

THE ROLE OF MAMASA WATERSHED TOWARDS BAKARU POWER PLAN WATER RESOURCES

Sri Mawar Said¹, Salama Manjang², M.Wihardi Tjaronge³, Muh.Arsyad Thaha³
S3 students Civil Engineering¹, Electrical Engineering Lecture², Civil Engineering Lecturer³
Hasanuddin University, Makassar-Indonesia.

Abstract

Watershed has an important role on water resources uses in hydro power plan. Water resources of Bakaru Hydro Power Plan derived from Mamasa River. In order to find out Mamasa river flow can be calculated using rainfall data recorded in Mamasa river catchment area. In order to predict discharge in Mamasa River can be evaluated using rainfall data from Mamasa Watershed Recording Station and comparing to its topography condition. Rainfall data used in this study is the rainfall data of Mamasa station, Sumarorong Station, and Lembang Station. The role of Mamasa watershed in Bakaru Power Plan Water Resources can be calculated by using rainfall prediction and water discharge that would occur in Mamasa upstream. Rainfall prediction using time series method has been done in previous studies, and water discharge predictions using fuzzy method.

Keywords: water resources, Hydro Power Plan, time series, fuzzy logic. The result of study show that in the year 2017 water discharge is 74.03 m³/sec, this value is lower than water discharge at year 1999 which 91.88m³/sec.

1. Introction

Hydro Power Plan is a power plan that uses water as the potential energy of a turbine diving in generator. Usually hydro power plan in Indonesia using the reservoir to accommodate the flow of Water River. The amount of water that can be accommodated in the reservoir depends on the intensity of rainfall in the watershed that located in the catchment area of a hydroelectric power plant

The problems that occurred in Indonesia is lots of the hydro power plant do not work optimally after operated more than 15 years^[1,2,3,4]. It is because water resources in the power plant is degraded by time, therefore we need to conduct a study research about the sustainability of water resources by making predictions of the rainfall will occurred in the watershed of a hydro power plan.

Table 1. Monthly Average Rainfall at Each Station

The study was conducted in the Mamasa watershed. This watershed as water resources of Bakaru hydro power plans (Bakaru hydro power plan). Location of the plant's reservoir is geographically located between 3⁰30'00"-2⁰51'00" LS and 119⁰15'00"- 119⁰45'00" BT.

2. Review of Literature

2.1 Rainfall

The amount of rainfall affects the water flow into the Bakaru Hydro Power Plan Reservoir. Rainfall data obtained from the Maros Meteorological, Climatology and Geophysics Agency. There are several rainfall recording devices placed in the Mamasa watershed.

The monthly average of rainfall in Mamasa between year 1995 to 2012 as shown in Table 1 and the prediction of annual average of rainfall between year 2013 to 2030 as shown in Table 2.

Month	Monthly average rainfall at each station (mm)					
	Mamasa (I)		Sumarorong (II)		Lembang (III)	
	1990	2012	1990	2012	1995	2012
January	94	250	155	316	286	261
February	270	44	481	275	514	458
March	61	77	210	344	310	376
April	254	246	373	346	354	313
May	93	99	307	241	375	211
June	135	135	201	227	192	231
July	70	44	256	227	209	175
August	77	22	100	210	8	19
September	117	116	185	299	135	62
October	46	218	233	211	32	220
November	30	223	225	504	319	478
December	95	63	380	362	308	527
Average rainfall per year (mm)	112	128	259	297	254	278

Table 2. Annual Average rainfall prediction at each station^[4]

Year	Annual average rainfall prediction at each station (mm)			
	I	II	III	Amount
2013	163	234	294	692
2014	125	336	265	726
2015	136	244	342	722
2016	152	261	241	653
2017	134	311	375	820
2029	146	270	361	777
2030	159	308	273	740

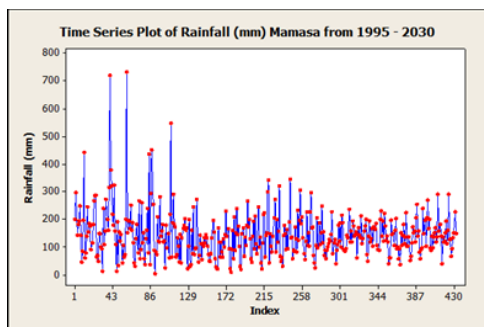


Figure 1. Rainfall of Mamasa Station year 1995 to 2030

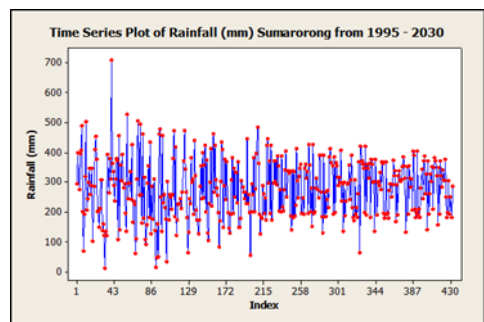


Figure 2. Rainfall of Sumarorong Station year 1995 to 2030

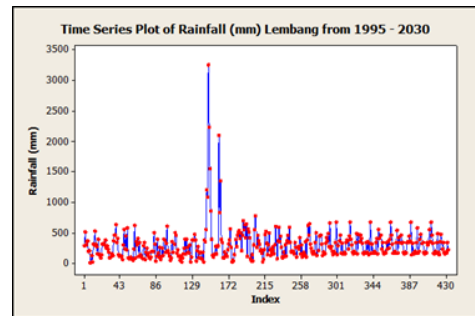


Figure 3. Rainfall of Lembang Station year 1995 to 2030

2.2 Water Discharge

Water Discharge in a hydro power plan is the amounts of incoming flow into the turbine generator, it can be calculated using the fuzzy logic models, with the input parameters such as rainfall data and watershed characteristics such as slope, sensitivity of soils and land cover. Description is as follows: Water Discharge can be calculated.

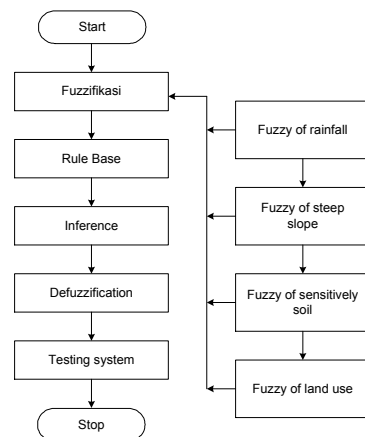


Figure 4. Flowchar of water discharge prediction

3. Research Method

3.1 Type and data Resource

Rainfall data is divided into two parts, first rainfall data ranging from 1995 to 2012, and the data is derived from measurement results of Mamasa Station, Sumarorong Station and Lembang Station. These stations are under the coordination of Maros

Meteorology, Climatology and Geophysics (BMKG) Agency. Second are the results of predicted rainfall from 2013 to 2030(4).

The Topography data of hydro power catchment area obtained from the field survey where area that includes the Mamasa, Sumarorong and Lembang, can be seen in Table3, below.

Table 3. Topography of Mamasa Watershed

Area	Village	Steep Slope (%)	Type of Soil	Land Use
Mamasa :	Village: Kanora, Minangatallu, Rantetambola, Salumata and Pena	relatively steep	sensitive	forest - moor
Sumarorong :	Village: Lempangan, Pakawan, Paladan, Beting and Salinduk	relatively steep	medium sensitive	forest - moor
Lembang :	Village: Bakaru, Kaluku, Rampusa, Bakka, Lamba and Katumbangan	relatively steep	sensitive	forest - moor

3.2 Data Analysis

Data analysis using monthly rainfall data ranging from 1995 to 2012 and the data of Mamasa watershed topography, data is processed using fuzzy verification method and verification has been done using existing data in the PT. PLN Sulsebar region. If the calculation results are not too far from the data, the fuzzy model can be used as a method to predict the water discharge for year 2013 to 2030.

Data input in Fuzzy system are rainfall, slope, soil type, and land covering which are transform into Fuzzy Model, output of rainfall Fuzzification are shown in Figure5.

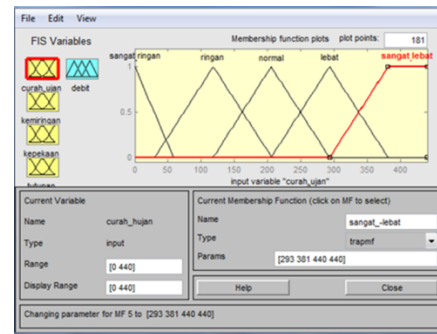


Figure 5. Rainfall Fuzzification

4. The results

The results of water discharge calculation in Mamasa watershed is divided into two parts: first the calculation of water discharge from 1995 to 2012 and second is the calculation of water discharge prediction in 2013 until 2030.

4.1 Calculation of water flow1995-2012

The results of water discharge calculation in Mamasa year 1995 to 2013 are shown in Table 4.

Table 4. Calculation of Water Discharge years 1995 – 2012

Month	Debit (m3/det.) each year						
	1995	1997	1999	2003	2005	2009	2012
January	137.30	110.00	152.00	124.30	109.40	139.20	115.80
February	139.20	107.20	143.80	133.60	116.99	143.30	110.40
March	136.60	109.60	160.70	131.80	114.80	148.80	111.80
April	140.80	110.40	161.00	116.70	110.50	152.90	113.10
May	132.90	99.80	147.00	116.10	107.50	153.30	105.70
June	121.40	92.70	138.10	112.10	99.80	143.70	101.70
July	109.00	91.60	144.00	104.10	94.10	121.40	94.70
August	101.10	84.20	130.70	118.80	96.58	114.20	99.10
September	110.30	93.50	134.90	122.70	112.39	120.50	106.40
October	126.60	98.60	146.50	120.60	123.50	133.90	121.40
November	142.90	112.50	174.10	133.40	121.80	146.10	131.30
December	709.80	604.00	794.50	726.50	656.69	818.10	644.30
Debit total	2107.90	1714.10	2427.30	2060.70	1864.05	2335.40	1855.70
Debit average	175.66	142.84	202.28	171.73	155.34	194.62	154.64

4.1. Verification of Calculation Results

Verification was conducted in 1995 to 2007. Verification results can be seen in Table5.

Table5. Water Discharge Verification

Year	Debit (m3/det.) each year	
	Calculation Result	PT. PLN Sulsebar Data
1995	74.60	68.38
1996	67.88	69.48
1997	58.22	41.29
1998	102.65	84.76
1999	91.88	61.34
2000	59.37	61.41
2001	62.35	59.09
2002	65.03	58.30
2003	68.07	51.61
2004	73.00	52.76
2005	60.68	53.97
2006	55.74	31.74
2007	195.85	57.33

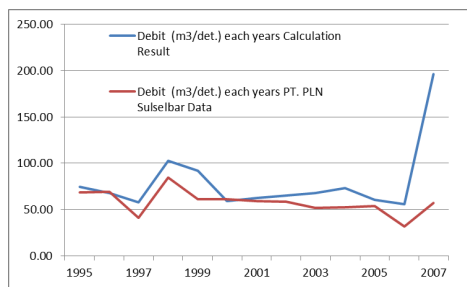


Figure 6. Water Discharge Verification Curve

In The results of water discharge calculation in 2007 there were significant differences, this is due to the rainfall data from Lembang Station in the year 2007 is huge, this is shown in Fig. 3, by using a fuzzy model calculations of water discharge from year 1995 to 2012, the water discharge prediction results obtained in 2013 to 2030, can be seen in Table 6.

4.2 Water Discharge Prediction Results

Prediction of water discharge in Mamasa watershed using rainfall prediction models between year 1995 to 2012, the prediction result as shown below.

Table 6. The results of the water flow prediction

Month	Debit (m3/det.) each year					
	2014	2017	2020	2023	2027	2030
January	89.70	96.20	74.60	90.70	76.20	77.70
February	88.00	88.80	75.40	80.00	71.40	72.90
March	96.70	98.20	78.70	90.10	83.40	80.10
April	93.60	100.10	81.70	96.00	83.40	83.80
May	83.80	88.20	69.70	86.20	76.20	75.90
June	82.10	91.90	74.60	88.80	73.00	72.80
July	78.90	78.50	63.70	78.30	67.40	68.60
August	84.30	87.70	71.70	84.70	72.20	71.80
September	83.90	79.70	68.10	79.90	68.90	71.70
October	86.80	81.60	72.90	86.30	69.70	76.50
November	88.50	94.80	77.80	88.70	73.20	75.40
December	88.00	92.20	79.40	91.10	79.50	78.00
Debit Total	1040.10	1077.90	888.30	1040.80	892.50	905.20
Debit average	86.68	89.83	74.03	86.73	74.38	75.43

5. Conclusion

The role of Mamasa watershed towards Bakaru Power Plan Water Resources is evaluated from Mamasa discharge prediction below :

- 1) The lowest water discharge in 2020 is 74,03 m³/sec.
- 2) The highest water discharge in 2017 is 89.83 m³/sec., this value is lower than water discharge calculation in 1999 which is 91,88 m³/sec.

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