D_2 + \cdots + L_n \cdot D_n \]

Information:
A : Cross-section area (m²)
L : Horizontal cross-section width
D : Depth (m)
The width of the river is known by measuring the wet cross section of the river, while the height / depth of the water is done by dividing the cross section of the river into several parts and measuring the depth of each part using a scale stick. The deepest cross section of the river is the maximum depth ($h_{\text{max}}$). Meanwhile, secondary data are rainfall data, administrative maps, climate maps, and elevation maps.

Rainfall measurements are taken every day (one rainy day) using an observatory-type rainfall gauge. The rainfall gauge is placed in a place that meets the requirements, that is a sloping land surface, avoiding bumpy mountain ridges, especially sloping areas that oppose wind currents [5]. Rainfall data will be observed every 08.00 in the morning, because at this time it is expected that there is no evaporation that can affect the actual amount of rainfall.

For secondary data, which is supporting data in this study obtained from government agencies or related agencies such as land cover data in this case the type and area of each land cover (2013) obtained from BPKH Wil.VII Makassar and slopes, land, and other physical watershed conditions obtained from aster DEM, soil from RePPProt 1987, geological data from the Geological Research and Development Center (Puslitbang) of the Ujung Pandang Sheet in 1982, rainfall from Global weather in the last ten years (2004-2013) and conditions other physical watersheds were collected using the available maps.

2.4. Data analysis
Data analysis was performed by calculating the river discharge with the formula [6]:

$$Q = \frac{A}{a} \times Q_m$$

Information:
$Q$ : River discharge ($\text{m}^3/\text{sec}$)
$A$ : River cross-sectional area ($\text{m}^2$)
$a$ : The cross-sectional area of the Improvised Current Meter Mappangaja tool (0.000491 $\text{m}^2$)
$Q_m$ : Discharge on the Improvised Current Meter Mappangaja tool ($\text{m}^3/\text{sec}$)

Analysis of the biophysical characteristics of the sub-watersheds includes morphology, morphometry, land cover and rainfall. Watershed morphology consists of geology, topography, watershed orientation, and soil types. Geological data is sourced from the Research and Development Center (Puslitbang) Geology of Ujung Pandang Sheet in 1982, topography is sourced from Aster DEM, and soil types are obtained from RePPProt 1987. Whereas for watershed orientation is described by visually observing the direction of the main river flow.

Watershed morphometry includes watershed area, shape, river network, flow patterns, flow density, and river gradient. The area of the watershed is known by GIS analysis and the flow pattern can also be described by visually observing the Rupa Bumi map of Indonesia. As for river gradient, watershed shape, and flow density, this is done by using the following mathematical equation:

2.4.1. River gradient. The river gradient classification uses intervals of <0.5 (Very low), 0.5 - 1.0 (Low), 1.1 - 1.5 (Moderate), 1.6 - 2.0 (High) and> 2, 0 (Very high). For the calculation of the river gradient using the following equation [4]:

$$Su = \frac{(h_{85} - h_{10})}{0.75 \times L_b} \times 100\%$$

Information:
$Su$ : river gradient (%)
$p_{85}$ : Elevation at the point as far as 85% from DAS outlet (mdpl)
$h_{10}$ : Elevation at the point as far as 10% from the outlet of the watershed (mdpl)
$L_b$ : Main river length (m).
2.4.2. **Watershed shape.** According to Soewarno in Purwanto (2013), the value of the watershed shape is described in the Circulation ratio \((R_c)\). If the value of \(R_c > 0.5\) then the watershed is spherical, \(R_c < 0.5\) the watershed is elongated. The equation for calculating the \(R_c\) value or the shape of the watershed is as follows [4]:

\[
R_c = \frac{4\pi A}{P^2}
\]

Information:
- \(R_c\) : Shape factor
- \(A\) : Watershed area (km\(^2\))
- \(P\) : Perimeter of watershed (km)

2.4.3. **Flow density.** The river flow density index \((D_d)\) is classified as if the \(D_d\) value \(<0.25\) km/km is categorized as low, \(0.25 - 10\) km/km\(^2\) is categorized as moderate, \(10 - 25\) km/km\(^2\) is categorized as high, and \(>25\) km/km\(^2\) is categorized as very high. To find out the flow density level, the following equation is used [4]:

\[
D_d = \frac{L}{A}
\]

Information:
- \(D_d\) : River flow density index (km/km\(^2\))
- \(L\) : Total length of river including length of tributaries (km)
- \(A\) : Watershed area (km\(^2\))

2.4.4. **Concentration time.** The flow concentration time \((T_c)\) can be calculated using the mathematical equation by Kirpich (1940) in Arsyad (2010)[7]:

\[
T_c = 0.0195 L^{0.77} S^{-0.385}
\]

Information:
- \(T_c\) : Concentration time
- \(L\) : Maximum length of flow from outlet to upstream of the watershed
- \(S\) : The height difference between the outlet and the farthest location in the watershed is divided by the maximum length of flow from the outlet to the upstream watershed.

3. **Result and discussion**

3.1. **Biophysical characteristics of the Je’ne Rakikang catchment area**

The morphological characteristics of the watershed consists of geology, topography, soil type, and watershed orientation.

3.1.1. **Geology.** Based on Table 1, the geological conditions of most of the Je’ne Rakikang catchment are dominated by camba formations. The constituent of this camba formation is composed of sediment, clastic, and fine.

| No. | Compiler Formations         | Compiler                  | Area (Ha) | Percentage (%) |
|-----|-----------------------------|---------------------------|-----------|----------------|
| 1.  | Basalt and Basalt Hack      | Intrusive, intermediate   | 275.53    | 6.52           |
| 2.  | Baturape volcanic rock      | Extrusive, mafic, polymic | 663.32    | 15.69          |
| 3.  | Alluvium Deposits           | Sediments, clastics, alluvium | 85.33    | 2.02           |
| 4.  | Camba Formation             | Sediment, clastic, fine   | 3,203.88  | 75.77          |
|     | **Total**                   |                           | 4,228.06  | 100.00         |

Source: Research and Development Center for Geology, Ujung Pandang Sheet, 1982
3.1.2. Topography. The topography of the Je'ne Rakikang catchment has a steep and very steep slope of 58.10% of the watershed area presented in Table 2.

| No. | Topography Class | Slope Class | Area (ha) | Percentage (%) |
|-----|------------------|-------------|-----------|----------------|
| 1.  | Flat             | 0 - 8%      | 394.33    | 9.33           |
| 2.  | Sloping          | 8 - 15%     | 407.34    | 9.63           |
| 3.  | moderate steep   | 15 - 25%    | 969.90    | 22.94          |
| 4.  | Steep            | 25 - 45%    | 1,784.52  | 42.21          |
| 5.  | Very steep       | > 45%       | 671.95    | 15.89          |
|     | Total            |             | 4,228.06  | 100.00         |

3.1.3. Type of soil. Soil types that dominate the Je'ne Rakikang Catchment Area are from the Ultisol which is 66.12% with a moderate potential for soil damage. Details of soil types in the Je'ne Rakikang catchment are presented in Table 3.

| No. | Ordo          | Sub Ordo   | Potential Soil Damage | Area (Ha) | Percentage (%) |
|-----|---------------|------------|------------------------|-----------|----------------|
| 1.  | Inceptisol    | Humitropept| High                   | 1,239.61  | 29.32          |
| 2.  | Ultisol       | Tropohumult| Moderate               | 2,795.55  | 66.12          |
| 3.  | Oxisol        | Haplortox  | Light                  | 178.66    | 4.23           |
| 4.  | Entisol       | Tropofluvent| High                  | 14.24     | 0.34           |
|     | Total         |            |                        | 4,228.06  | 100.00         |

Source: Regional Physical Planning Program for Transmigration South Sulawesi, 1987

3.1.4. Watershed orientation. Based on visual observations, the Je'ne Rakikang catchment area has a watershed direction facing west. According to the Regulation of the Director General of BPDAS and Social Forestry (2013) this determination is based on the direction of the main river flow which is used as a general guideline for watershed orientation.

3.1.5. Watershed morphometry. The morphometric characteristics of the watershed include the area, shape, the length of the river and river order, river gradient, flow patterns, and flow density.

- The watershed area in the Je'ne Rakikang catchment area is 4228.06 ha. Based on the Regulation of the Director General of BPDAS and Social Forestry (2013), it is classified as very small, which is less than 10,000 ha.
- The shape of the watershed is obtained from the calculation of the Circulation Ratio equation, which is 0.32. These results indicate that the Je'ne Rakikang catchment area has a bird feather shape (elongated).
- The overall length of the river in the Je'ne Rakikang catchment is 29.7 km with a river network of 3 order levels.
- The gradient of the Je'ne Rakikang catchment area is 1.68%. According to Paimin, et al. (2013), river gradients are in the high category, with the range of 1.6% -2.0% [8].
- Flow patterns are obtained based on visual observations. The shape of the flow pattern in the Je'ne Rakikang catchment is dendritic that resembles a tree branch.
- The river flow density in the Je'ne Rakikang catchment is 0.70 km/km². The flow density index is included in the moderate flow density.
- The time of flow concentration (Tc) was obtained at 95.39 minutes. The concentration time explains that the water travel time from upstream (inlet) to downstream (outlet) of the Je'ne Rakikang
catchment area is 95 minutes 39 seconds with a distance of 13390 m (13.39 km) with a height difference between the outlet and the farthest location in the watershed of 627 m.

3.1.6. Rainfall. Rainfall in the Je’ne Rakikang catchment area is obtained from Global Weather. The rainfall data is monthly rainfall data for the last ten years from 2004-2013 which is presented in Table 4.

Table 4. Monthly average rainfall data for the last ten years in Je’ne Rakikang Catchment area (2004-2013).

| Month | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    | 2011    | 2012    | 2013    | 2014    |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Jan   | 531.66  | 370.14  | 511.59  | 357.65  | 329.17  | 641.32  | 555.93  | 188.19  | 133.07  | 555.09  | 417.38  |
| Feb   | 486.93  | 563.31  | 326.77  | 466.12  | 278.36  | 323.46  | 599.47  | 173.32  | 162.94  | 148.03  | 352.87  |
| Mar   | 574.53  | 562.53  | 304.76  | 383.32  | 444.99  | 259.33  | 493.74  | 274.16  | 139.02  | 148.77  | 358.51  |
| Apr   | 251.61  | 288.14  | 349.31  | 415.27  | 280.43  | 314.89  | 459.97  | 94.1    | 94.45   | 199.75  | 274.79  |
| May   | 270.95  | 126.23  | 141.01  | 366.79  | 148.99  | 115.2   | 255.28  | 19.26   | 104.63  | 146.35  | 236.37  |
| Jun   | 87.99   | 75.88   | 140.1   | 141.01  | 366.79  | 148.99  | 255.28  | 19.26   | 104.63  | 148.55  | 110.3   |
| Jul   | 59.69   | 134.53  | 22.99   | 47.76   | 55.48   | 99.56   | 389.35  | 19.52   | 77.96   | 128.33  | 103.51  |
| Aug   | 5.2     | 40.16   | 2.34    | 31.42   | 68.98   | 11.31   | 387.82  | 13.18   | 1.99    | 44.68   | 60.7    |
| Sep   | 21.46   | 15.19   | 0.65    | 11.71   | 13.29   | 56.21   | 456.19  | 7.23    | 13.36   | 1.6     | 59.68   |
| Oct   | 36.03   | 263.91  | 7.35    | 165.42  | 253.03  | 148.41  | 556.88  | 73.91   | 51.72   | 31.72   | 158.83  |
| Nov   | 289.09  | 507.18  | 73.51   | 431.42  | 505.85  | 308.54  | 635.91  | 128.57  | 81.83   | 49.88   | 301.17  |
| Dec   | 525.23  | 558.87  | 540.61  | 672.87  | 391.66  | 550.26  | 513.84  | 185.97  | 96.67   | 292.83  | 432.88  |
| Total | 3,140.37| 3,506.10| 2,667.30| 3,561.19| 2,893.90| 3,162.93| 5,808.03| 1,338   | 989.8   | 1,963   | 2,903.10|

Source: Global Weather (2015)

3.1.7. Land cover. Land cover in the Je’ne Rakikang catchment area is dominated by secondary forest. The size of the secondary forest area is 62.25% of the total area of the Je’ne Rakikang catchment area which can be seen in Table 5.

Table 5. Details of types and area of land cover in the Je’ne Rakikang catchment area.

| No.  | Land cover               | Area (Ha) | Percentage |
|------|--------------------------|-----------|------------|
| 1    | Secondary forest         | 2,632.27  | 62.25      |
| 2    | Plantation Forest        | 7.40      | 0.17       |
| 3    | Mining                   | 8.14      | 0.20       |
| 4    | Dry Land Mixed Shrub Farm| 154.16    | 3.65       |
| 5    | Savana                   | 89.88     | 2.12       |
| 6    | Rice fields              | 256.37    | 6.06       |
| 7    | Shrubs                   | 1,073.72  | 25.40      |
| 8    | Body of Water            | 6.12      | 0.15       |
| Total|                         | 4,228.06  | 100.00     |

Source: Forest Area Consolidation Center Wil. VII Makassar 2015
3.2. River discharge fluctuation analysis

The movement of river discharge on the Je'ne Rakikang River is depicted in a graph as shown in Figure 1.

![Graph of Je'ne Rakikang river discharge](image)

**Figure 1.** Graph of Je'ne Rakikang river discharge at 08.00, 12.00 and 16.00.

Based on the graph shown in Figure 1, it shows that the highest river discharge for 31 measurement days occurred on the 17th day at 16.00 at 6.75 m³/second and the lowest discharge occurred on the 15th day at 12.00 at 0.32 m³/second. On the 17th day the river discharge is high due to rain throughout the day so that the process for evapotranspiration is very small. Meanwhile, the lowest discharge is on the 15th day because there is no rain so that the sun’s radiation lasts all day long and the evapotranspiration process goes well. The river flow movement in Figure 1 can be seen in curves as in Figures 2, 3, 4, and 5.

3.2.1. River discharge movement curve pattern A. The movement curve of the river pattern A as in Figure 2 occurs during 19 days of observation, those are on days 1, 2, 5, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, and 25.

![River discharge movement curve pattern A](image)

**Figure 2.** River discharge movement curve pattern A.
The river discharge with the Figure 2 pattern experienced a large decrease occurred on the 8th day with a difference of 0.60 m$^{3}$/second (morning-afternoon) and 0.61 m$^{3}$/second (afternoon-evening). This is because the length of the sun's exposure is ± 8 hours which causes the evapotranspiration process to take longer too. Meanwhile, a low decrease in river discharge occurred on the 25th day, it only decreased by 0.03 m$^{3}$/second (morning-afternoon) and 0.02 m$^{3}$/second (afternoon-evening) because on that day the sun's radiation was only about 4.5 hours in the morning until near noon then punctuated by cloudy and relatively short rains in the afternoon and evening, which causes the evapotranspiration process to not last long.

3.2.2. River discharge movement curve pattern B. The movement curve of the river flow pattern B occurred for 3 days of observation, which are on the 6th, 17th, and 29th days.

![Figure 3. River discharge movement curve pattern B.](image)

The river discharge in Figure 3 pattern which has a high increase occurs on the 17th day, which is around 1.09 m$^{3}$/second (morning-afternoon) and 1.03 m$^{3}$/second (afternoon-evening) due to relatively long periods of rain interspersed with cloudy too. While the low increase occurred on the 29th day, which was only 0.19 m$^{3}$/second (morning-afternoon) and 0.15 m$^{3}$/second (afternoon-evening) where there was ± 3 hours of solar radiation so that the evapotranspiration process took place.

3.2.3. River discharge movement curve pattern C. The movement curve of river flow pattern C occurred for 3 days of observation as well, start on the 26th, 27th, and 31st days.

![Figure 4. River discharge movement curve pattern C.](image)

The river discharge in the Figure 4 pattern which experienced a quite high decline occurred on the 31st day of 0.09 m$^{3}$/second (morning-afternoon) due to ± 4 hours of prolonged exposure to the sun. Meanwhile, the river discharge which experienced a low increase also occurred on the 31st day of 0.08 m$^{3}$/second (afternoon-evening) due to cloudy weather conditions accompanied by rain.
3.2.4. River discharge movement curve pattern D. The movement curve of the river flow pattern B occurred for 6 days of observation as well, starting on the 3rd, 4th, 15th, 16th, 28th, and 30th day. The river flow which has decreased quite significantly occurred on the 4th day of 0.2 m$^3$/second (morning-afternoon) due to the evapotranspiration process which lasted quite a long time with solar radiation for ±3 hours. Meanwhile, the river discharge which experienced a high increase occurred on the 4th day of 0.3 m$^3$/second (afternoon-evening) due to rain that lasted quite a long time before the afternoon.

![Discharge movement curve pattern D](image)

Figure 5. River discharge movement curve pattern D.

3.3. Analysis of the biophysical characteristics of the Je’ne Rakikang catchment area

The biophysical characteristics of the Je'ne Rakikang catchment that affect the longitudinal shape of the Je'ne Rakikang catchment and the time of concentration or travel time of water from the upstream watershed to the river discharge measurement point (outlet) are rather slow. Although the concentration time from the calculation results is quite long, because the area of the Je'ne Rakikang catchment area which is included in the classification of the catchment area is very small, the concentration time is a bit faster.

Steep slopes dominate the Je'ne Rakikang catchment. This has an effect because although the watershed shape index value of 0.32 indicates an elongated watershed with a small flood discharge, due to the steep and very steep slopes that dominate the Je’ne Rakikang catchment area, there is potential for forest disturbance which can cause the river discharge value to be quite large. The resulting high and low river discharge is also supported by the aspect of the river slope (river gradient) which shows the steepness of a river. The river gradient in the Je'ne Rakikang catchment area of 1.68% is included in the high river gradient category.

Another watershed aspect that increases river discharge is the watershed flow pattern. The flow pattern of the Je’ne Rakikang catchment area is a river that has a dendritic pattern. According to Badaruddin (2014) a watershed with a dendritic flow pattern has a good drainage system but tends to experience drought in the dry season due to low infiltration rates [9]. Generally, dendritic patterns exist in an area with homogeneous rocks, for example covered by sedimentary deposits. In accordance with the geological constituents of the Je'ne Rakikang catchment, it is mostly composed of sediments. Porous rock types such as limestone or limestone will produce low peak discharge and relatively long concentration times.

The Je’ne Rakikang catchment area has a river network with 3 levels of river orders with a total river length of 29.7 km. The more branches/orders in the river, the greater the resulting discharge. The Je'ne Rakikang catchment area which has a flow density index of 0.70 km / km2 is obtained based on the calculation results. This figure shows that the flow density index in the Je'ne Rakikang catchment is in the range 0.25 - 10 km / km2 and is included in the medium density category.

The Je’ne Rakikang catchment which has a flow density in the medium category (0.70 km / km2) indicates that the Je'ne Rakikang catchment has moderate runoff velocity. This is supported by Asdak (2010) that the greater the flow density value, the greater the runoff speed and the smaller the infiltration [10]. However, sooner or later the peak discharge that occurs can also be influenced by the aspect of land cover. Land cover obtained from BPKH Wil. VII Makassar shows that most of the land cover in
the Je'ne Rakikang catchment area is dominated by secondary forest, amounting to 62.82%. This condition causes the fluctuation of river discharge to not be too high during the rainy season because the forest cover can reduce the surface runoff that occurs.

The land cover in the form of forest is 62.42% indicating suitable forest conditions so that it can also cover some of the slope of the slope is rather steep (15-25%), steep (25-45%), and very steep (> 45%) of 81.08 % so that the time required for water from upstream (inlet) to downstream (outlet) experiences a slowdown and reduces the time for peak discharge to occur. The rest of the slope is rather steep, steep, and very steep, 18.79% covered by dry land farming mixed with shrubs and shrubs of 28.82%.

Apart from the land cover aspect, another influencing aspect is the type of soil. Soil type affects the process of infiltration of water into the soil. Je'ne Rakikang catchment area was dominated by Trophon mult from the Ultisol order amounting to 66.12%. Soil types from the ultisol order have the potential for moderate soil damage. This potential indicates that the soil is sensitive to erosion. If the soil is sensitive to erosion, there is potential for erosion to occur whenever surface runoff occurs. The result of large surface runoff causes river discharge to become large during the rainy season. The variation of river discharge that occurs in the Je'ne Rakikang catchment is also due to the varied rainfall. Sometimes it rains for most of the day, sometimes it only rains only in the morning, during the day, and in the evening, and there is no rain in a day or even more. The amount of rainfall is shown in Figure 6.

![Figure 6. Graph of Daily Rainfall in the Je’ne Rakikang catchment area for 31 days (15 February-17 March 2015).](image)

Based on the daily rainfall chart in Figure, there are days that rain and there are those that don't rain at all. The highest rainfall occurred on the 17th day with the amount of rainfall of 108.2 mm and the lowest rainfall occurred on the 3rd day of 1.8 mm. Meanwhile, the days where there was no rain were on days 1, 8, 10, 12, 13, 18, 21, 22, 23, and 24. The high rainfall on the 17th day caused river discharge to increase.

Another aspect that affects the high and low of river discharge is the aspect of watershed orientation. The orientation of the watershed is determined based on the direction of the main river flow. Based on visual observations, the main river orientation of the Je’ne Rakikang catchment is facing west. The direction of the watershed facing West tends to get intensive direct sunlight but the rainfall that occurs is more intensive so that it affects the amount of discharge, on the contrary, the direction of the watershed facing east tends to get less intensive sunlight so that maximum evapotranspiration takes place but the rainfall is less intensive.

Based on this, the Je’ne Rakikang catchment tends to get intensive sunlight, shown by the river discharge conditions in Figures 2 and 4 which occurred for 22 days of observation. Meanwhile, the effect of intensive rainfall in the direction of the watershed facing west on river flow fluctuations is shown in Figures 3 and 5 occurring for 9 days during the observation. This curve shows the increase in river discharge in the Je’ne Rakikang catchment due to the occurrence of rain for a relatively long time.

4. Conclusions
The Je’ne Rakikang catchment area has a very variable fluctuation in river flow. This discharge variation is influenced by the biophysical characteristics of the Je'ne Rakikang catchment in the form of geology,
topography, soil type, orientation, area, shape, flow density, flow pattern, river gradient, land cover and rainfall. The different biophysical characteristics of the Je’ne Rakikang catchment provide a response to river discharge when it rains for a fairly short period of time.

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