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Research Original Article

Potential Planning for Micro Hydro Power Plants (PLTMH) by Utilizing River Flows in Kab. Gayo Lues

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Abstract
The abstract should be clear, concise, descriptive and should provide a brief introduction to the problem. A statement: Electricity is a necessity that plays an important role in human life. So, the potential plan for Persada Tongra village is to build an environmentally friendly power plant that includes renewable energy. Terangun district, Gayo Lues Regency, has the potential of a river that can be used as a micro-hydro power plant (PLTMH) source. The purpose of this research is to find out how big the potential of water to generate electrical energy is in the river in Persada Tongra Village. The method used in calculating the water discharge in the river flow uses the floating method, and measurements are made using a stopwatch. Based on the measurement results at the location, it produces water potential with a maximum discharge of 1.16 m3/s, a total height of 1.47 m, and the highest generated power is 16.71 kW. It is hoped that the results of this study can later be used as an energy source where this energy source can be used to generate electricity in the Gayo Lues district.
Keywords: PLTMH, Renewable Energy, Water Potential

Introduction
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In modern times like today, electricity is a necessity that plays a very important role for human needs. Basically in Indonesia, the largest supply of electrical energy is the State Electricity Company (PLN). Electrical energy at this time has not been fully enjoyed or used by some people in areas that have not yet been reached by electricity, such as in remote areas. . This is caused by several factors, namely natural conditions, roads that are difficult to reach and housing conditions for residents who are not in the form of a village or in other words, the distance between one resident's house and another is quite far. For this reason, a sustainable energy policy is needed by expanding access to adequate, reliable and affordable energy supplies by taking into account the necessary facilities and infrastructure and the resulting environmental impacts such as air pollution. So that the plan is to build a power plant that is environmentally friendly and also includes a renewable energy, namely a micro-hydro power plant (PLTMH) as a source of electrical energy supply [1], [2].

The main need in human life is energy. In line with socio-economic development, the need for electrical energy from time to time tends to increase [3], [4]. As the population increases, the need for electrical energy will also increase so that providers of electrical energy will not be able to meet the demand for electrical energy longer [5]. To overcome the problem of dwindling energy sources, it is necessary to develop renewable energy, One of them is a hydroelectric power plant (PLTA) on a micro hydro scale. Indonesia which is on the equator with a tropical climate is blessed with a lot of renewable energy with the potential of reaching 441.7 GW. The hydropower potential allocated for hydroelectric power plants (PLTA) and micro-hydro power plants is 11% spread throughout Indonesia [6].

At this time electrical energy has become a primary need for modern human life to carry out social and economic activities to achieve a better level of life. So that the magnitude of the level of electricity consumption can also be considered as a benchmark for the level of income and prosperity for a country or region. Furthermore, seen from the role of electricity in the economy, the electricity industry including the upstream industry, so that its development can stimulate other sectors that utilize electrical energy as input [7].

Gayo Lues Regency is located at an average altitude of 400-1,200 m above sea level. The most dominant altitude is at an altitude of 1500-2000 asl or 29.21%, while the smallest area is at an altitude of ≤3,000, namely 6,023 ha or around 1.05%. Meanwhile, based on the slope, most areas of the Gayo Lues district have a slope above 40% [8]. An electrical system generally has several generating centers consisting of a power generating center [9]. The vast forest cover in Gayo Lues district shows enormous potential for water resources. . The relatively high level of river network density is a combination of topography and forest area as water storage and retention. The general utilization of the potential of these water resources is for agricultural irrigation, sources of clean water and electricity generators. From 1997 to 2012 there were 11 units of micro-hydro power plants (PLTMH) built in the Gayo Lues district with the generated power reaching 1,298 kW from 1,510 kW. And this area is the upstream of 5 river areas [10].

Persada Tongra Village, Terangun District, Gayo Lues Regency is one of the villages in the highlands. Which in the village has quite a lot of potential for river water flow which can be utilized to become a Micro Hydro Power Plant (PLTMH). This potential source of energy comes from hillside rivers which have a continuous flow of water throughout the year. . In order to utilize the energy source of river water flow to become a MHP, it is necessary to carry out a survey to find strategic locations with high potential. The topography of Kampung Persada Tongra is hilly and also has many rivers which have the potential to be used as a research location to study the potential for micro-hydro power generation. To design the manufacture of new and renewable power plants such as PLTHM, it is necessary to conduct research on the available debits, as well as the amount of energy and power generated at that location [10].

In previous research conducted by Susanto Ointu et al regarding the planning study of a micro-hydro power plant (PLTMH) based on the existing water potential in Pinogu village, based on the measurement results at the location of the dam in Pinogu village, Pinogu sub-district, Bone Bolango district, it produces a potential water with a maximum discharge of 1.67 m3/second with a plunge height of 3.57 m, then the maximum total power obtained is 29.83 kW and can serve 99 homes with a power of 300 watts for each house [1].

Ady Purnama also conducted a study entitled Feasibility study for the construction of a case study micro-hydro power plant: PLTMH moves to the irrigation channel, moves to the village of Klagaran, Sendang Rejo village, Minggir sub-district, Sleman district, the results of the research results of the research show that the power potential generated from the PLTMH stands aside is 23.54 kW. The construction of this micro-hydro power plant meets the technical feasibility criteria. In contrast, this development cannot profit financially if financed with a bank loan with an interest of 18% per year. However, profits will be obtained if financed with interest-free loans or grants from the government or donors [11]. Ari Maghfur Dimyati also conducted research with the title of a feasibility study on the potential of micro-hydro power plants in the village of Stren and Slogaomo sub-district, Monogiri regency. Obtaining the appropriate results at that location has a decent potential to build a micro-hydro power plant (PLTMH). The existing potential can produce power with a capacity of 1×20 kW. Micro hydro power plants are designed to use crossflow and induction generators and induction generators with a capacity of 25 kW [12]. Several parameters must be considered in the distribution network to maintain the quality of electrical energy. The quality of electric power distribution in the distribution network is an important thing that must be considered [13].

This is the reason for the authors in this study from the several references above. Entitled "Planning Potential for Micro Hydro Power Plants Using River Flows in Kab. Gayo Lues.

PLTMH (Micro Hydro Power Plant) is a power plant with a small capacity that utilizes water flow as a driving force, such as in river canals, irrigation, and waterfalls, using a difference in height and water discharge. Micro-hydro has the term micro, which means small, and hydro means water. Hydroelectric power plants have 3 primary elements, namely water (as the prime mover), turbine (to convert the flow of water into potential energy and generator (to convert potential energy into electrical energy) [10]. The principle of PLTMH utilizes the potential energy of falling water (Head) and the amount of water discharge that is distributed in the penstock, where the higher the waterfalls, the greater the potential energy of water that can be converted into electrical energy. The flowing water then drives the turbine to produce mechanical energy, where the turbine is connected to the generator with the aim that the generator can produce electricity [11]. The energy capacity of micro-hydro power plants can generally be classified into two groups: small-scale (small hydro) and full or large-scale (large hydro) categories. Classification of hydropower plant capacity and classification based on the height of the hydropower plant can be seen in Tables 1 and 2 [14].

Table 1. Capacity classification based on the power generated by hydropower

No	Type	Capacity
1	Pico-hydro	<5 kW
2	Mikro-hydro	5kW – 100 kW
3	Mini-hydro	100 kW < daya< 1 MW
4	Small-hydro	1 – 15 MW
5	Medium-hydro	15 – 100 MW
6	Large-hydro	>100 MW

Table 2. Classification based on the height of the hydroelectric power plant

No	Type	Head
1	Low head	2 – 30 m

2	Medium head	30 – 100 m
3	Large head	>100 m

Research Methods

As for the flowchart in this study, you can see Figure 2 of the following research flowchart:

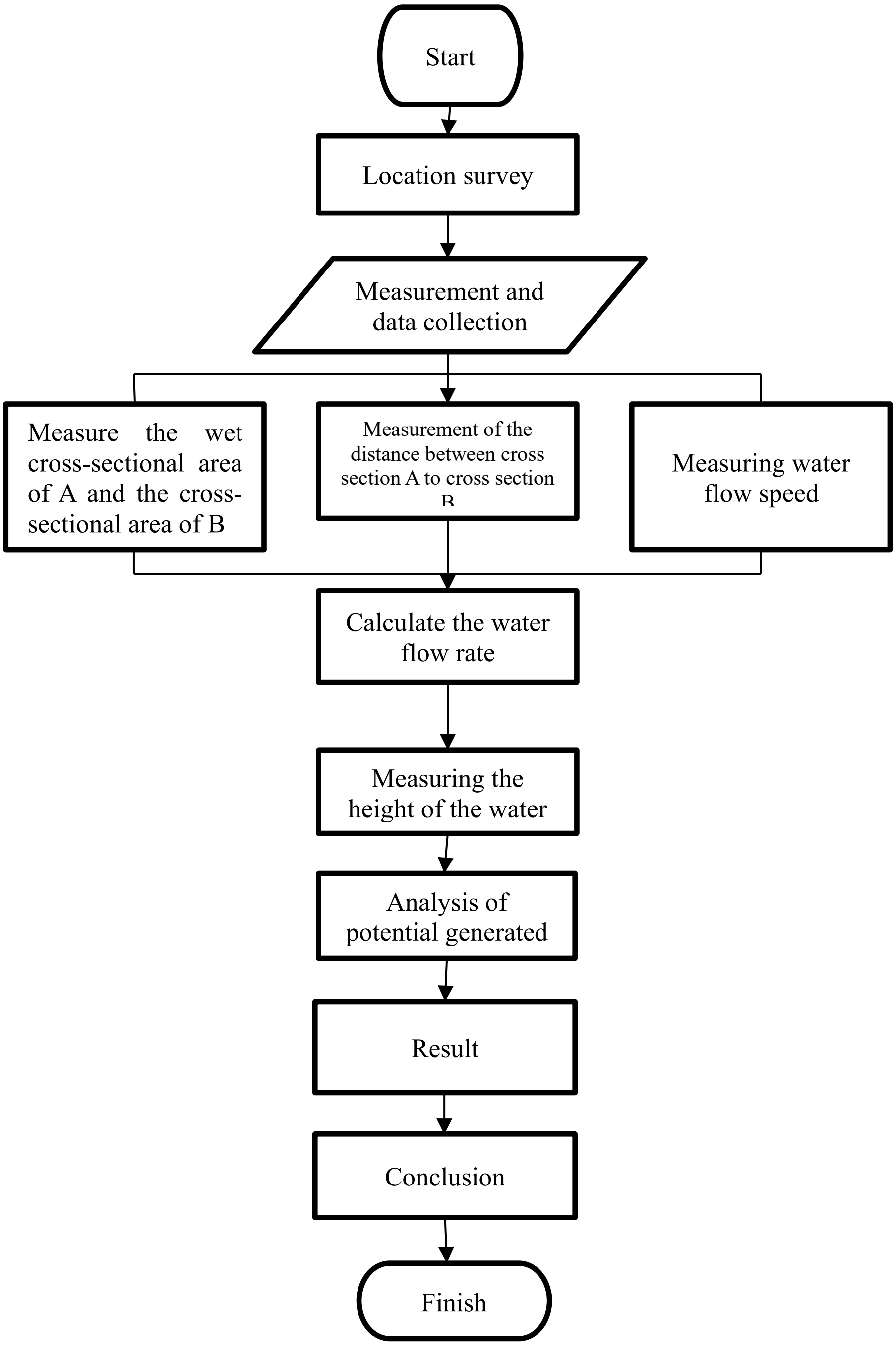

Figure 1. Research flowchart

1. Method of collecting data

The method used in this study is the floating method, the average speed will be obtained by dividing the distance that has been determined by the time that has been taken, the measurement can be done with the following methods: Draw a line with a rope at the upstream and downstream of the river in a position to cross the river. Determine the distance between the two lines, for example, 10 meters later Float the buoy (objects that can float such as used bottles, corks, ping pong balls and the like) next. return the button on the stopwatch to record the time and do it periodically to produce more accurate data.

2. Data analysis technique

Data analysis techniques are needed to obtain the overall data and then use the literature that has obtained the data and analyzed it to draw conclusions.

a. Water discharge calculation
Water discharge is the amount of water flowing in the canal or channel per unit time. Calculation of water discharge can be solved using equation 1 below:
$Q = A.V$……………………………………………………………..… (1)

b. Cross-sectional area
The cross-sectional area is measured using a meter and piscal (bamboo or wooden sticks) and flow velocity is measured using a meter or also by the floating method. To calculate the cross-sectional area can be calculated by equation 2 below:
$A = L.d$ .... (2)

c. Flow rate
Measuring flow velocity using the floating method is carried out by floating an object, for example a tennis ball or a used bottle, which can be formulated in equation 3 below.
$V= \frac{D}{t}$ ....(3)

d. Hydraulic Potential
Hydraulic potential is the energy potential generated by water pressure due to the earth's gravity. The magnitude of the hydraulic potential depends on the flow rate of the water and the height of the slope of the flow. Mathematically it can be described by equation 2.4 as follows:
$Ph = \rho.Q.g.h$ .... (4)

Results and Discussion

1. Data Processing and Retrieval

This observation was carried out on a river located in the vicinity of Persada Tongra village, sub-district. Terangun, Gayo Lues district. And the water flow rate is also not too large but can be relied upon for the construction of a Microhydro Power Plant system. The rivers studied are generally only used by the community for water sources in rice fields, bathing and drinking.

2. Results of River Cross-sectional Area Measurements

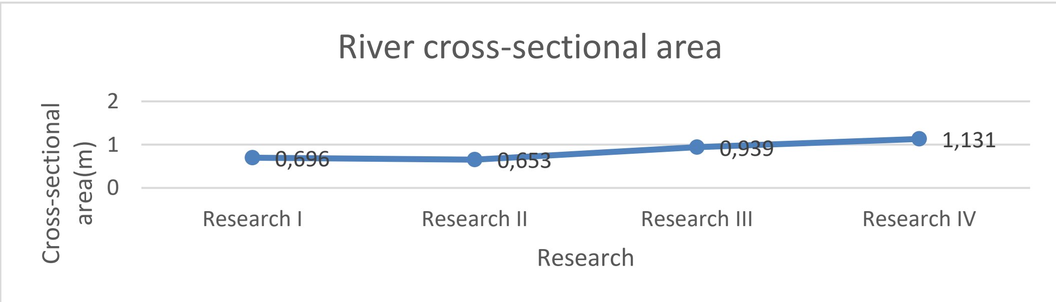

Figure 2. cross-sectional area of the river

From the graphs 2 and above, it is known that the widest cross-sectional area occurred in the fourth study, namely 1.131 m, and the smallest cross-sectional area occurred in the second study, namely 0.653 m. This happened because the 2nd study was conducted during the dry season and the 4th study was conducted during the rainy season.

3. Water Flow Rate

The speed of water flow can be seen in graphic image 3 as follows:

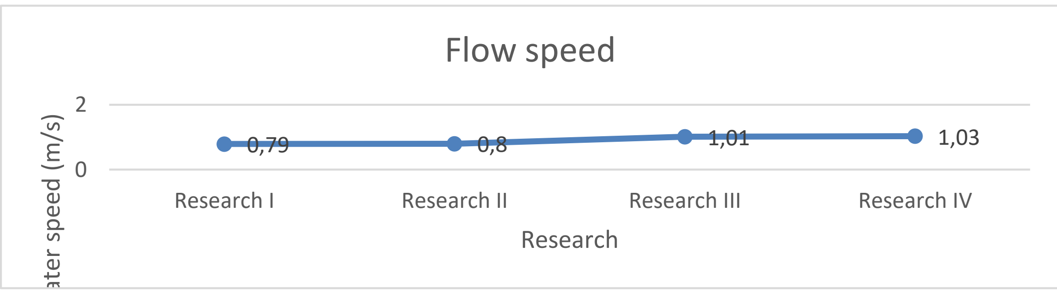

Figure 3. water flow velocity

Based on graph 4.2 above, it is known that the results of measuring the highest water flow velocity occurred in research III, namely 1.01 m/s, while the slowest water flow velocity occurred in research I, namely 0.79 m/s.

4. Rainfall Data

The rainfall graph can be seen in Figure 4 below

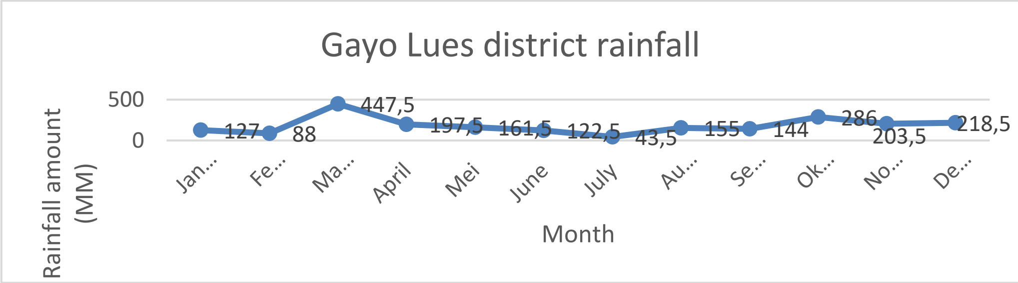

Figure 4. Rainfall chart in Gayo Lues Regency

In graphic image 3 it can be seen that the highest rainfall in 2021 occurs in March with total rainfall of 447 MM and the lowest rainfall occurs in July with 43 MM rainfall. in June and July when research was conducted the rainfall was quite low, only at 122 MM and 43 MM.

5. Results of River Discharge Calculations

River flow discharge is obtained by calculating the speed of water flow, and the cross-sectional area of the river. This measurement is carried out using a simple tool because the measurement equipment is limited So the measurement results are less accurate.

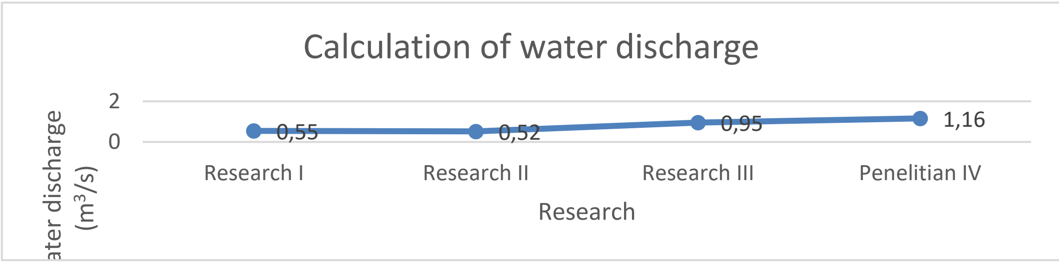

Figure 5. graph of water discharge

In Figure 4.4 it can be seen that the graph of water discharge is very dependent on the flow rate. When the water speed increases, the water discharge will increase, the largest water discharge measurement occurs in the fourth study, namely 1.16 m3/s and the lowest water discharge occurs in study II, namely 0.52 m3/s.

6. Height Measurement (head)

Measuring the height of the river slopes was carried out using simple tools, namely a waterpass, wooden sticks and tape measure

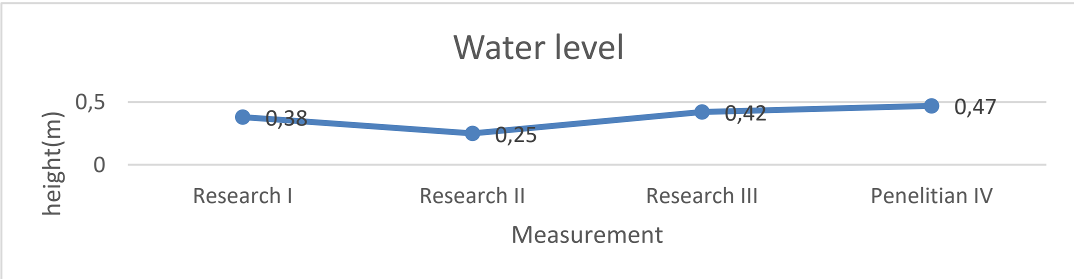

Figure 6. measurement of water level

From the graphic image 4.5 above, it can be concluded that the highest height occurred in research IV, namely 0.47 m and the lowest water level occurred in research II, namely 0.25 m.

7. Calculation of Hydraulic Potential (Generated Power)

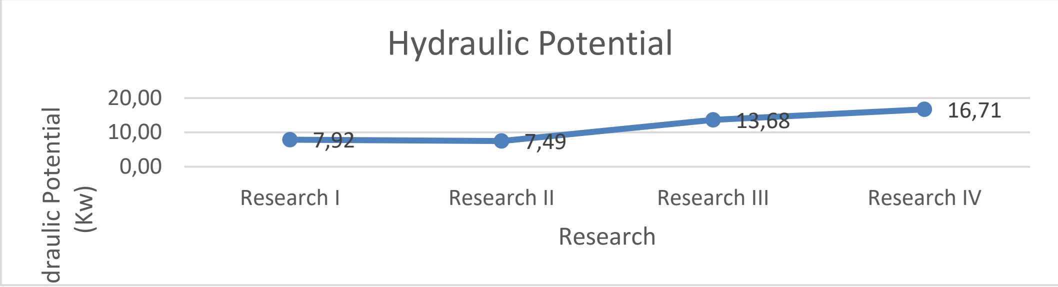

Figure 7. graph of hydraulic potential

Based on the hydraulic potential in graph 4.4 above, it can be seen that the hydraulic potential is not constant at any time. The highest value occurred in study IV, namely 16.71 kW and the lowest hydraulic potential occurred in study II, namely 7.49 kW.

Conclusions

Provide Based on the results and analysis of the system that has been made, several conclusions are obtained, namely:

1. The generated power from the river flow by means of measurements and calculations obtained the following values: in the first study with a water discharge of 0.55 m3/s the generated power was around 7.92 kW, in the second study with a water discharge of 0.52 m3/s the power generated is around 7.49 Kw, in the third study with a water discharge of 0.95 m3/s the power generated is around 13.68 Kw, in the fourth study with a water discharge of 1.16 m3/s The generated power is around 16.71 kW.
2. The highest water discharge measurement was 1.16 m3/s with a height of 1.47 m, and the lowest water discharge obtained was 0.52 m3/s with a height of 1.47 m.

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