Science and Technology Indonesia
e-ISSN:2580-4391 *p*-ISSN:2580-4405
Vol. 5, No. 2, April 2020

Research Paper

Analysis of Ogan Ilir Regency's Kelekar River Runoff Discharge in Micro Hydro Power Plant (PLMTH) Planning

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Abstract
Micro hydro power plant (PLTMH) is an alternative source of electrical energy for the community where by using this PLTMH the community can utilize the existing river flow as electricity generation. The country of Indonesia has many rivers and creeks that can be used optimally in producing alternative electricity. Kelekar River, located in Ogan Ilir Regency has the potential to be developed as a Micro Hydro Power Plant (PLTMH) that can be used to supply electricity in the region around the Ogan River. Data analysis includes: catchman area analysis, rainfall analysis, calculation of rainfall intensity plan, calculation of runoff discharge, and analysis of river flow rates. Based on the analysis that has been done, the Kelekar river runoff discharge is Q_{Rmax} of 211.109 m^3/second and QRmin of 15.732 m^3/second. From this result, the selection of turbines to be used in PLTMH planning is Propeller Type turbines.

Keywords
River, Runoff, Discharge, PLMTH

Received: 3 March 2020, Accepted: 06 April 2020
https://doi.org/10.26554/sti.2020.5.2.41-44

1. INTRODUCTION

Population growth causes an increase in electricity demand, this causes the supply of electric power sources derived from petroleum, coal, and natural gas used as fuel will certainly decrease and eventually will run out and besides that the use of earth energy sources can also cause negative impacts. Micro Hydro Power Plant (PLTMH) is an alternative source of electrical energy for the community, where by using this PLTMH the community can utilize existing river flow as electricity generation, considering that Indonesia has many rivers and creeks that can be used optimally in producing electricity alternative (Dhana et al., 2019; Ady et al., 2016; Buyung, 2016; Wibowo et al., 2015; Sukamta and Kusmantoro, 2013).

Ogan Ilir Regency is a regency in South Sumatra Province which is geographically on position 3° 02'- 3° 48' LS and 104° 20'- 104° 48' BT, with an area of territory 2.666,07 km^2 and located about 35 km from the city of Palembang. Kelekar River located in Ogan Ilir Regency has the potential to be developed as a Micro Hydro Power Plant (PLTMH) that can be used to supply electricity in the region around the Ogan River, this is supported by the average annual rainfall of 2902 mm per year. The highest rainfall in November with an average of 435 mm, and the lowest rainfall in August with an average of 83 mm (BMKG, 2019). In addition the existence of a reservoir of a Sriwijaya University at the study site also strongly supports the construction of a Micro Hydro Power Plant (PLTMH). Based on data from the field observations, a reservoir of Sriwijaya University has an overflow design using a wide threshold with a peak elevation of +6.00 and is equipped with 2 sluice gates with dimensions P x L = 2 x 1.5 meters (PUPR, 2019). From the geographical conditions and the existence of a reservoir of a Sriwijaya University, the PLTMH development planning was carried out in Ogan Ilir Regency where this research focused on the location of the Kelekar River. To design this PLTMH the first step is to analyze the flow of flow that exists in the Kelekar River, so obtained the amount of discharge generated to be able to move the turbine that will be used on the PLTMH. From this background, so a study was carried out on the analysis of water flow discharge in the Kelekar River to obtain discharge of water flow that can be used as a basis for selecting turbines as a driver of PLTMH.

2. EXPERIMENTAL SECTION

2.1 Location of study

The study was conducted in the Kelekar River and a reservoir of a Sriwijaya University, Ogan Ilir Regency. The map of the Ogan Ilir Regency area can be seen in Figure 1, while the map of

research locations can be seen in Figure 2.

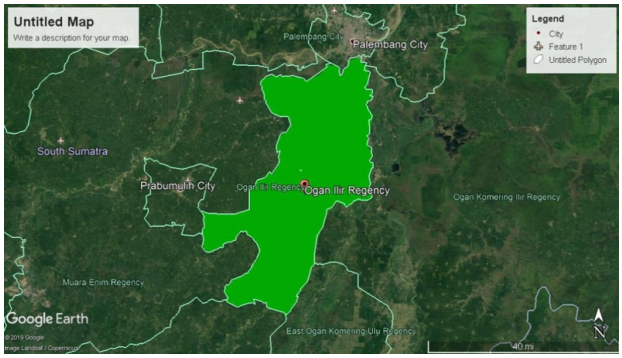

Figure 1. Map of Ogan Ilir Regency

Figure 2. Study Location Map

2.2 Analysis method

The data needed in this study consists of primary data, include the measurement of the Kelekar River water flow velocity and the calculation of the Kelekar River discharge calculated using the rational method based on maximum and minimum rainfall data, while secondary data is obtained from relevant agencies that provide the data needed in the research process, include maximum and minimum daily rainfall data and river topography data.

The data processing and analysis phase carried out includes: (i) catchment area analysis is carried out using GIS as has been done previous studies, among others, conducted by Indrayani et al. (2017), (ii) rainfall analysis calculation is done using 3 frequency analysis methods, and then the compatibility test is done using the smirno-kolmogorof test, (iii) calculation of the rainfall intensity of the plan, (iv) runoff discharge calculation, and (v) river flow discharge analysis.

3. RESULTS AND DISCUSSION

3.1 Rainfall Analysis

The data used is the maximum daily rainfall data for the last 10 years (2009 - 2018) obtained from the BMKG of the city of Palembang, at the Indralaya penakar station, Ogan Ilir Regency.

Table 1. Data on River Slope, River Length and Tc Value

SUB Catchment Area	Length_L (km)	Slope (S)	Concentration Time_Tc (Hours)
Sub-watershed 3	5	0.144	0.4826

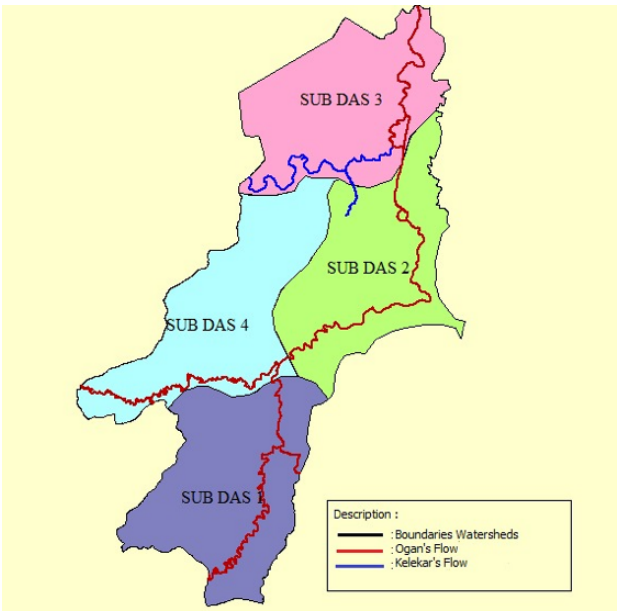

Figure 3. Ogan Watershed

Based on the calculation results of the Smirnov-Kolmogorov compatibility test, for Rmax only the gumbel distribution can be accepted because it has a value of Δmax < Δkritik . For Rmin there are two acceptable probability distributions, the normal distribution and the gumbel, because the gumbel distribution has a value Δmax < Δkritik. Because the value of the gumbel distribution is smaller than the normal distribution that is 0.172 <0.409, the gumbel distribution is chosen.

Rainfall intensity is one of the parameters needed in the calculation of runoff discharge using the rational method. The relatively high rainfall intensity will generally only last for a short duration and cover a small area.

3.2 Catchment Area of rain

The Kelekar River is part of the Ogan river basin. The division of the Ogan River watershed was made using the ArcGIS 10.5 model builder program. The division of the Ogan River watershed from the modeling results can be seen in Figure 3.

From Figure 3 can be seen that Kelekar river are in sub-watershed 3.

3.3 Calculate concentration time (Tc)

In this study the longest path length and channel slope data were analyzed using the help of the Google Earth Pro and ArcMap10.3 programs. Slope and river length data can be seen in Table 1.

Table 2. Intensity of Rain of Plan

Tr (Year)	Sub Catchment Area	Tc (hour)	Rmax		Rmin	
			R24 (mm)	I (mm/hour)	R24 (mm)	I (mm/hour)
2	Watershed 3	0.4826	408.803	230.337	30.465	17.1653
5			520.1637	293.0824	65.7365	37.0387
10			593.8999	334.6285	89.091	50.1977
25			687.0574	387.1174	118.5969	66.8226
50			756.1667	426.0565	140.486	79.1558
100			796.3355	448.6893	153.2088	86.3243

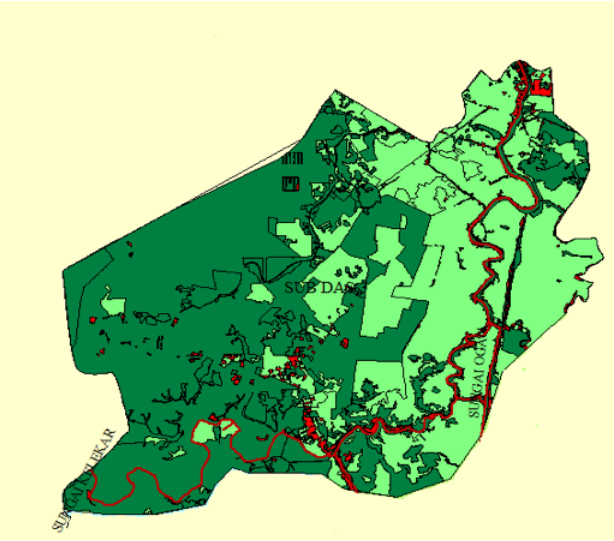

Figure 4. Land Use of Sub-watershed 3

Table 3. Details of types of land use

Description	Area (km^2)	Percentage of Area (%)
Settlement	0.14343	4.44
Plantation/ farming	2.3172	71.69
Shrub	0.77157	23.87
Total	3.2322	100

3.4 Intensity of Rain of Plan

Recapitulation of the results Calculation of rainfall intensity in the annual return period can be seen in Table 2.

3.5 Determination Runoff Coefficient Value

Land use area for sub-watershed 3 was obtained from the processing of location maps using Google Mapper. Map processing results can be seen in Figure 4 and Table 3.

The recapitulation of catchment area runoff coefficient calculation results can be seen in Table 4.

3.6 Runoff Discharge Calculation

To calculate runoff discharge, the rational method is used. The parameters used that is runoff coefficient (C), the area of the sub-catchment km^2, and the value of rainfall intensity (mm/hour). Discharge calculation for return period of 2 years as follows:

- Area of sub catchment 3 = 3,2322 km^2
- Runoff coefficient (C) = 1,02
- Intensity rain of sub catchment 3 (I) Rmax = 230,337 mm/hour
- Intensity rain of sub catchment 3 (I) Rmin = 17,165 mm/hour
- Q_{Rmax} = 0,278 C I A
  = 0,278 x 1,02 x 230,337 mm/hour x 3,2322 km^2
  = 211,109 m^3/second
- Q_{Rmin} = 0,278 C I A
  = 0,278 x 1,02 x 17,165 mm/jhour x 3,2322 km^2/second
  = 15,732 m^3/second

The results of this water flow discharge analysis can be used to determine the type of turbine to be used (Hanggara and Irvani, 2017; Dwiyanto et al., 2016). From the results of the discharge analysis that has been carried out on the Kelekar River flow, the turbine that will be used in the planning of micro hydro power plants is a propeller turbine, where this turbine can be driven by a discharge in the range 250 ≤ Ns ≤ 1000 (JICA, 2011).

4. CONCLUSIONS

Land use in the catchment area in the sub-watershed 3 consists settlement with an area of 0.1434 km^2, plantation/ farming with an area of 2.3172 km^2 and shrub with an area of 0.7716 km^2. Based on the analysis that has been done, the Kelekar river discharge is QRmax of 211.109 m^3/second and QRmin of 15.732 m^3/second, so the selection of turbines to be used in PLTMH planning based on the characteristics of water flow is a Propeller Type turbine, but must be reviewed further on the height of falling water.

5. ACKNOWLEDGEMENT

Acknowledgements for: (i) Ministry of Research and Technology/ Research Agency and National Innovation Deputy of Field Research and Development for Megister Thesis grant funding, (ii) Politeknik Negeri Sriwijaya, Palembang, Indonesia.

Table 4. The recapitulation of catchment area runoff coefficient calculation results

Description	Area (km^2)	Total Area (A)	C	C x A	ΣC x A	Land Coefficient (C)
Settlement	0.1434	3.2322	0.75	2.42415	3.296844	1.02
Plantation/ farming	2.3172		0.2	0.64644		
Shrub	0.7716		0.07	0.22625		

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