

Water Availability of the Lambidaro Sub-Watershed, Palembang City

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Abstract

This research aims to determine the water availability (Q_s) for various return periods Q_2 , Q_5 , Q_{10} , Q_{25} , Q_{50} , and Q_{100} in the Lambidaro sub-watershed. The initial stage of the research involves collecting various supporting data—primarily rainfall data from the Kenten Rainfall Station for use in hydrological analysis. These data include maximum daily rainfall, topographic conditions derived from a Digital Elevation Model (DEM), land-use types, and soil types. Meanwhile, the hydraulic analysis utilizes data such as channel geometry and river cross-sections, river surface roughness, and high-tide water levels. All these data play a crucial role in supporting the analysis and modeling of the hydrological and hydraulic systems within the Lambidaro Sub-watershed.

The study results show that the water availability (Q_s) for various return periods is as follows: $Q_2 = 1,244.567 \text{ m}^3/\text{s}$; $Q_5 = 1,597.641 \text{ m}^3/\text{s}$; $Q_{10} = 1,831.422 \text{ m}^3/\text{s}$; $Q_{25} = 2,126.852 \text{ m}^3/\text{s}$; $Q_{50} = 2,345.955 \text{ m}^3/\text{s}$; and $Q_{100} = 2,563.458 \text{ m}^3/\text{s}$.

Keywords: Water availability, Lambidaro river, Rainfall, Return period

Date of Submission: 13-09-2026

Date of acceptance: 24-09-2026

I. INTRODUCTION

Hydrologically, the Palembang area is divided into 21 sub-watersheds. Of these, only 18 drain directly into the city's main rivers. These sub-watersheds include RengasLacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, LawangKidul, Buah, Juaro, Batang, Sei Lincah, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring, and Plaju. The high volume of water flowing from these 18 sub-watersheds is a primary cause of flooding in Palembang. The direct discharge of water into the Musi River leads to a significant rise in water volume, particularly in the city center (Palembang City Public Works Agency, 2018).

Water balance describes a state in which the water cycle is in equilibrium, with the amount of incoming water (inflow) matching the amount of outgoing water (outflow). In other words, the volume of available water corresponds to the water demand within a system. Key inflow components include rainfall, river flow, and springs, while outflow components encompass raw water usage, water loss due to evaporation and evapotranspiration, and water consumption for irrigation. An imbalance between inflow and outflow is referred to as a water imbalance.

The water balance of a region depends heavily on the characteristics of the area under observation, particularly the ratio between water inflow and outflow. In a broader context, the hydrological cycle is a fundamental concept that explains global water balance while illustrating the processes and elements associated with the presence of water on Earth (I Made AgusDwiHadryana et al., 2015).

The hydrological cycle cannot occur without the atmosphere, which is capable of holding and transporting water vapor. The atmosphere plays a vital role in distributing water to various regions across the Earth's surface. Analyzing water balance involves various calculation methods that generally rely on climate data. Such data are typically obtained from observations at climatological stations, which provide information on weather conditions and related climatic elements (AchmadSyarifudin, 2018).

The F.J. Mock model is a hydrological model used to analyze watershed systems and predict their hydrological responses. The method's advantage lies in its higher level of accuracy, as it accounts for various

natural conditions that influence water availability. The F.J. Mock approach relies on two primary principles for calculating surface runoff: the surface water balance and the subsurface water balance.

Fundamentally, the surface water balance describes how the soil retains rainfall after accounting for evaporation and plant transpiration. This absorbed water affects soil moisture levels, and changes in moisture play a role in determining the volume of direct surface runoff. Direct runoff occurs as excess water that fails to infiltrate the soil once the soil's absorption capacity—determined by the specific infiltration coefficient—has been reached.

The subsurface water balance is primarily influenced by the rate at which water infiltrates the soil and percolates downward to the groundwater table. Fluctuations in groundwater volume over time determine the magnitude of the base flow that eventually discharges into the river. Consequently, the F.J. Mock method is frequently employed as an effective means of estimating river water availability, particularly in areas characterized by the simultaneous occurrence of surface runoff and subsurface flow.

II. MATERIAL AND METHODS

The study was conducted in the Lambidaro sub-watershed of Palembang City; Figure1 illustrates the watershed system of Palembang City,

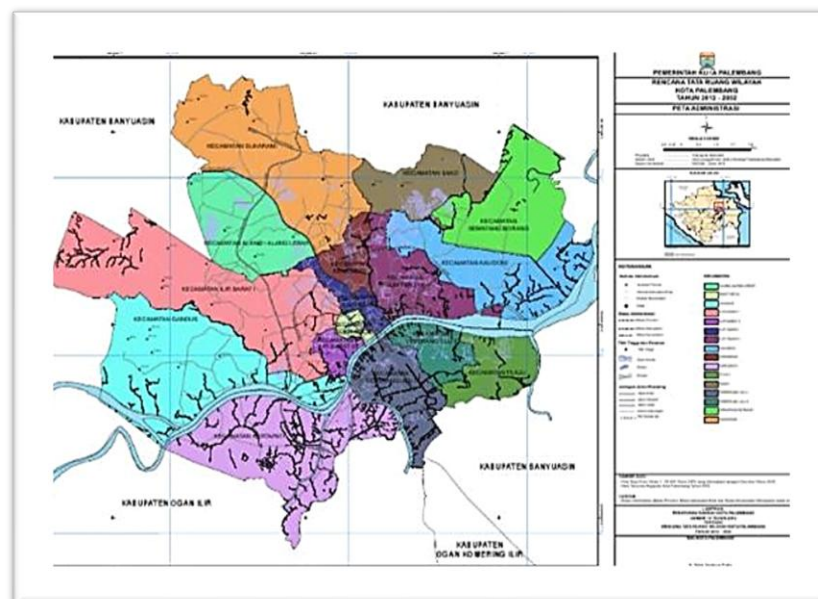


Figure 1: Map of the Sekanak-Lambidaro Sub-watershed

2.1. Research Stages

The initial stage of the research involves collecting various supporting data—specifically rainfall data from the Kenten BMKG Station—for use in hydrological analysis. These data include maximum daily rainfall, topographic conditions derived from a Digital Elevation Model (DEM), land-use types, and soil types. Meanwhile, the data used for hydraulic analysis include channel geometry and river cross-sections, river surface roughness, and tidal water levels. All these data play a crucial role in supporting the analysis and modeling of the hydrological and hydraulic systems within the Lambidaro Sub-watershed.

1. The first stage involves gathering references from journals, books, and other secondary data sources.
2. The second stage involves conducting a field orientation survey (site visit) to assess current site conditions and capturing photographs to serve as preliminary research data.
3. The fourth stage involves analyzing the frequency of annual maximum rainfall data spanning at least 10 years, based on specific return periods (2, 5, 10, 25, 50, and 100 years).
4. The fifth stage involves analyzing the results and discussion, utilizing graphs and figures illustrating flood discharge distribution patterns for specific return periods (2, 5, 10, 25, 50, and 100 years).
5. Formulating conclusions based on the results and discussion, and providing recommendations for future researchers interested in this study.

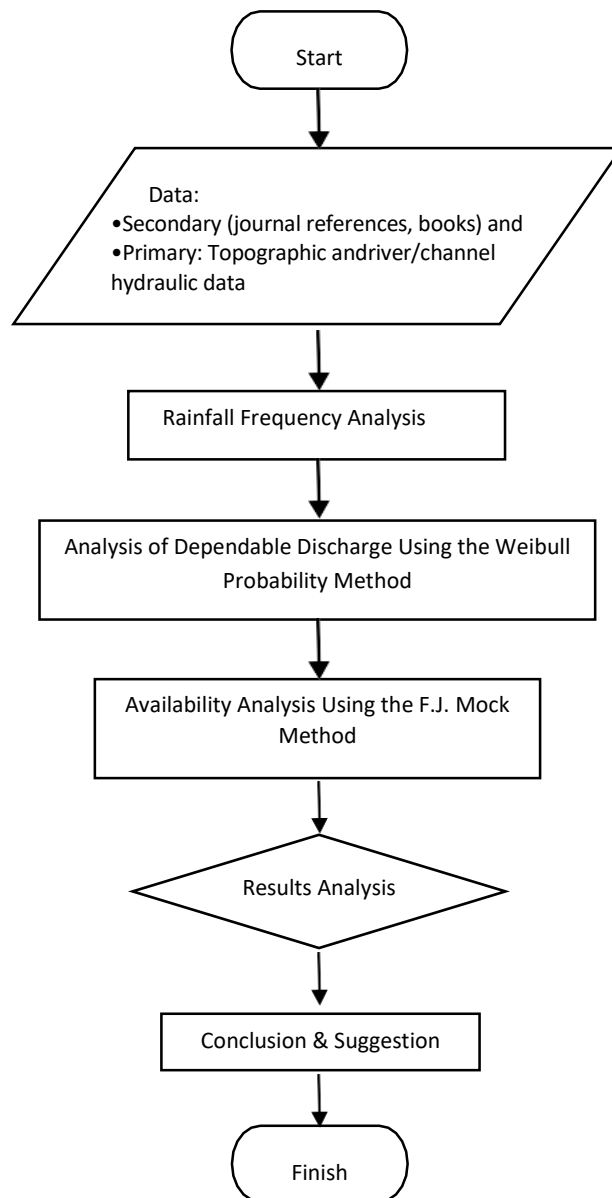


Figure 2: Flowchart

III. RESULTS AND DISCUSSION

3.1 Flow Capacity (Qs)

For flow capacity, the following empirical approach is used:

$$Q_s = 0,2778 C I A$$

where:

Qstorage = Flow capacity (m³/s)

C = Runoff coefficient

I = Rainfall intensity with a duration equal to the flood time of concentration(mm/h)

A = Catchment area (km²)

$$Q_2 = (0.2778) \times (0.85) \times (57.03 \text{ mm/h}) \times (64.31 \text{ km}^2)$$

$$Q_2 = 14.431 \text{ m}^3/\text{s}$$

Furthermore, Q₂, Q₅, Q₁₀, Q₂₅, Q₅₀, and Q₁₀₀ can be analyzed using dependable discharge values of 80% (Q₈₀, m³/s) and 90% (Q₉₀, m³/s), as shown in Table 4.2 below:

Table 3.1 Summary of dependable discharge (Q₈₀) results for various return periods

Return period (year)	Q (m ³ /sec)	Q ₈₀ (m ³ /sec)	R ₂₄	I (mm/hour)
2	1,244.567	995,653	93,270	81,957
5	1,597.641	1,278.113	119,730	105,208
10	1,831.422	1,465.138	137,250	120,603
25	2,126.852	1,701.481	159,390	140,058
50	2,345.955	1,876.764	175,810	154,486
100	2,563.458	2,050.766	192,110	168,809

The availability of water—specifically storage capacity (Q_s) and dependable flow (Q₈₀)—can be illustrated as shown in Figure 3.

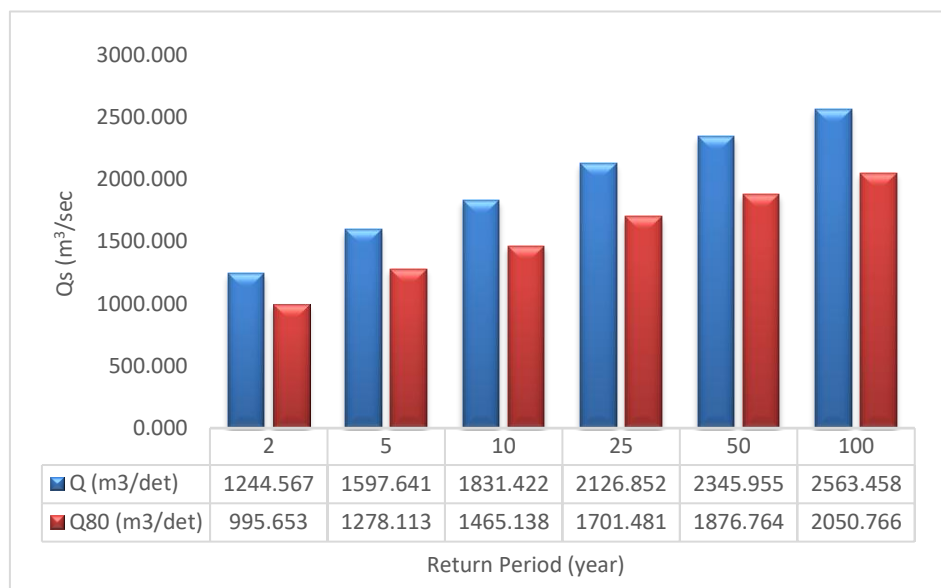


Figure 3: Storage capacity (Q_s) versus dependable discharge (Q₈₀)

IV. CONCLUSION

Based on the data analysis and discussion, the conclusions of this study is water availability (Q_s/storage capacity) for various return periods Q₂ = 1,244.567 m³/s; Q₅ = 1,597.641 m³/s; Q₁₀ = 1,831.422 m³/s; Q₂₅ = 2,126.852 m³/s; Q₅₀ = 2,345.955 m³/s; and Q₁₀₀ = 2,563.458 m³/s.

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