

Potential Analysis of Muncar River for Utilization of Micro Hidro Power Plant (MHPP)

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ABSTRACT

The Muncar River in Gondang Village, Candimulya, Kertek Subdistrict, Wonosobo Regency has abundant springs, even in the dry season the water in the village remains abundant. Therefore, there is a need for research to utilize these water sources to be used as Micro Hydro Power Plants. The research method in data collection is direct observation in the field. The type of data used for the purposes of primary data includes geometric data, environmental conditions data, water discharge and annual rainfall data. To obtain optimal electrical and discharge power, the planned plunge height (H) is used in the field as high as 10 m. the selling price of electricity is Rp. 1,350 - / Kw, the purchase price of electricity is Rp. 1,500 - / Kw. Whereas to get optimal discharge is done by trying to discharge the plan with different values so that the maximum profit is obtained. From the calculation of electric power and optimal discharge obtained: Electric power = 603.61 Kw and optimal discharge = 8.05 m³/sec.

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Introduction

1. Water has enormous benefits for human life. No one doubts that. It was proven when the community complained when the water in the drains did not come out. The benefits of water are truly felt as a "savior of life". One of the smartest uses of water is the establishment of a hydroelectric power plant [6]. Rivers are a source of water for the lives of humans, animals and plants that exist on earth, all living creatures need water to maintain their survival. The river flows from upstream to downstream from a high place to a low place.

The benefits of water that is quite large and influential on human life as a whole should be balanced with awareness of maintaining the water resources that exist on earth. Wasting water on something unnecessary is not a noble job. The use of water for use as a Hydro Power Plant will be far more useful for life [5]. Many areas in rural areas in Indonesia are close to adequate river flows to be used as power plants. One of them is Gondang Candimulyo village, Kertek Subdistrict, Wonosobo Regency, which is at the foot of Sindoro Mountain and Sumbing Mountain. The water in the village is quite large and abundant even during the dry season the area is not short of water. Aside from just flowing the river is also

used for rice field and fisheries irrigation, but the utilization of river water in the village is not maximal. The village only uses the river water for basic household needs, irrigation, and fisheries.

2. Therefore, it is expected that by utilizing the existing potential, the village can meet its own energy needs in anticipation of rising electricity costs or the difficulties of the national electricity grid. For this reason, the researcher intends to conduct a research entitled "Analysis of the Potential of Muncar River for the Use of Micro Hydro Power Plants (MHP). Electric energy is also equally important for human life, but at this time the cost for that energy is relatively expensive, therefore the role of the government is needed to find out the use of watersheds that can be utilized more optimally [7].

Water and electricity are two needs that cannot be replaced by anything. Daily activities will be very disturbed when the water and electricity supply is disrupted. Therefore, efforts to keep these two things from happening must be done [5].



Microhydro or what is meant by Microhydro Power Plant (MHP) is a small scale power plant that uses hydropower as power for its drive such as irrigation canals, rivers or natural waterfalls by using plunge height and the amount of water discharge [4].

In rivers that can be utilized for Micro Hydro Power Plants, they must have sufficient availability of water throughout the year, reliable discharge and suitable contours [2].

To use the river flow, special generators are used so that the use of the river as a power plant without having to make a dam, but can still be used for irrigating rice fields so that they can be maximized [3].

The river that requires a dam is a river that has a ratio of discharge between the dry season and the rainy season is quite high. Therefore, to use the river as a power plant requires a dam / reservoir. [6]

For rivers where the flow of water carrying gravel or other sediments requires a sediment / sedimentary building so that the sediment carried by water is not easy to damage the generator. [1]

2. Methods and Materials:

2.1. Data Analysis and Evaluation Methods

- Analysis of survey data is carried out by using indicators and formulas as listed in the reference journal [3].
- Data collection methods used for measuring discharge by calculating discharges using rain and plunge height data. [7]

2.2. Field Orientation

To get a good picture of the characteristics of research objects, relevant information is needed. This information is obtained by conducting a field survey, including the geometric conditions of the river, environmental conditions.

2.3. Tools and Materials

Stationary

- Data processing tools such as: calculators, computers or laptops equipped with Microsoft office and Auto CAD
- Data collection tools used such as: Global Positioning system (GPS), measuring tape, ruler and stopwatch



3.5. Data Collection

a) Primary Data

- River data (discharge and cross section) and falling height.
- Making curves from the results of discharge collection.

b. Secondary Data

- Area contour map data
- Rainfall data from 2012-2016

3. Results and Discussion:

3.1. Processing of Rainfall Data

Table 1: Monthly average rain data in one year

| Num | Month | Year | | | | | Total | Average |
|-----|-----------|-------|-------|--------|-------|-------|--------|---------|
| | | 2012 | 2013 | 2014 | 2015 | 2016 | | |
| 1 | January | 3.24 | 18.77 | 121.55 | 14.81 | 12.74 | 171.11 | 34.22 |
| 2 | February | 5.76 | 13.06 | 9.21 | 12.38 | 12.39 | 52.79 | 10.56 |
| 3 | March | 14.53 | 9.83 | 12.84 | 14.87 | 23.23 | 75.29 | 15.06 |
| 4 | April | 22.56 | 17.11 | 6.77 | 14.63 | 9.49 | 70.57 | 14.11 |
| 5 | May | 17.85 | 15.76 | 3.77 | 6.55 | 17.85 | 61.78 | 12.36 |
| 6 | June | 9.49 | 4.43 | 4.93 | 1.65 | 10.42 | 30.93 | 6.19 |
| 7 | July | 7.53 | 8.32 | 13.90 | 0.00 | 6.62 | 36.37 | 7.27 |
| 8 | Agustus | 10.08 | 1.01 | 1.55 | 0.87 | 7.53 | 21.04 | 4.21 |
| 9 | September | 6.84 | 3.17 | 0.00 | 0.03 | 22.56 | 32.60 | 6.52 |
| 10 | October | 17.34 | 21.45 | 4.35 | 0.66 | 14.53 | 58.33 | 11.67 |
| 11 | November | 48.40 | 29.77 | 36.10 | 11.57 | 22.08 | 147.92 | 29.58 |
| 12 | December | 54.90 | 29.08 | 56.92 | 15.76 | 18.75 | 175.42 | 35.08 |

Source: Analysis of Data Calculation Results

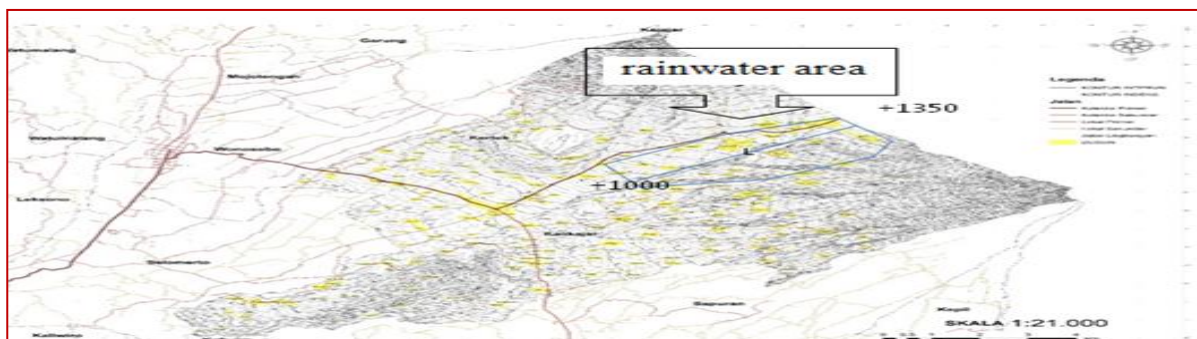


Figure 1. Rainfall area



3.2. Calculation Results

a) Rainfall area calculating (A)

With a scale of 1: 21,000, in the picture:

$$1 \text{ mm} = 125 \text{ m}$$

$$A = p \times l$$

Where :

A = wide area of rainfall

p = long rain pool

l = width of the container

if

$$p = 651.5 \times 125 = 81,437.5 \text{ m}$$

$$l = 2 \times 125\text{m} = 250 \text{ m}$$

then :

$$A = p \times l$$

$$= 81,437.5 \times 250$$

$$= 20,359,375 \text{ m}^2$$

a. Calculate the slope average of flow area (S) and determine ©

$$S = H / L$$

Where :

S = Slope of the average flow area

H = High farthest difference with the channel point

L = Farthest distance in the flow area (m)

$$S = H / L$$

$$= 1350/1000$$

$$= 0.064$$

$$S = \text{tg } \alpha$$

$$\alpha = \text{cotg } S$$

$$= \text{cotg } 0.064$$

$$= 3,670, \text{ then}$$

C = 0.20 (Fine sandy soils and fields)

b) Calculating the concentration time (Tc)

Kirpich formula

$$Tc = 0.0195 \times \{L / S^{0.5}\}^{0.77}$$

Where :

TC = duration of concentration (minutes)

L = farthest distance in the area of flow (m)

S = slope of the average flow area

$$Tc = 0.0195 \times \{5,500 / 0.064^{0.5}\}^{0.77}$$

$$= 0.0195 \times \{5,500 / 0.252\}^{0.77}$$

$$= 42,726 \text{ minutes}$$

c) Calculating Rainfall Intensity (i)

Rainfall intensity formula (i)

$$I = \{R / 24\} \times \{24^{2/3} / TC\}$$

Where :

I = rainfall intensity (mm / hour)

R = planned rainfall (taken from average monthly

rainfall in one year) (mm)

TC = duration of concentration (minutes)

R Januari = 34.22 mm

$$I \text{ Januari} = \{34.22/24\} \times \{24/42,726\}^{2/3}$$

$$= 1,426 \times 0,681$$

$$= 0.971 \text{ mm / minute}$$

$$= 0.000971 \text{ m / minute}$$



Table 2 - Rainfall intensity calculation results (I)

| Num | Month | R Plan | I |
|-----|-----------|--------|----------|
| 1 | January | 34.22 | 0.000971 |
| 2 | February | 10.56 | 0.000299 |
| 3 | March | 15.06 | 0.000427 |
| 4 | April | 14.11 | 0.000400 |
| 5 | May | 12.36 | 0.000350 |
| 6 | June | 6.19 | 0.000175 |
| 7 | July | 7.27 | 0.000206 |
| 8 | Agustus | 4.21 | 0.000119 |
| 9 | September | 6.52 | 0.000185 |
| 10 | October | 11.67 | 0.000331 |
| 11 | November | 29.58 | 0.000839 |
| 12 | December | 35.08 | 0.000995 |

Source: Data calculation results analysis

d) Average monthly discharge

$$Q_n = C \times I_n \times A$$

Where

Q_n = n month discharge

C = run-off coefficient

I_n = n month rainfall intensity (mm/minute)

A = rain catchment area (m²)

Table 3- Discharge calculation results

| Num | Month | Discharge |
|-----|-----------|-----------|
| 1 | January | 65.88 |
| 2 | February | 20.32 |
| 3 | March | 28.99 |
| 4 | April | 27.17 |
| 5 | May | 23.79 |
| 6 | June | 11.91 |
| 7 | July | 14.00 |
| 8 | Agustus | 8.10 |
| 9 | September | 12.55 |
| 10 | October | 22.46 |
| 11 | November | 56.95 |
| 12 | December | 67.54 |

b. Rainfall discharge correction based on Hcr

$$Q_{Hcr\ n} = Q_{bulan\ n} \times Q\ correction$$

Where

$Q_{Hcr\ n}$ = Discharge based on correction of Hcr (m³/sec)

$Q_{month\ n}$ = Discharge on month based on rainfall data

Correction = Comparison between Discharge based on Hcr divided by Discharge in n month based on rainfall data.

Table 4-Hcr Calculation Results

| Num | Month | Discharge |
|-----|-----------|-----------|
| 1 | Januari | 26.09 |
| 2 | Februari | 8.05 |
| 3 | Maret | 11.48 |
| 4 | April | 10.76 |
| 5 | Mei | 9.42 |
| 6 | Juni | 4.72 |
| 7 | Juli | 5.55 |
| 8 | Agustus | 3.21 |
| 9 | September | 4.97 |
| 10 | Oktoner | 8.89 |
| 11 | November | 22.55 |
| 12 | Desember | 26.75 |

Source: Data calculation results analysis



Table 5 - Calculation results comparison

| Num | Month | Ranfall Discharge | Discharge |
|-----|-----------|-------------------|-----------|
| 1 | Januari | 65.88 | 26.09 |
| 2 | Februari | 20.32 | 8.05 |
| 3 | Maret | 28.99 | 11.48 |
| 4 | April | 27.17 | 10.76 |
| 5 | Mei | 23.79 | 9.42 |
| 6 | Juni | 11.91 | 4.72 |
| 7 | Juli | 14.00 | 5.55 |
| 8 | Agustus | 8.10 | 3.21 |
| 9 | September | 12.55 | 4.97 |
| 10 | Oktoner | 22.46 | 8.89 |
| 11 | November | 56.95 | 22.55 |
| 12 | Desember | 67.54 | 26.75 |

Source: Data calculation results analysis

g) Calculation of Profit Results

Based on the data in the field, it can be planned as high as 10 m. So that the height can be used to calculate electrical power.

Calculation of electric power

Formula

$$P = \eta \times Q \times H \times \gamma$$

Where :

$$\eta = 0.75$$

$$Q = Q \text{ plan}$$

$$H = 10 \text{ m}$$

$$\gamma = 10 \text{ KN / m}^3$$

$$\text{Selling price} = \text{Rp. } 1,350, - / \text{ Kw}$$

$$\text{Buying price} = \text{Rp. } 1,500, - / \text{ Kw (approximate)}$$

a). Try $Q = 3.21 \text{ m}^3/\text{sec}$

$$P = 0.75 \times 3.21 \times 10 \times 10$$

$$= 240.58 \text{ Kw}$$

$$\text{Selling} = P \times \text{selling month} \times \text{selling price}$$

$$= 240.58 \times 12 \times \text{Rp. } 1,350.00$$

$$= \text{Rp. } 3,897,342.76$$

By using discharge $3.21 \text{ m}^3/\text{sec}$ then the month that was bought because of insufficient discharge is 0 months / discharge in 1 year is sufficient

$$\text{Buy} = P \times \text{month buy} \times \text{purchase price}$$

$$= 240.58 \times 0 \times \text{Rp. } 1,500.00$$

$$= \text{Rp. } 0$$

$$\text{Profit} = \text{Sell} - \text{Buy}$$

$$= \text{Rp. } 3,897,342.76 - \text{Rp. } 0$$

$$= \text{Rp. } 3,897,342.76$$

$$= \text{Rp. } 3,898,000.00$$

b). Try $Q = 10.76 \text{ m}^3 / \text{sec}$

$$P = 0.75 \times 10.76 \times 10 \times 10$$

$$= 806.93 \text{ Kw}$$

$$\text{Selling} = P \times \text{selling month} \times \text{selling price}$$

$$= 806.93 \times 12 \times \text{Rp. } 1,350.00$$

$$= \text{Rp. } 13,072,210.10$$

By using discharge $10.76 \text{ m}^3 / \text{sec}$, the month purchased due to insufficient discharge is 7 months

$$\text{Buy} = P \times \text{month buy} \times \text{purchase price}$$

$$= 806.93 \times 7 \times \text{Rp. } 1,500.00$$

$$= \text{Rp. } 8,472,728.77$$

$$\text{Profit} = \text{Sell} - \text{Buy}$$

$$= \text{Rp. } 13,072,210.10 - \text{Rp. } 8,472,728.77$$

$$= \text{Rp. } 4,599,481.33$$

$$= \text{Rp. } 4,600,000.00$$

c). Try $Q = 8.05 \text{ m}^3 / \text{sec}$

$$P = 0.75 \times 8.05 \times 10 \times 10$$

$$= 603.61 \text{ Kw}$$

$$\text{Selling} = P \times \text{selling month} \times \text{selling price}$$



$$= 603.61 \times 12 \times \text{Rp. } 1,350.00$$

$$= \text{Rp. } 9,778,445.72$$

By using 8.05 m³/sec discharge, the month purchased due to insufficient discharge is 4 months

$$\text{Buy} = P \times \text{month buy} \times \text{purchase price}$$

$$= 603.61 \times 4 \times \text{Rp. } 1,500.00$$

$$= \text{Rp. } 3,621,646.56$$

$$\text{Profit} = \text{Sell} - \text{Buy}$$

$$= \text{Rp. } 9,778,445.72 - \text{Rp. } 3,621,646.56$$

$$= \text{Rp. } 6,156,799.15$$

$$= \text{Rp. } 6,157,000.00$$

d). Try $Q = 26.75 \text{ m}^3 / \text{sec}$

$$P = 0.75 \times 26.75 \times 10 \times 10$$

$$= 2,005.88 \text{ Kw}$$

$$\text{Selling} = P \times \text{selling month} \times \text{selling price}$$

$$= 2,005.88 \times 12 \times \text{Rp. } 1,350.00$$

$$= \text{Rp. } 32,495,192.19$$

$$\text{Buy} = P \times \text{month buy} \times \text{purchase price}$$

$$= 2,005.88 \times 11 \times \text{Rp. } 1,500.00$$

$$= \text{Rp. } 33,096,955.01$$

$$\text{Profit} = \text{Sell} - \text{Buy}$$

$$= \text{Rp. } 32,495,192.19 - \text{Rp. } 33,096,955.01$$

$$= - \text{Rp. } 601,762.82$$

$$= - \text{Rp. } 602,000.00$$

So the optimal electrical power of MHP in Muncar River, Candimulyo Village, Kertek Subdistrict, Wonosobo Regency is 063.61 Kw in river discharge amounting to 8.05 m³/sec.

4. Conclusion:

After conducting research and data calculation at the 820 m, the result in Kertek Station is:

- Muncar River according to MHP criteria is including Run Of River.
- The optimal discharge from a stream leading to MHP is 8.05 m³/sec in February.
- With a discharge of 8.05 m³/sec, the electricity produced is 603.61 Kw = 603,610 watts can be used for 464 houses with a power of 1300 watts/house.

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