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EVALUATION OF THE VOLUME OF INFILTRATED WATER IN THE UPSTREAM OF THE CEMPAKA RETENTION BASIN IN BANJARBARU CITY

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ABSTRACT

Cempaka Subdistrict experienced severe floods in 2021, resulting from the worst impact on the surrounding area. The Cempaka Retention Basin (a.k.a "Embung") in Banjarbaru City is an artificial pond that is used to protect an upstream area of Cempaka Subdistrict in Banjarbaru City from flooding and inundation. This study aims to analyze the volume of infiltrated water that penetrates the pond and analyze the area of infiltrated water based on the infiltrated water rate in the pond area.

In this research, the collection of data includes land elevation, photos and location coordinates, and data from infiltration rate measurements. The infiltration rate measurement was conducted using a double-ring infiltrometer (turf tec infiltrometer). The analytical methods used in this study were the Horton Method. The test was carried out three times at the same time and on different dates at two points located in the inflow and outflow of The Cempaka Retention Basin.

Based on the analysis of this study, it can be concluded that the first test and the third test have the same infiltration rate classification, while the second test has a different infiltration rate classification. This is influenced by differences in land conditions when testing in the field.

Keywords: *Infiltration Rate, Horton Method, Flood, The Cempaka Retention Basin*

1. INTRODUCTION

Flood is a natural phenomenon that often occurs in various regions. Flooding is an event where river water overflows caused by river discharge that exceeds the capacity of the river in conditions of high rainfall (Ariyora et al., 2015). One of the areas in Indonesia that often faces floods is the City of Banjarbaru, South Kalimantan. Several areas in Banjarbaru City are still prone to flooding when heavy rains occur, for example, in the Liang Anggang Region, Kemuning, and the worst case is in Cempaka District (Huda, 2020). Topographically, Cempaka District has a height of 5-25 meters and 25-75 meters above sea level and has a slope of 0-8%. Cempaka District has a wet climate type. The status of agricultural land in Cempaka District is non-irrigated paddy fields. In this agricultural land, the residents rely on rainwater. Cempaka is an area that often

experiences flooding during heavy rains. One of the efforts to deal with flooding is to build a reservoir upstream. The reservoir built in the Cempaka flood area is The Cempaka Retention Basin. Embung is a water conservation building in the form of a pond or basin to collect water from rain, ditches, or small rivers, springs, and other water sources (DINPERTAN Grobogan, 2013). With its function as an air reservoir, the reservoir can absorb the air it holds through the infiltration process. The process of filtration is the flow of air into the ground, which generally comes from rainfall. The infiltration rate is the amount of air that enters the soil per unit of time. This process is a very important part of hydrological recycling, which can affect the amount of water that is on the ground surface, where the air on the ground surface will enter and then flow into the river. Not all of the water on the ground surface flows into the ground (Irawan & Budi Yuwono, 2016). This study aims to analyze the rate of infiltrated water in the reservoir area.

2. THEORETICAL STUDY

Retention Basin

A retention basin is an artificial building used to accommodate or store water with a certain small volume capacity, smaller than the capacity of reservoirs and dams. A retention basin can be built by damming small rivers or can be built outside the river (Kodoatie & Sjarief, 2010).

Measurement of The Infiltration Rate

Measurement of the infiltration rate using an infiltration rate measuring instrument, namely the double ring infiltrometer (turf tec infiltrometer). Double infiltrometer (double ring infiltrometer) in which one infiltrometer cylinder is placed inside another larger infiltrometer cylinder. Measurements are only made on small cylinders; larger cylinders only function as a buffer which will reduce the boundary effect arising from the presence of a cylinder (Arsyad, 2009).

Infiltration Capacity

Infiltration capacity is the ability of soil to absorb infiltration water under certain conditions. Effective infiltration will reduce runoff and vice versa; if infiltration is not

effective, it will increase runoff (Arsyad, 2009). When rainwater collects above the ground surface, it will filter through the surface and enter the soil with an initial infiltration rate whose value depends on the soil water content at that time. As rain continues, the infiltration rate decreases as the soil become wetter (Triatmodjo, 2008).

Horton Method

Soil infiltration testing was carried out using the Horton Method. According to Horton, the infiltration capacity decreases with increasing time until it approaches a constant value. He expressed his view that the decrease in infiltration capacity is more controlled by factors operating at the soil surface than by the flow processes in the soil. Factors that play a role in reducing infiltration rates include land cover, the closing of soil cracks by soil colloids and the formation of soil crusts, destruction of land surface structures, and transport of fine particles to the soil surface by raindrops (Aidatul F., 2015).

Infiltration capacity based on the Horton method can be expressed mathematically following the following equation (Triatmodjo, 2008).

$$f = f_c + (f_0 - f_c) .e^{-k.t} \quad (1)$$

Description:

F : Infiltration capacity or maximum infiltration rate (cm/hour)

f_0 : Infiltration capacity at the beginning of the infiltration process (cm/hour)

f_c : Infiltration capacity constant (when t approaches infinity) (cm/hour)

e : The base of the Naperian logarithm

t : Time calculated from the start of the rain (hours)

k : constant for soil type

3. METHOD

This research was conducted at the Cempaka Reservoir, Banjarbaru City, South Kalimantan. In this study, the data were obtained from surveys and direct field observations to obtain documentation photos at the research location, determine the coordinates of the research location, measure infiltration using a double-ring infiltrometer, and land elevation measurement using a water pass tool. The analytical

method used in this study is the Horton Method. To measure the rate of infiltration using a double ring infiltrometer (turf tec infiltrometer).

4. RESULT AND DISCUSSION

Research Sites

The research was conducted in The Cempaka Retention Basin Area, Cempaka District, Banjarbaru City, South Kalimantan. Infiltration testing in this study was carried out at two points, namely, the first point (Point CEC-1) around the inflow reservoir, which is located at coordinates 3º 29' 27.0" S 114º 50' 57.38" E, and the second point (Point CEC-2) around outflow pond located at coordinates 3o 29' 31.23" S 114º 50' 56.89" E. The CEC Point Name stands for "Cempaka - Embung Cempaka," which is taken based on the name of the research area which is used to make it easier to distinguish it from other points when taking point coordinates with a GPS device and distinguish it from other research points around the area.

Picture 1 Infiltration Test Point

Infiltration Testing in the Field

Infiltration testing was carried out at two different points located around the inflow and outflow of the Cempaka Dam, Banjarbaru City. Tests were carried out in open land. The location for data collection or measurement of infiltration rate was carried out by purposive sampling, meaning infiltration data collection and placement of the infiltrometer in an area that is considered representative of the entire area studied.

Infiltration data were collected at three different times, namely in August, September, and November. Observations take into account the same time with the assumption that at the same hour, they will have the same climatological aspects. Infiltration testing is carried out with the following conditions.

1. The test can be carried out if there is no rain the day before.
2. The test is carried out at the same time as the previous test at each point.
3. The duration of each test is approximately one month (estimated study time of 3 months).
4. The reading time for the decrease in the test is every 5 minutes.

The first test was carried out on August 6, 2022; the second test was carried out on September 18, 2022, and the third test was carried out on November 22, 2022. The first CEC-1 point infiltration test was carried out at 08.55 WITA, and the second CEC-2 point was carried out at 10.03 WITA; the test time is the same for all tests. After conducting field tests three times, differences in data were found at each test site. At the CEC-1 point in the first test, a constant value of 0.9 cm was obtained at the 40th minute; in the second test, a constant value was 0.5 cm in the 20th minute; in the third test, a constant value was obtained of 1 cm in the 20th minute. -25. At the CEC-2 point in the first test, a constant value was obtained of 0.5 cm in the 25th minute; in the second test, a constant value of 4.5 cm in the 25th minute, and in the third test, a constant value of 0.2 cm in the 30th minute.

The value of infiltration capacity in each field has different results. This difference can be influenced by soil texture and water content in the soil. In the analysis of the infiltration capacity of the Horton Method, a constant value of k is needed, whereas in finding a constant value of k, the value of m obtained from the curve is used.

Table 1 Value of m and k of infiltration testing at The Cempaka Retention Basin

TESTING 1			
Number	Point Name	m	k
1	CEC-1	-0,8685	2,6530
2	CEC-2	-1,9946	1,155193
TESTING 2			
Number	Point Name	m	k
1	CEC-1	-3,0633	0,752178
2	CEC-2	-1,1587	1,988563
TESTING 3			
Number	Point Name	m	k
1	CEC-1	-1,8152	1,269363
2	CEC-2	-1,3942	1,652666

In calculating the infiltration capacity, a curve is obtained that produces a value of m, which then obtains a value of k. Getting the infiltration capacity, m, and k values are needed. In this calculation, it was obtained 13.02 cm/hour for the CEC-1 point in the first test, 7.79 cm/hour in the second test, and 18.68 cm/hour in the third test. In addition, it was also obtained 9.51 cm/hour for the CEC-2 point in the first test, 58.82 cm/hour in the second test, and 8.69 cm/hour in the third test.

Infiltration Rate Calculation

The infiltration rate was calculated using the Horton Method. Horton Method infiltration rate analysis can be seen in Table 2.

Table 2 Infiltration Rate Analysis

TESTING 1											
Number	Point Name	t (hour)	f0 (cm/hour)	fc (cm/hour)	f0-fc (cm/hour)	m	e	k	-k.t	f (cm/hour)	Classification
1	CEC-1	0.583	21.3	10.8	10.5	-0.87	2.72	2.65	-1.55	13.02	FAST
2	CEC-2	0.333	11.2	6.0	5.2	-1.99	2.72	1.16	-0.39	9.51	RATHER FAST
TESTING 2											
Number	Point Name	t (hour)	f0 (cm/hour)	fc (cm/hour)	f0-fc (cm/hour)	m	e	k	-k.t	f (cm/hour)	Classification
1	CEC-1	0.250	8.2	6.0	2.2	-3.06	2.72	0.75	-0.19	7.79	RATHER FAST
2	CEC-2	0.333	63.4	54.0	9.4	-1.16	2.72	1.99	-0.66	58.82	VERY FAST
TESTING 3											
Number	Point Name	t (hour)	f0 (cm/hour)	fc (cm/hour)	f0-fc (cm/hour)	m	e	k	-k.t	f (cm/hour)	Klasifikasi
1	CEC-1	0.333	22.2	12.0	10.2	-1.82	2.72	1.27	-0.42	18.68	FAST
2	CEC-2	0.417	14.9	2.4	12.5	-1.39	2.72	1.65	-0.69	8.69	RATHER FAST

After conducting field tests three times, differences in data were found at each test site. In the infiltration test at all points, the first test (August 6, 2022) and the third (November 15, 2022) had the same classification; namely, CEC-1 was classified as fast, and CEC-2 was classified as rather fast. However, in the second test (September 18, 2022), there was a difference in classification with the first and third tests, where at point CEC-1, it was classified as rather fast, and at point CEC-2, it was classified as very fast. This is because at the time of the second test, there had just been dredging of the river around the reservoir, and then the dredged soil was placed over the infiltration site; this certainly affected the results of the infiltration test so that the classification was different from the first and third tests. The third test still has the same classification results as the first test. In addition, the average infiltration rate at point CEC-1 was 13.17 cm/hour, and at point, CEC-2 was 25.67 cm/hour, and the combined average infiltration rate from the two points was 19. 42 cm/hour or 1701.131138 m/year.

5. CONCLUSION

Based on the analysis of this study, it can be concluded that the first test and the third test have the same infiltration rate classification, while the second test has a different infiltration rate classification. This is influenced by differences in land conditions when testing in the field.

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