

# Article

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# Analysis of Ogan Ilir Regency's Kelakar River Runoff Discharge in Micro Hydro Power Plant (PLTMH) Planning

Renny Citra Ramadhani<sup>1</sup>, Muhammad Yerizam<sup>2</sup>, Indrayani<sup>3,\*</sup>

<sup>1</sup> Postgraduate Students of Renewable Energy Study Programs, Politeknik Negeri Sriwijaya, Palembang, Indonesia.

<sup>2</sup> Chemical Engineering Department, Politeknik Negeri Sriwijaya, Palembang, Indonesia.

<sup>3\*</sup> Civil Engineering Department, Politeknik Negeri Sriwijaya, Palembang, Indonesia.

\*Corresponding Author: iin\_indrayani@polsri.ac.id

## 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. Kelakar 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 Kelakar river runoff discharge is  $Q_{Rmax}$  of 211.109 m<sup>3</sup>/second and  $Q_{Rmin}$  of 15.732 m<sup>3</sup>/second. From this result, the selection of turbines to be used in PLTMH planning is Propeller Type turbines.

**Keywords:** River, Runoff, Discharge, PLTMH

## 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 (Ady, et al, 2016; Buyung, 2016; Handy, et al, 2015; Sri 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<sup>2</sup> and located about 35 km from the city of Palembang. Kelakar 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 (Ministry of PUPR BBWS Sumatera VIII, 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 Kelakar River. To design this PLTMH the first step is to analyze the flow of flow that exists in the Kelakar 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

Kelakar 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 Kelakar 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  
(Source: Google Earth, 2019)

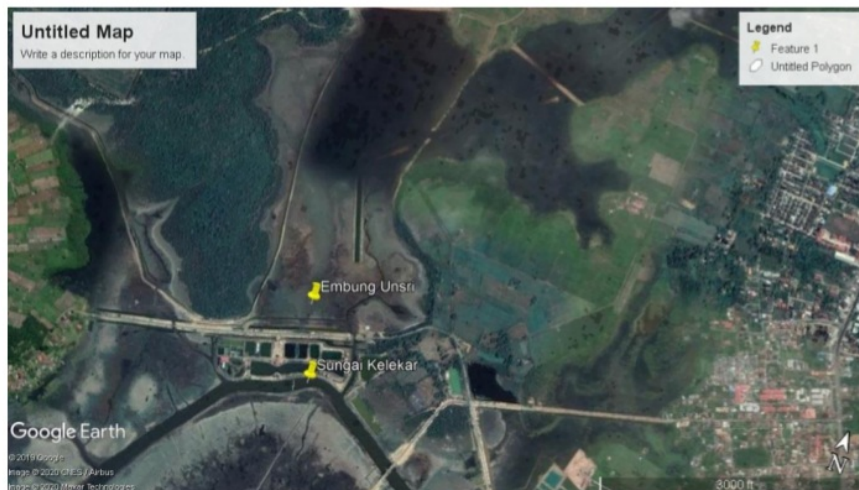


Figure 2. Study Location Map  
(Source: Google Earth, 2019)

### 2.2 Analysis method

The data needed in this study consists of primary data, include the measurement of the Kelakar River water flow velocity and the calculation of the Kelakar 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.

## <sup>2</sup> 3. Result and Discussion

### 3.1 Rainfall Analysis<sup>2</sup>

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. Based on the calculation results of the Smirnov-Kolmogorov compatibility test, for  $R_{max}$  only the gumbel distribution can be accepted because it has a value of  $\Delta_{max} < \Delta_{kritik}$ . For  $R_{min}$  there are two acceptable probability distributions, the normal distribution and the gumbel, because the gumbel distribution has a value  $\Delta_{max} < \Delta_{kritik}$ . 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 (Suripin, 2006).

### 3.2 Catchment Area of rain

The Kelakar 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.

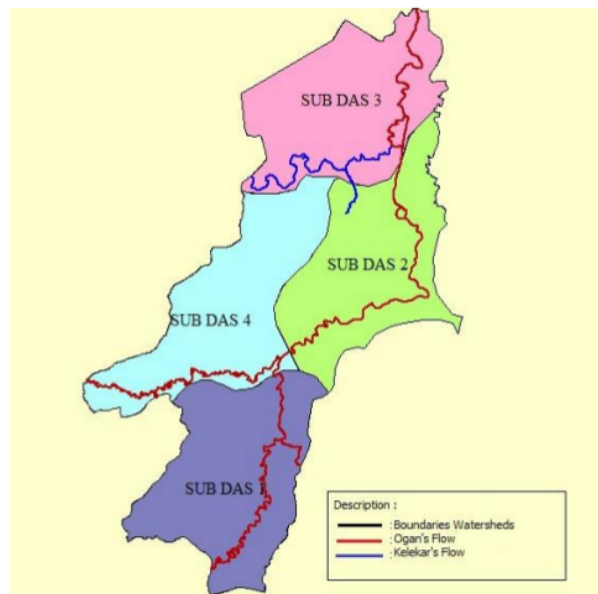


Figure 3. Ogan Watershed

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 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

### 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.

Table 2. Intensity of Rain of Plan

Tr (Year)	Sub-Catchment Area	Tc (hour)	R <sub>max</sub>		R <sub>min</sub>	
			R24 (mm)	I (mm/hour)	R24 (mm)	I (mm/hour)
2	Watershed 3	0.4826	408.8030	230.3370	30.4650	17.1653
5			520.1637	293.0824	65.7365	37.0387
10			593.8999	334.6285	89.0910	50.1977
25			687.0574	387.1174	118.5969	66.8226
50			756.1667	426.0565	140.4860	79.1558
100			796.3355	448.6893	153.2088	86.3243

### 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.

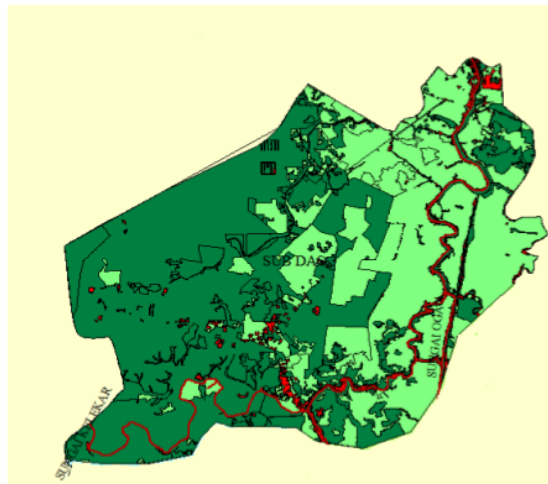


Figure 4. Land Use of Sub-watershed 3



Table 3. Details of types of land use

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

The recapitulation of catchment area runoff coefficient calculation results <sup>12</sup> can be seen in Table 4.

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

Description	Area (km <sup>2</sup> )	Total Area (A)	C	C x A	$\Sigma C \times A$	Land Coefficient (C)
Settlement	0.1434	3.2322	0.750	2.42415	3.296844	1.02
Plantation/ farming	2.3172		0.200	0.64644		
Shrub	0.7716		0.070	0.22625		

### 3.6 Runoff Discharge Calculation

<sup>16</sup> To calculate runoff discharge, the rational method is used. The parameters used that is runoff coefficient (C), the area of the sub-catchment (km<sup>2</sup>), 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<sup>2</sup>  
 Runoff coefficient (C) = 1,02  
 Intensity rain of sub catchment 3 (I)  $R_{max}$  = 230,337 mm/hour  
 Intensity rain of sub catchment 3 (I)  $R_{min}$  = 17,165 mm/hour

$$\begin{aligned}
 Q_{Rmax} &= 0,278 C / A \\
 &= 0,278 \times 1,02 \times 230,337 \text{ mm/hour} \times 3,2322 \text{ km}^2 \\
 &= 211,109 \text{ m}^3/\text{second}
 \end{aligned}$$

$$\begin{aligned}
 Q_{Rmin} &= 0,278 C / A \\
 &= 0,278 \times 1,02 \times 17,165 \text{ mm/hour} \times 3,2322 \text{ km}^2 \\
 &= 15,732 \text{ m}^3/\text{second}
 \end{aligned}$$

### 3.7 Discussion

The results of this water flow discharge analysis can be used to determine the type of turbine to be used (Very, et al, 2016; Ikrar, 2017). From the results of the discharge analysis that has been carried out on the Kelakar 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  $250 \leq N_s \leq 1000$  (Japan International Cooperation Agency, 2011).

### 4. Conclusion

Based on the analysis that has been done, the Kelekar river discharge is  $Q_{Rmax}$  of 211.109 m<sup>3</sup>/second and  $Q_{Rmin}$  of 15.732 m<sup>3</sup>/second, so that the selection of turbines to be used in PLTMH planning is Propeller Type turbines.

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## References

- 11  
Ady, W.N., Dermawan, V., dan Harisuseno, D., 2016. "Studi Perencanaan Pembangkit Listrik Tenaga Mikro Hidro (PLTMH) Wamena di Kabupaten Jayawijaya Provinsi Papua". Jurnal Teknik Pengairan. Universitas Brawijaya.
- BMKG, 2019. "Data Curah Hujan Kabupaten Ogan Ilir". Badan Meteorologi, Klimatologi, dan Geofisika.
- 10  
Buyung, S. 2016. "Analisis Pengaruh Tinggi Jatuhnya Air (Head) Terhadap daya Pembangkit Listrik Tenaga Micro Hydro Tipe Turbin Pelton". Jurnal Teknik Mesin. Politeknik Katolik Saint Paul Sorong.
- 1  
Handy, H., Daud, A., Al Amin, M.B., 2015. "Kajian Teknik dan Ekonomi Perencanaan Pembangkit Listrik Tenaga Mini Hidro di Sungai Jemtang Kota Pagaralam". Cantilever, Jurnal Penelitian dan Kajian Bidang Teknik, Vol. 4, No. 1, DOI: <http://dx.doi.org/10.35139%2Fcantilever.v4i1.10>
- 13  
Ikrar, H., and Irvani, H., 2017. "Potensi PLTMH Pembangkit Listrik Tenaga Mikro Hidro) di Kecamatan Ngantang Kabupaten Malang Jawa Timur". Jurnal Teknik Sipil. Vol 2, No. 2. Universitas Tribbuwana Tunggadewi, Malang.
- 3  
Indrayani, Buchari, E., Putranto, D.D,A., and Saleh, E., 2017. "Analysis of land use in the Banyuasin district using the image Landsat 8 by NDVI method". AIP Conference Proceedings, <https://doi.org/10.1063/1.5011514>
- 5  
Japan International Cooperation Agency, 2011. "Guideline and Manual for Hydropower Development." Vol.2, Small Scale Hydropower, Electric Power Development Co., Ltd. JP Design Co., Ltd.
- Ministry of PUPR, 2019. "Document BBWSS VIII". Balai BWS Sumatera VIII, <http://sda.pu.go.id/bbwssumatera8/>
- 9  
Sri, S., dan Kusmantoro, A., 2013. "Perencanaan Pembangkit Listrik Tenaga Mikro Hidro (PLTMH) Jantur Tabalas Kalimantan Timur". Jurnal Teknik Elektro. Vol 5, No.2. Universitas Negeri Semarang.
- 7  
Very, D., Indriani, D.K., Tugiono, S., 2016. "Analisis Pembangkit Listrik Tenaga Mikro Hidro (PLTMH) Studi Kasus : Sungai Air Anak (Hulu Sungai Way Besai)". Journal Rekayasa Sipil dan Desain, Vol 4, No. 3, Hal. 407-422.

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