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Submission date: 03-Oct-2022 04:30AM (UTC+0700)
Submission ID: 1914523618
File name: 11_1442-Article_Text-7497-3-10-20220719__1.pdf (344.98K)
Word count: 2099
Character count: 10855

Anjoro: International Journal of Agriculture and Business
Vol. 3 Issue 1, April 2022
p-ISSN: 2721-8678 | e-ISSN: 2721-7914. **DOI: 10.31605/anjoro.v3i1.1442**

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Received January 20th, 2022; revised March 4th, 2022; accepted March 21st, 2022

ABSTRACT

The Walanae Watershed plays an essential role as a water provider for irrigation and industry in the central part of South Sulawesi Province, Indonesia. The Walanae River flows through Enrekang, Soppeng, and Bone Regencies. This paper describes the availability of water in the Walanae watershed. Water discharge of the Walanae river recorded at Tampangeng station from 2000 to 2014 is analyzed using descriptive statistics to obtain a flow duration curve. The calculation results show that the available discharge is quite extensive throughout the year with a range of 16.5 $m^3.s^{-1}$–316 $m^3.s^{-1}$, and an average of 138 $m^3.s^{-1}$. The minimum discharge generally occurs from September to November, while the peak discharge generally occurs in January and July. The results show that water availability for 9, 10, 11 months, and all years are: 92.2 $m^3.s^{-1}$, 83.4 $m^3.s^{-1}$, 66.3 $m^3.s^{-1}$, and 15.8 $m^3.s^{-1}$, respectively.

Keywords:
Cenranae river, Lake Tempe, Rainfall, Water discharge

1. Introduction

Walanae River originates in Enrekang Regency and empties into the Gulf of Bone, part of the Walanae-Cenranae river basin. This river basin consists of two main rivers, namely the Cenranae River with a length of 47 km, a width of 115 m, a depth of 0.7 m, and the Walennae River 28 km long, 95 m wide, and 0.6 m deep. It was traversing the regencies of Enrekang, Wajo, Soppeng, and Bone. In the middle, there is Lake Tempe, which has a vital role in the local community's economy [1,2].

There are various uses of the river basin [3], including irrigation, industrial raw water, fisheries, domestic water, and livestock. The Walanae-Cenranae river basin has been assigned as a national strategic river basin. Thus, multi-stakeholder synchronization is urgently needed so that the utilization for these various purposes can occur optimally without neglecting the function of the watershed as a natural resource for the benefit of sustainable development and community welfare. Multi-stakeholder synchronization can be realized in the form of watershed management [4,5], in the form of studies on the potential and carrying capacity carried out before utilization activities.

This paper examine the potential for water availability in the Walanae watershed for various development interests and community welfare, as well as a description of its quantity and continuity. The study of water availability is essential for agricultural, human consumption, industry, and energy generation for the Enrekang Regency especially for the sustainability of the Lake Tempe environmental function. However, the climate change phenomena will affect water availability through the changes of rainfall [6].

2. Method

Administratively, the study area is located in Wajo Regency, South Sulawesi Province, and geographically it is located at the position of 3^{0}39' – 4^{0}16' S and 119053' – 112^{0}27' E. Wajo Regency is one of the regencies within the region of South Sulawesi Province. The river water elevation was obtained from Tampangen Station, operated by the Water Resources Management Department, South Sulawesi Province. The automatic water level recorder is established at Tampangeng, Sitampae village, Tempe district, Wajo Regency (409’21,2” S, 12002’10,4” E). Based on daily water level measurements in the period of 2000-2014, a rating curve can be made. There are 4863 records of processed water level data. Discharge is calculated based on the equation generated by the rating curve, as shown in Figure 1. The generated conversion equation is:

$$Q = 44.922h^{0.9827} \quad (1)$$

Regression analyisis as a simple statistical analysis is then performed to figure out the characteristics of annual and monthly discharge of the Walanae River. This analysis is used in the quantification of the relationship between a water level and the water discharge.

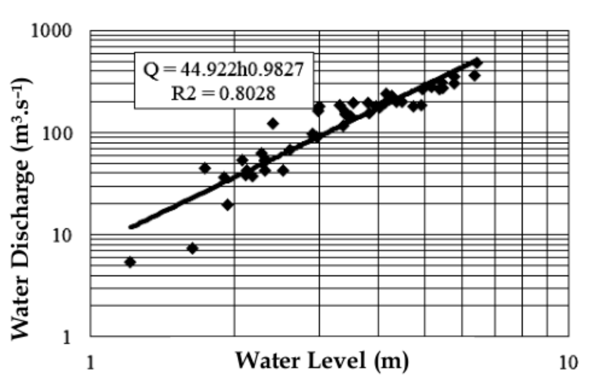


Figure 1. Rating curve of Walanae River

The obtained discharge is further analysed to estimate potential water availability using Flow Duration Curve (FDC). It is an old technique that is still in use today [7,8]. The calculation is following these steps: (1) Sort daily discharges of n record from the most significant value to the smallest value; (2) Divide the record into *m* class and sum each class records; (3) These class records are summed cumulatively again to obtained cumulative distribution *Q*; (4) The exceedance probability (P) is calculated as follows:

$$P = 100 \times (1 - Q/Q_{min}) \quad (2)$$

The probability of *P* for a certain period will reflect the availability of water.

3. Results and Discussion

3.1. Rainfall

Based on climatological data from the Paria rain station, the study location has moderate rainfall intensity throughout the year, with the highest rainfall intensity (337mm.month^{-1}) occurring in June (Figure 2). This rainfall pattern shows that the peak of the rainy season occurs between the transitional season (March-April-May) and the dry season (June-July-August), although in the western season (December-January-February) the rainfall in the study location reaches 104 mm.month^{-1}. Based on the Olderman climate classification, this area can be categorized into climate type D, which has three consecutive wet months (≥200 mm) if the rain is assumed to begin to fall during the west season [9]. This shift in peak rain indicates that the influence of the western monsoon in this area is not too dominant compared to other areas on the west and south coast of South Sulawesi Province. The number of rainy days in a year range from 74 to 204 days, with an average of 124 rainy days per year and an average of 11 rainy days per month. The number of rainy days is above the average monthly rainy days for nine months, January-July and November-June.

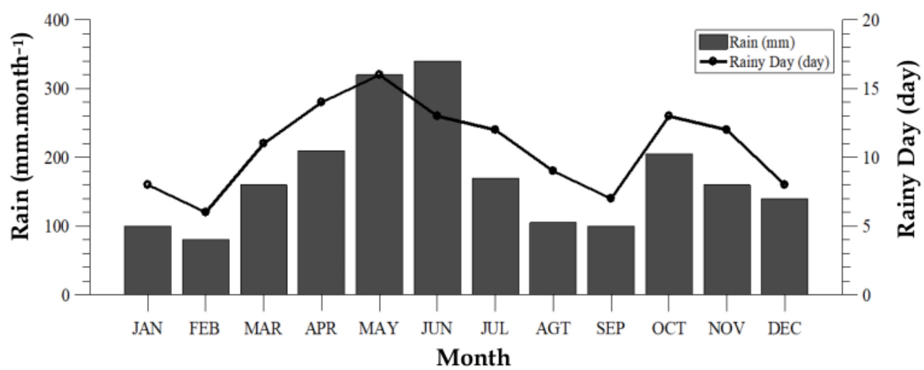


Figure 2. Monthly rainfall of the study area

3.2. Water Discharge

Potential water availability has been calculated based on the water level recorded by the staff gauge of the Cenranae-Walanae River, located downstream of Cenranae-Walanae using a rating curve equation (1). The variation in annual water discharge over the period 2000-2014 is shown in Figure 3. The highest discharge was seen in 2002 and 2010, while the lowest discharge occurred in 2004 and 2009. The calculation results show that the available water discharge is quite abundant throughout the year with a range of 16.5 $m^3.s^{-1}$ to 316 $m^3.s^{-1}$, and an average of 138 $m^3.s^{-1}$. The annual average volume is 4.3 million $m^3.year^{-1}$.

The monthly discharge is depicted in Figure 4. The minimum monthly discharge generally occurs from September to November, while the peak discharge generally occurs in January and July. Mostly water discharge magnitude is dominantly in the range of 100–150 $m^3.s^{-1}$. According to [10–12] that discharge extremity is indicated by a more extreme difference between the minimum and maximum discharge. Discharge analysis of the minimum and maximum plan (dry-wet) is fundamental in the planning and evaluating water resources infrastructure.

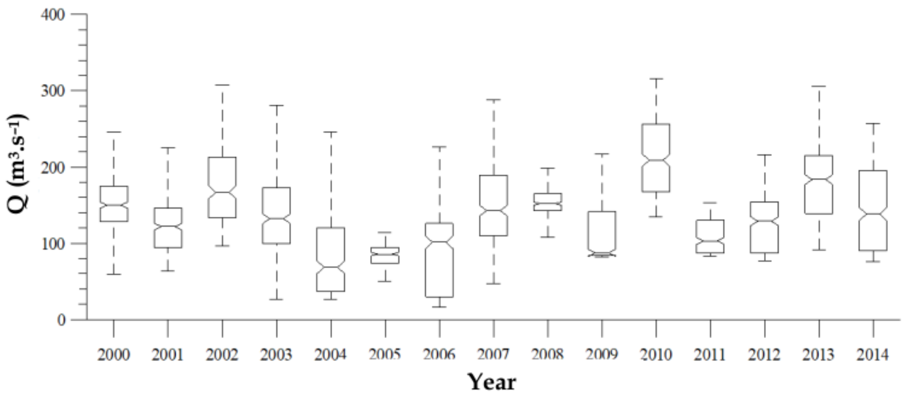
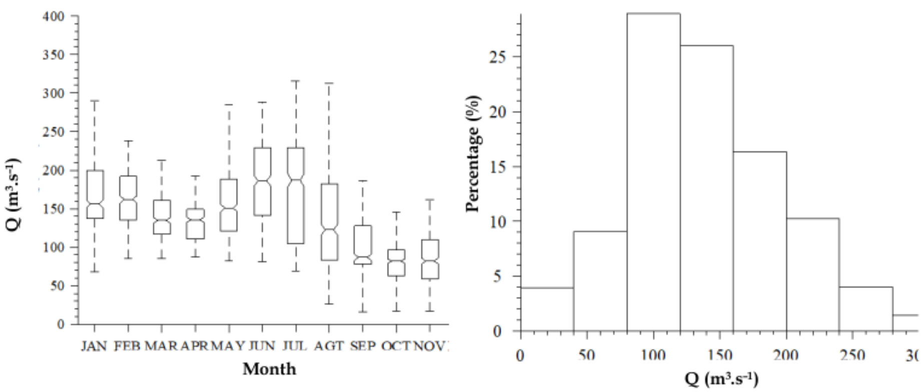


Figure 3. Boxplot of annual discharge of Walanae River



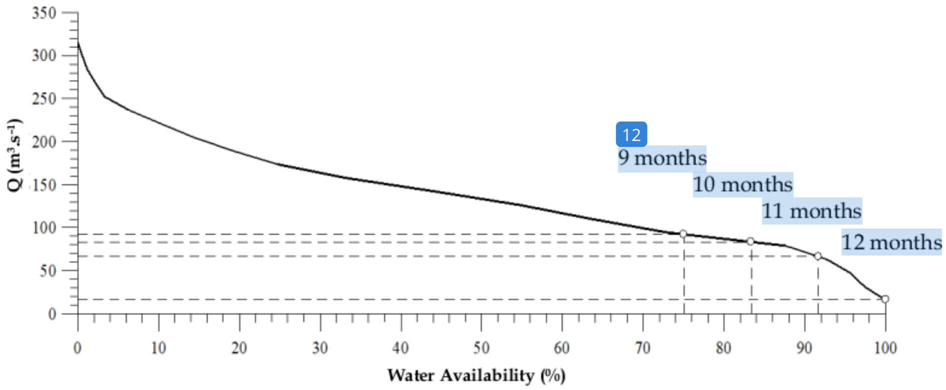
(a) Monthly Discharge (b) Histogram of Discharge

Figure 4. Monthly discharge of Walanae River

3.3 Water Availability

Water availability of the Walanae River is shown in the Flow Duration Curve (FDC), as shown in Figure 5. The flow duration curve is a plot that shows the percentage of time that flow in a stream is likely to equal or exceed some specified value of interest [13]. It characterizes the ability of the basin to provide flows of various magnitudes. Information concerning the relative amount of time that flows past a site is likely to equal or exceed a specified value of interest is extremely useful for the design of structures on a stream. The shape of the curve in the high-flow region indicates the potential flood regime, whereas the shape of the low-flow region characterizes the basin's ability to sustain low flows during dry seasons. The water availability for 9, 10, 11 months, and all years are 92.2 $m^3.s^{-1}$, 83.4 $m^3.s^{-1}$, 66.3 $m^3.s^{-1}$, and 15.8 $m^3.s^{-1}$, respectively. It seems that water is widely available from May to

July and a deficit in August - November (see Figure 6). This is consistent with rainfall patterns and variations in monthly discharge. The water availability analysis is extremely needed because it is closely related to food and energy security. It causes a high conflict of interest in water management [14,15]. In addition, with limited water availability in space and time, knowing how to use water effectively and efficiently is crucial [10].



Figur 5. Flow duration curve (FDC) of Walanae River

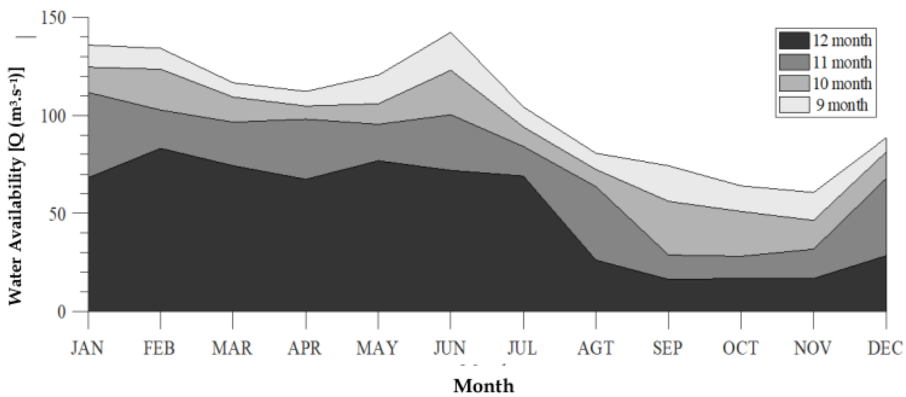


Figure 6. Monthly variation of water availability of Walanae River

4. Conclusion

The water discharge of the Walanae River throughout the year is in a range of 16.5 $m^3.s^{-1}$–316 $m^3.s^{-1}$, and an average of 138 $m^3.s^{-1}$. The minimum discharge generally occurs from September to November, while the peak discharge generally occurs in January and July. The water availability for 9, 10, 11 months, and all years are 92.2 $m^3.s^{-1}$, 83.4 $m^3.s^{-1}$, 66.3 $m^3.s^{-1}$, and 15.8 $m^3.s^{-1}$, respectively.

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