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Modelling Of Water Resources in Bakaru Hydropower Plant in Anticipating Load Increment in Sulselbar Power System

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ABSTRACT

Bakaru hydro power plan water resources model will describe a model in anticipating load growth in Sulselbar Power System until year 2030. Bakaru hydro power plan is supplied by Mamasa, Sumarorong, and Lembang watershed, water supply is influenced with rain fall volume, topography condition (steep slope, type of soil, and land use) of a water catchment area. A model is constructed using Fuzzy logic in water water inflow is $Y = 0{,}0687X^2 - 4{,}279X + 82{,}917$ *and erosion inflow is* $Y = -0.0001X^2 + 0.0106X + 0.117$*, the model shows that increament in operation time at catchment area where there are changes in land uses will affected lower water inflow and bigger erosion inflow.*

KEYWORD: *watershed, Fuzzy logic, catchment area*

I. INTRODUCTION

Bakaru hydro power plan is a power plan supplied by Garugureservoir which located at $3^0$30’00”–$2^0$51’00”LS dan $119^0$15’00”–$119^0$45’00”BT. The water resource is supplied by Mamasa watershed which the water flowing from Mamasa river in West Sulawesi to South Sulawesi.Bakaru hydro power plan is produce power to Sulselbar power system, power plan capacity is 2 x 63 MW with reservoir capacity is 6.919.000 m3 which is predict will be available for 50 years. Otherwise the power planreabilityin producing enery is decreased by year, because the disability of reservoir in saving maximal water volume. According to this situation it is really important to study the continuity of water supply by predicted the water inflow and erotion inflow inMamasa watershed.

II. REVIEW OF LITERATURE

Modelling of water resources of a hydro power plan is using the hydrolic side such as rainfall volume in water catchment area, and using the watershed characteristic. The watershed evaluated in the study is Mamasa, Sumarorong, and Lembang. The rainfall volume is really affected to water discharges in Bakaru power plan. The rainfall is records using Mamasa, Sumarorong, and Lembang recording station. The result of watershed characteristic (steep slope, type of soil, and land use) is described below.

Rainfall : Rainfall data of Mamasa, Sumarorong, and Lembang station reported from Metereology, Climatology and Geofisic department in Marosfrom year 1990 to 2012 is using to predict the rainfall for year 2013 to year 2030. The result is shown in table 1 below.

Table 1.Data Base and Data Result of Mamasa Watershed

Year	Data Base and Data Result of Mamasa Watershed (mm)											
	Mamasa Station				Sumarorong Station				Lembang Station			
	1995	2012	2017	2030	1995	2012	2017	2030	1995	2012	2017	2030
January	201	210	152	193	295	249	334	341	286	261	379	184
February	297	113	103	111	399	173	196	309	514	458	624	149
March	142	77	227	160	276	423	425	306	310	376	469	361
April	183	246	296	290	395	445	358	375	354	313	643	470
May	193	99	170	128	407	296	201	252	375	211	313	233
June	247	135	174	128	490	370	281	181	192	231	251	339
July	141	44	69	66	202	195	153	200	209	175	197	180
August	45	22	44	94	70	423	425	306	8	19	152	164
September	86	116	25	132	192	173	195	193	135	62	200	189
October	198	218	107	152	319	296	201	252	32	220	163	169
November	440	223	206	228	501	370	281	181	319	478	345	342
December	62	63	97	148	208	303	315	287	308	527	503	227

Topography : Topography of Bakaruwater catchment area is describe the steep slope, type of soil, and land use of Mamasa, Sumarorong, and Lembang. Steep slope is classified as flat, ramps, rather steep, steep andvery steep. The steep slope is shown in table 2 below.

Table 2.Steep Slope of Mamasa Watershed

Steep Slope of Mamasa Watershed		
Mamasa Area	Sumarorong Area	Lembang Area
Kanora Village: 45 - 60 % (steep – very steep)	Salubalo Village: 20 – 45 % (rather steep – steep)	Bakaru Village: 10 – 20 % (ramps – rather steep)
Minangatallu Village: 17 – 25 % (rather steep)	Lepangan Village: 12 – 25 % (ramps – rather steep)	Kaluku Village: 12 – 25 % (ramps – rather steep)
Rantetambola Village: 20 - 45 % (rather steep – steep)	Pakawan Village: 15 – 25 % (ramps - rather steep)	Rampusa Village: 45 - 60 % (steep – rather steep)
Salumata Village: 25 – 45 % (rather steep – steep)	Paladan Village: 8 – 15 % (ramps)	Bakka Village: 20 – 45 % (rather steep – steep)
Pena Village: 10 – 25 % (ramps – rather steep)	Beting Village: 17 - 25 % (rather steep)	Lamba Village: 45 - 60 % (steep – very steep)
	Salinduk Village: 17 – 30 % (rather steep – steep)	Katumbangan Village: 20 – 45 % (rather steep – steep)
Average: 31.7 % (rather steep)	Average: 18.9 % (rather steep)	Average: 37.7 % (steep)

Type of soil of Bakaru water catchment area generally sensitivy to erosion, this is effected by land variety, that construct the area which is Litosol and Lateric. The description is shown in table 3.

Table 3.Type of Soil of Mamasa Watershed

Type of Soil of Mamasa Watershed		
Mamasa Area	Sumarorong Area	Lembang Area
Kanora Village: Laterik – Litosol (sensitive: score 60 – very sensitive:	Salubalo Village: Laterik – Litosol (sensitive: score 60 - very sensitive:	Bakaru Village: Latosol – Cacao forest (rather sensistive: score 30 – medium
Minangatallu Village: Latosol (rather sensistive: score 30)	Lepangan Village: Latosol – Laterik (rather sensistive: score 30 - sensitive:	Kaluku Village: Latosol – Laterik (rather sensistive: score 30 - sensitive: score
Rantetambola Village: Laterik – Litosol (sensitive: score 60 – very sensitive:	Pakawan Village: Litosol (very sensitive: score: 75)	Rampusa Village: Laterik – Litosol (sensitive: score 60 – very sensitive:
Salumata Village: Laterik – Litosol (sensitive: score 60 – very sensitive:	Paladan Village: Planosol - Latosol (not sensistive: score 15 - rather sensistive:	Bakka Village: Laterik – Litosol (sensitive: score 60 – very sensitive:
Pena Village: Latosol - Cacao forest (rather sensistive: score 30 – medium sensistive: score 45)	Beting Village: Latosol (rather sensistive: score 30)	Lamba Village: Laterik – Litosol (sensitive: score 60 – very sensitive:
	Salinduk Village: Laterik – Litosol (sensitive: score 60 – very sensitive:	Katumbangan Village: Laterik – Litosol (sensitive: score 60 – very sensitive:
Average: score 54 (sensitive)	Average: score 48 (medium sensistive)	Average: score 63 (sensitive)

The land uses in Bakaru watershed are dominated by forest, pine forest and moor. The description of land used is shown in table 4.

Tabel 4.Land Use of Mamasa Watershed

Land Use of Mamasa Watershed		
Mamasa Area	Sumarorong Area	Lembang Area
Kanora Village: forest (score 10) - moor (score 30)	Salubalo Village: forest(score 10) - moor (score 30)	Bakaru Village: forest(score 10) - moor (score 30)
Minangatallu Village:forest (score 10) - moor (score 20)	Lepangan Village: forest (score 10) - moor (scorer 20)	Kaluku Village: forest (score 10) - moor (score 20)
Rantetambola Village: forest (score 15) - moor (score 25)	Pakawan Village: forest (score 10) - moor (score 30)	Rampusa Village: forest (score 15) - moor (score 25)
Salumata Village: forest (score 15) - moor (score 35)	Paladan Village: forest (score 15) - moor (score 35)	Bakka Village: forest (score 15) - moor (score 35)
Pena Village: forest (score 10) - moor (score 10)	Beting Village: forest (score 10) - moor (score 20)	Lamba Village: forest (score 10) - moor (score 20)
	Salinduk Village: forest (score 15) - moor (score 35)	Katumbangan Village: forest (score 15) - moor (score 35)
Average: score 18 (forest - moor)	Average: score 20 (forest - moor)	Average: score 20 (forest - moor)

III. RESEARCH METHOD

Modelling Water Resources : Modelling water resource using Fuzzy logic, with input parameter are rainfall, steep slope, type of soil and land use, the flowchart of power plan inflow is shown in picture 1 below.

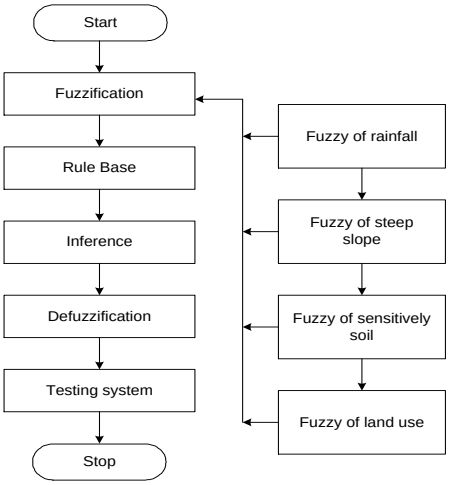

Figure 1.Flowchart inflow Hydro Power Plan

The result of water inflow and erotion inflow in Bakaru hydro power plan is the accumulative of inflow prediction result of Mamasa, Sumarorong, and Lembang. The result is shown in table 5 and table 6.

Table 5.Water Inflow in Bakaru Power Plan

Results of water inflow (m^3/sec.)					
Year	Inflow	Year	Inflow	Year	Inflow
1995	74.16	2007	46.80	2019	19.90
1996	67.25	2008	52.34	2020	18.63
1997	44.28	2009	19.05	2021	18.79
1998	83.16	2010	19.25	2022	17.49
1999	68.81	2011	20.54	2023	18.37
2000	57.81	2012	20.93	2024	17.92
2001	60.96	2013	21.02	2025	18.17
2002	63.23	2014	20.31	2026	16.32
2003	57.58	2015	20.08	2027	17.94
2004	59.25	2016	19.72	2028	17.88
2005	59.16	2017	19.93	2029	19.43
2006	35.64	2018	19.78	2030	16.00

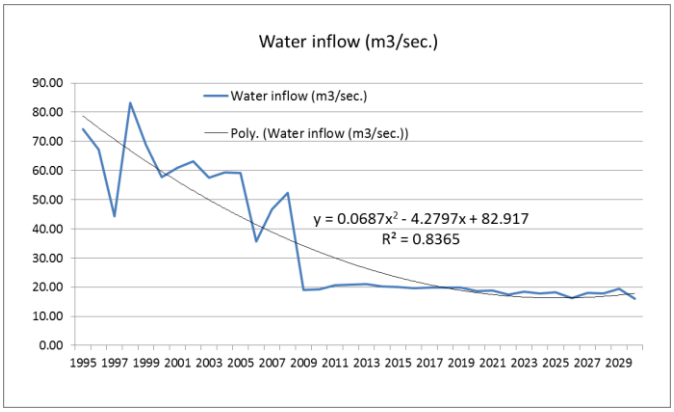

Figure 3.Water Inflow Curve of Bakaru Power Plan

Table 6.The Erosion Inflow Result of Bakaru Power Plan

Results of erosion inflow (m3/sec.)					
Year	Inflow	Year	Inflow	Year	Inflow
1995	0.11	2007	0.35	2019	0.31
1996	0.13	2008	0.67	2020	0.33
1997	0.15	2009	0.25	2021	0.34
1998	0.18	2010	0.25	2022	0.32
1999	0.18	2011	0.27	2023	0.33
2000	0.18	2012	0.26	2024	0.32
2001	0.19	2013	0.27	2025	0.32
2002	0.19	2014	0.26	2026	0.33
2003	0.20	2015	0.28	2027	0.34
2004	0.21	2016	0.33	2028	0.32
2005	0.21	2017	0.28	2029	0.35
2006	0.21	2018	0.29	2030	0.33

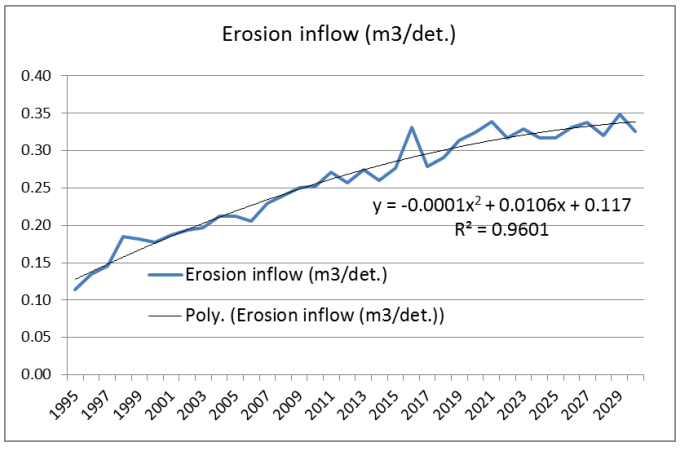

Figure 4.Erosion Inflow Curve of Bakaru Power Plan

IV. CONCLUSIONS

Water resources model of Bakarupower plan could be describe as polynomial model Y = 0,0687X^2 – 4,279X + 82,917 and erosion inflow could be describe as Y = - 0.0001X^2 + 0.0106X + 0.117, the model shows that by the increment of operate time of hydro power plan where there are changes in land use at catchement area will affected the decresement in water inflow and the increment in erosion inflow.

Average power produce by Bakaru hydro power plan in year 2013 to 2030 is 1 x 63 MW or half of its capacity, therefore the energy produce is decreased.

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