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ANALYSIS OF WATER AVAILABILITY IN CEMPAKA RESERVOIR AND GUNUNG KUPANG RESERVOIR FOR FLOOD CONTROL IN CEMPAKA DISTRICT BANJARBARU CITY

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ABSTRACT

During the rainy season, the Cempaka District in Banjarbaru City frequently experiences flooding. One of the government's efforts to mitigate flooding is the construction of reservoirs in the upstream area of Cempaka District, namely the Cempaka Reservoir and the Gunung Kupang Reservoir. Therefore, it is essential to conduct a study on the water availability in these reservoirs. The results of the water availability analysis show that the highest discharge for the Cempaka Reservoir is 1,032 m³/s, while the Gunung Kupang Reservoir records 0,378 m³/s. The largest dependable discharge is 1,07 m³/s for the Cempaka Reservoir and 0,39 m³/s for the Gunung Kupang Reservoir.

Keywords: *Water Availability, Dependable Discharge, Cempaka Reservoir, Gunung Kupang Reservoir*

1. INTRODUCTION

Indonesia is located in an area prone to various types of disasters, including natural disasters. Natural disasters are natural phenomena that can lead to environmental destruction and damage, causing losses in property and human lives and the destruction of infrastructure that has been built (Wahyuningsih et al., 2022). In 2021, Cempaka District was one of the districts that experienced the worst flooding in Banjarbaru City.

One of the efforts to reduce flooding is to construct reservoirs in the upstream areas. In 2016, the government built the Cempaka Reservoir; however, this reservoir was still unable to handle the flooding that occurred. As a result, in 2022, the government constructed a new reservoir, Gunung Kupang Reservoir, located upstream of Cempaka Reservoir. The construction of these two reservoirs is expected to serve as water storage and reduce the peak of floods that reach the downstream area of Cempaka District.

2. THEORETICAL STUDY

Reservoir

A reservoir is a water storage structure built in depressed areas, typically outside of riverbanks. The reservoir pond stores water during the rainy season, which is then used

by a village or community group during the dry season to meet their needs, with the following priority order: population, livestock, and gardens. The amount of these needs will determine the height of the reservoir's embankment and its storage capacity (Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2017).

Reservoir Storage Capacity

The reservoir's storage capacity is calculated based on the volume of available water and water demand (Zevri, 2021). In the analysis of reservoir storage capacity, the optimum storage volume/capacity is considered, which can be designed according to the topographical conditions and the maximum weather height that is still feasible, taking into account the seepage factor of the reservoir embankment and referring to the function of raw water supply services to meet the needs of the surrounding population (Suharyanto, 2022).

Water Availability

Water availability is the amount of water or flow estimated to be continuously present at a water structure location, with a certain quantity and over a specific period. The available water can be used for various purposes, such as raw water, which includes domestic water (drinking water and household use), non-domestic water (trade and office use), industry, livestock, fisheries, irrigation, and hydropower generation (Ariyani & Kayun, 2019).

Water Availability Analysis

One method to estimate water availability is the F.J. Mock method, which transforms rainfall into runoff, commonly called reliable discharge (Ramdani et al., 2022). In the Mock model, Evapotranspiration is an important factor because it serves as the second determinant in estimating the flow discharge after rainfall, where it acts as a reduction factor for the rainfall that will eventually become runoff (Adiningrum, 2015).

Water availability analysis is calculated using the F.J. Mock calculation method, which is formulated as follows (Putra et al., 2024).

$$Q = (Dro + Bf) \cdot A \quad \text{(2.1)}$$

Explanation:

Q = Reliable discharge (m^3/s)

Bf = Base flow ($m^3/s/km^2$)

A = Catchment area (km^2)

Dependable Discharge Analysis

Dependable flow is the minimum river flow at a certain probability level that can be used for water supply. An 80% reliable discharge is used for irrigation purposes, while for drinking water needs, a higher reliability of around 90%-95% is required (Saragi et al., 2023). Determining reliable discharge is done using the Weibull plotting position method, where the data is sorted from largest to smallest, and an order rank (r) is assigned from 1 to N. The probability of the r-th order is as follows (Muhardiono & Arthamefia, 2024).

$$P = \frac{r}{(N+1)} \text{ x } 100\% \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

Explanation:

P = Probability

r = Rank or order of occurrence or discharge

N = Total number of data points

3. METHOD

Research Location

The research location is in Cempaka District, Banjarbaru City, South Kalimantan Province. Geographically, Cempaka District is situated at 233º 27' S and 114º 45' E. The location map of the research area can be seen in Figure 1.

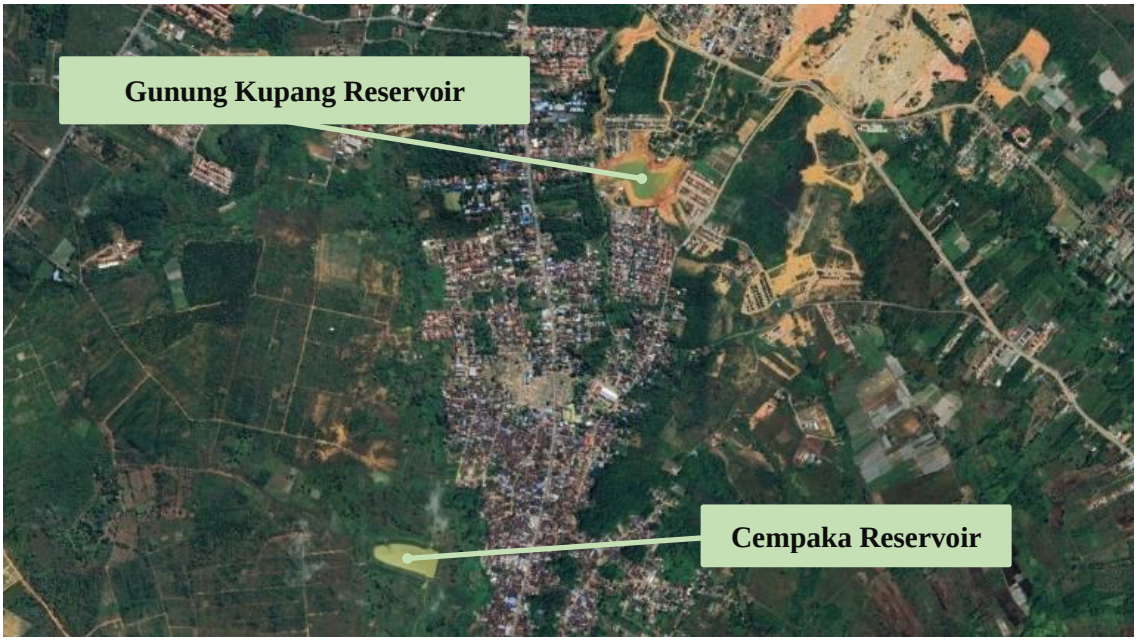


Figure 1. Research Location

4. RESULT AND DISCUSSION

Rainfall Analysis

The rainfall data used for the water availability analysis spans from 2001 to 2023 (23 years), obtained from the Class I Climatology Station of South Kalimantan, which was downloaded from the BMKG website (*data online.bmkg.go.id*).

Table 1. Cumulative Annual Rainfall Value

Years	Cumulative Annual Rainfall Value (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
2001	354,6	145,2	235,5	174,4	136,5	73,8	32,7	42,3	73,4	131,7	227,8	346,0
2002	194,6	99,3	321,3	113,2	105,4	148,5	11,1	18,0	29,8	104,0	256,7	300,0
2003	267,6	346,8	231,2	170,9	76,4	60,4	26,1	62,0	42,7	220,5	347,5	644,1
2004	523,5	384,7	245,5	211,1	215,3	24,1	165,1	0,0	9,8	24,9	227,0	255,3
2005	269,7	290,1	260,7	221,7	199,1	138,8	71,6	20,1	15,3	211,5	186,7	264,0
2006	362,6	299,9	294,8	213,3	72,5	182,8	24,7	4,6	2,9	16,5	107,6	403,4
2007	240,6	329,3	482,7	329,6	235,3	170,9	229,3	54,8	30,1	62,4	169,8	255,9
2008	272,1	240,0	554,3	241,2	54,4	259,5	143,8	82,8	99,1	77,7	287,8	420,5
2009	384,3	148,1	211,9	278,8	236,5	21,8	73,0	24,6	20,9	189,2	291,7	287,4
2010	148,0	349,0	258,0	222,0	117,0	94,0	85,0	86,0	92,0	109,0	333,0	238,0
2011	398,7	211,8	331,1	250,8	210,5	83,1	21,3	26,8	77,3	133,5	276,4	856,4
2012	223,7	258,4	313,0	319,1	149,1	58,4	193,5	70,3	58,2	157,2	297,8	409,7
2013	355,2	414,6	308,3	305,5	346,5	140,7	125,7	81,5	33,6	106,0	439,1	349,4
2014	443,2	220,0	331,5	222,7	155,6	221,1	112,5	53,2	4,7	16,0	183,9	386,8
2015	515,2	322,5	196,7	0,0	64,3	104,4	23,7	38,8	0,0	7,4	112,7	327,2
2016	128,9	295,1	258,5	477,7	268,2	210,5	92,5	72,7	140,0	112,2	270,4	140,0
2017	464,5	389,1	235,6	221,7	210,8	196,2	203,1	102,6	90,6	138,2	299,4	364,6
2018	390,8	313,4	369,6	174,4	75,0	111,7	77,2	78,3	106,7	106,8	227,4	433,1
2019	283,8	350,4	282,1	322,1	54,3	146,1	18,4	12,5	0,0	59,3	121,2	269,2
2020	572,4	334,3	302,4	266,4	138,0	218,0	62,4	57,2	162,9	190,4	282,1	554,4
2021	878,6	481,3	440,4	177,3	177,0	142,8	178,7	147,9	140,9	121,9	304,4	389,9
2022	214,7	269,7	407,3	113,6	219,8	121,7	248,0	218,5	305,2	178,6	303,8	137,2
2023	327,4	564,6	403,9	206,7	140,4	74,9	71,5	19,8	4,5	28,3	241,8	363,5

(Source: BMKG, accessed on October 23, 2024)

Evapotranspiration (ET_0)

The method used for calculating Evapotranspiration in this study is the Penman-Monteith method. The data used in this calculation includes climatological data obtained from the BMKG website (*data online.bmkg.go.id*).

Table 2. Annual Evapotranspiration

Annual Evapotranspiration (mm)												
Years	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2001	92,96	86,07	104,05	92,54	97,59	84,16	104,23	104,46	114,11	109,24	92,90	99,19
2002	101,46	89,68	102,12	98,82	99,20	78,29	106,90	114,59	110,07	121,24	100,41	105,95
2003	97,50	77,31	100,17	91,22	92,81	93,65	95,64	112,13	109,44	109,69	96,08	83,57
2004	100,74	85,31	96,79	98,35	91,26	93,90	95,60	118,75	114,17	122,04	102,10	88,60
2005	98,27	89,88	103,64	93,93	93,80	80,85	95,45	113,20	114,93	102,07	95,43	75,63
2006	88,68	88,48	101,29	90,95	96,83	75,59	108,61	121,24	135,46	147,21	116,41	110,67
2007	100,21	79,25	100,84	95,71	96,38	78,63	95,63	119,11	129,53	120,21	98,00	99,97
2008	101,95	87,18	95,73	96,03	96,81	88,75	88,65	97,70	109,70	99,47	98,87	83,01
2009	95,07	87,01	106,88	99,02	101,41	99,46	109,57	128,15	139,51	122,51	108,07	95,11
2010	99,34	102,10	99,58	103,67	100,93	83,78	84,06	101,04	94,53	109,31	98,54	96,93
2011	100,07	100,54	92,19	95,42	100,85	112,54	119,19	139,46	126,28	126,67	115,51	89,04
2012	102,63	94,54	105,94	109,88	110,39	102,19	94,26	131,05	146,35	136,45	115,33	102,23
2013	94,66	102,77	110,66	109,88	95,07	106,97	91,37	118,19	118,25	141,66	110,04	92,14
2014	97,36	107,96	105,34	106,07	104,23	96,30	111,70	129,36	155,83	159,39	124,21	104,07
2015	109,28	103,17	125,62	137,96	129,21	112,19	137,33	155,96	153,49	150,72	139,58	122,31
2016	132,49	119,39	118,03	113,72	118,07	100,52	121,51	132,14	128,24	114,62	111,78	120,01
2017	108,82	111,92	112,30	101,46	100,04	96,19	105,93	111,66	124,93	129,30	111,50	111,13
2018	104,15	110,16	98,31	114,00	113,49	106,04	131,86	135,08	146,05	141,25	115,31	100,47
2019	105,17	122,69	111,84	113,85	126,12	100,39	132,03	165,66	174,44	164,36	147,95	117,68
2020	125,21	122,46	132,54	127,79	122,04	109,44	122,61	147,96	118,44	137,30	125,49	105,60
2021	106,78	120,19	117,51	129,20	115,61	113,98	107,08	119,48	113,20	115,97	105,52	93,89
2022	109,41	102,34	121,04	132,66	111,90	110,68	112,66	123,28	121,25	113,98	123,47	118,54
2023	104,35	105,11	116,32	113,98	121,45	133,09	149,98	181,94	186,27	155,38	140,71	119,32

(Source: BMKG, accessed on October 23, 2024)

Water Availability Analysis

The water availability analysis for Cempaka Reservoir and Gunung Kupang Reservoir is calculated using the F.J. Mock method.

1. Calibration Stage

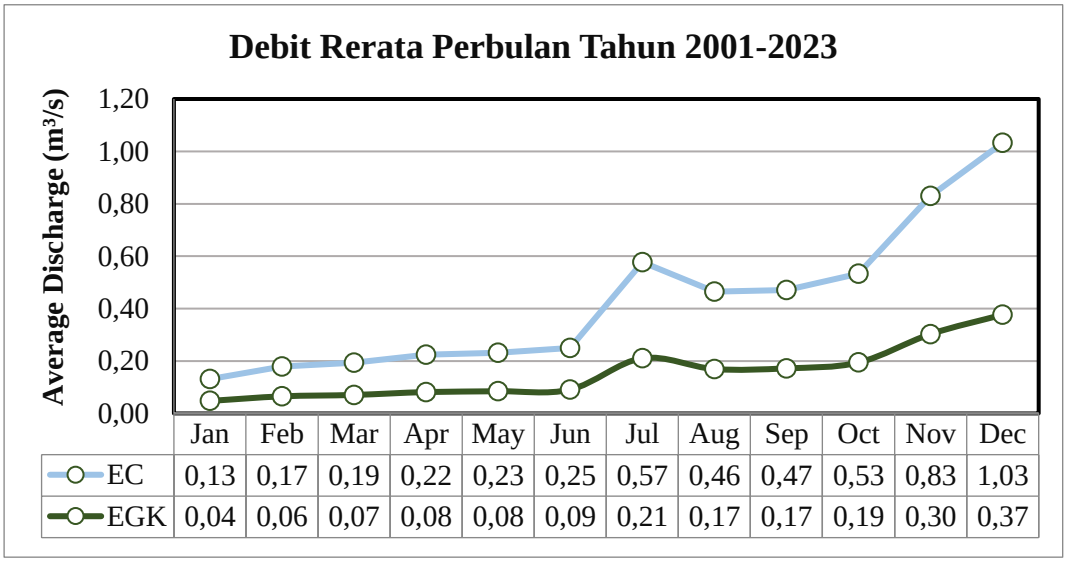
In this calibration calculation, measured discharge data from the Riam Kiwa River in 2001 was used, with a watershed area of 382 km², as no discharge data is available for Cempaka Reservoir and Gunung Kupang Reservoir. The parameters used are as shown in Table 3. The calibration results showed a volume error value of 0.014 and a correlation value of 0.520.

Table 3. Calibration Stage Calculation Parameters

Parameter Perhitungan	
DAS Area	382 Km²
Wet Season Infiltration Coefficient (WIC)	0,9999
Dry Season Infiltration Coefficient (DIC)	0,0001
Initial Soil Moisture (ISM)	250 mm
Soil Moisture Capacity (SMC)	50 mm
Initial Groundwater Storage (IGWS)	1200 mm
Groundwater Recession (k)	0,6

2. Simulation Stage

The parameter values obtained in the calibration stage will be used as calculation parameters in the simulation stage. The catchment area (DAS) of Cempaka Reservoir is 4.534 km², and the catchment area of Gunung Kupang Reservoir is 1.6598 km².

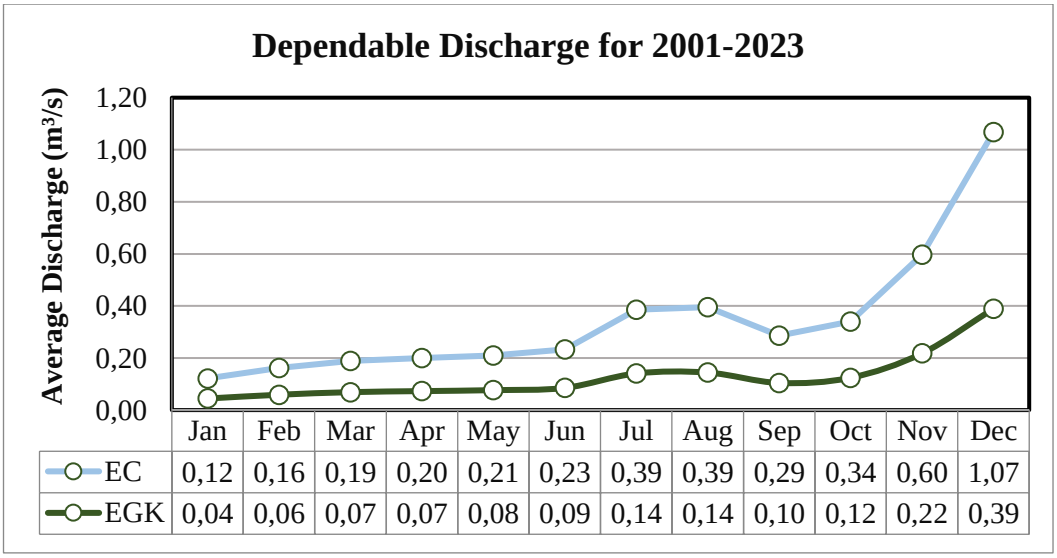


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EC	0,13	0,17	0,19	0,22	0,23	0,25	0,57	0,46	0,47	0,53	0,83	1,03
EGK	0,04	0,06	0,07	0,08	0,08	0,09	0,21	0,17	0,17	0,19	0,30	0,37

Figure 2. Average Discharge Chart for 2001-2023

Dependable Discharge Analysis

The reliable flow analysis is calculated by sorting the average annual discharge from 2001 to 2023 in descending order, then determining the average discharge value at the 90% probability level for raw water supply purposes.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EC	0,12	0,16	0,19	0,20	0,21	0,23	0,39	0,39	0,29	0,34	0,60	1,07
EGK	0,04	0,06	0,07	0,07	0,08	0,09	0,14	0,14	0,10	0,12	0,22	0,39

Figure 3. Chart of the 90% Dependable Discharge for 2001-2023

5. CONCLUSION

Based on the water availability analysis from 2001 to 2023, at Cempaka reservoir, the highest water availability recorded was 1.032 m³/s, which occurred in December, and the lowest was 0.131 m³/s, which occurred in January. Meanwhile, at Gunung Kupang reservoir, the highest water availability was 0.378 m³/s in December, and the lowest was 0.048 m³/s, which occurred in January.

Based on the analysis of the reliable flow (Q90), at Cempaka reservoir, the most enormous reliable flow recorded was 1.07 m³/second, which occurred in December, while the most minor reliable flow was 0.12 m³/second, which occurred in January. Meanwhile, at Gunung Kupang reservoir, the most enormous reliable flow was 0.39 m³/second, and the smallest was 0.04 m³/second, which occurred in January.

REFERENCES

Adiningrum, C. (2015). **Analisis Perhitungan Evapotranspirasi Aktual Terhadap Perkiraan Debit Kontinyu dengan Metode Mock**. *Jurnal Teknik Sipil*, *13*(2), 158–172.

Ariyani, D., & Kayun, K. N. P. (2019). **Permodelan Neraca Air di Embung Oeltua untuk Memenuhi Kebutuhan Air Domestik di Desa Oeltua**. *CESD*, *2*(1), 6–12.

BMKG Online. (2024). ***Data Online Pusat Database***. https://www.bmkg.go.id/

Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2017). ***Modul Pengantar Perencanaan Embung***. Kementerian Pekerjaan Umum dan Perumahan Rakyat.

Muhardiono, I., & Arthamefia, D. (2024). **Analisis Luas Potensi Lahan Irigasi Berdasarkan Neraca Air Embung Kembangan**. *Jurnal Sumber Daya Air*, *2*(1), 51–60.

Putra, C. A. N., Nomeritae, & Saputra, R. H. (2024). **Analisis Daya Dukung Sumber Daya Air DAS Kahayan**. *Jurnal Serambi Engineering*, *IX*(3), 9316–9324.

Ramdani, A., Kristalia, R., & Permana, S. (2022). **Perencanaan Embung Hiang, Kabupaten Kuningan, Jawa Barat**. *Jurnal Ilmiah Teknologi Informasi Terapan*, *8*(2), 253–259.

Saragi, T. E., Zai, E. O., & Zebua, E. (2023). **Analisa Debit Andalan (Studi Kasus pada PLTM Parmongan II)**. *Jurnal Teknik Sipil*, *2*(2), 13–24.

Suharyanto, I. S. S. (2022). **Penghitungan Kapasitas Volume Tampungan Embung Rogodadi Kabupaten Kebumen**. *Civil Engineering Technology Journal*, *IV*(1), 20–29.

Wahyuningsih, N., Ruslan, M., & Badaruddin. (2022). **Analisis Penyebab Banjir di Kecamatan Cempaka Kota Banjarbaru Provinsi Kalimantan Selatan**. *Jurnal Sylva Scienteae*, *05*(6).

Zevri, A. (2021). **Analisis Kebutuhan Kapasitas Tampungan Embung Danau Asam di Kabupaten Kotawaringin Barat**. *Jurnal Sumber Daya Air*, *17*(2), 83–94.