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Management of Annual Water Allocation for Irrigation Water Needs in the River Watershed of Kobi-Central Maluku

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ABSTRACT
Professional water management is essential to ensure water availability, given its critical importance. In Eastern Indonesia, following the era of rice self-sufficiency, communities have sought to maintain their food supplies and have become accustomed to consuming rice as a staple food. This study aims to describe irrigation water management in the Kobi District of Central Maluku Regency, Eastern Indonesia. The National Rural Electric Cooperative Association (NRECA) method was selected for the analysis, considering three water availability scenarios based on rainfall probability: Wet Scenario (Q30%): High rainfall, Normal Scenario (Q50%): Moderate rainfall, Dry Scenario (Q80%): Low rainfall. In the event of a water deficit, allocations are adjusted according to a priority scale. The correlation (r) between measured water discharge data and simulation results was 0.647, indicating a moderate relationship. The RMSE (mean error) is 0.858, which indicates that this model was quite good. The analysis results revealed variations in water discharge of each scenario for Kobi Irrigation Area and Kobi Watershed. In the Kobi Irrigation Area, the highest discharge occurred in wet conditions, which was 18.42 m^3/s in May, while the lowest discharge occurred in dry conditions, which was 1.17 m^3/s in May. In the Kobi watershed, the highest discharge occurred in wet conditions, which was 16.75 m^3/s in May, while the lowest discharge occurred in dry conditions, which was 0.15 m^3/s in May.

INTRODUCTION

Indonesia, a country in South East Asia Region rapidly had a massive growth in its resident that effects the poverty rate (Worldometer, 2023). Numerous indicators effected Poverty rate, with water supply named as a vital issue (Bachri et al., 2025). Water demand escalates with the increase of the human population, later becoming an issue due to water resource limitation (Fatristya et al., 2025). East area of Indonesia is categorised as the nation's worst area for its shortage of water availability (Ikhram & Sani, 2025). It includes the Kobi Watershed in Maluku Province, precisely located in Central Maluku Regency. Previous research has never pictured the actual condition of the Kobi Watershed. But there are several studies that talked about the condition near the Kobi Watershed, such as the analysis of access to fresh water in the Amahai region in Central Maluku Regency (Mokiha & Salakory, 2025). The other study discusses the water quantity demand at Waya Udara Village in Central Maluku for domestic purposes. Kobi Watershed is different from others since it is charged not only as a domestic water supply but also for irrigation purpose After Rice Self-Sufficiency era. Vital for irrigation, Kobi Watershed should analyze the allowable discharge and required the fair water allocation to supply all the inquiries.

To meet the requirement, professional water management is needed. One of the important instruments in water management is the Annual Water Allocation Plan (Wlary et al., 2023). This plan was effectively created to ensure a fair, sustainable, and optimal distribution of water for various sectors, as well as to prevent losses due to water shortages or overwater (Putri & Putro, 2020). Some of the main reasons for the preparation of this plan are the limitation of water resources, potential conflicts between users, climate change, and ecosystem needs(Mopangga, 2020).

The objectives of an integrated water allocation system as part of public service activities to the community include: (1) determine the allocation of water for each Irrigation and non-irrigation sector based on priority; (2) take into account the availability of water in the rainy and dry seasons in the irrigation sector; and (3) prevent overexploitation of water source use. Annual water allocation is the process of dividing water resources into various sectors (agriculture, industry, households) in a sustainable manner (Defiana & Hartati, 2024). To determine water availability and demand, the Non-Recorded Catchment Area (NRECA) Water Balance Model method is used. This model is particularly useful for analysing water availability, especially in areas where hydrological data is lacking, and supporting spatial planning and irrigation (Rudi Saputri & Saves, 2023).

RESEARCH METHOD

This study used the National Rural Electric Cooperative Association (NRECA) method. The general steps in the calculation of the water balance with the NRECA model (Krisnayanti et al., 2022):

1. Data Collection:
   - Rainfall Data: Monthly or daily rainfall data in recent years.
   - Evapotranspiration Data: Potential evapotranspiration (ETp) data that could be computed using methods such as Penman-Monteith.

   $$ET_0 = (0.408\,\Delta\,(Rn - G) + \gamma\left(\frac{900}{(T+273)}\right) U_2$$
   $$\left(\frac{es - ea}{(\Delta + \gamma(1 + 0.34\,U_2))}\right)$$

   Penman's method evapotranspiration formula, especially Penman-Monteith, is an approach to calculating potential evapotranspiration (ET_0), which is the evapotranspiration rate of the surface of reference plants, such as grass growing under ideal conditions (Krisnayanti, 2021). This method combines meteorological factors such as solar radiation, temperature, humidity, and wind speed, as well as plant properties (through plant coefficients) to estimate evapotranspiration (Hawari et al., 2025).
   - Watershed characteristics: Watershed area, soil type, land use, slope, and vegetation conditions.
   - Calibration Parameters: Values of calibration parameters such as surface runoff coefficient (PSUB), subsurface runoff coefficient (GFW), and groundwater storage capacity.
2. Watershed Division:
   - Watersheds were divided into several sub-watersheds based on their physical characteristics. This division aims to take into account the heterogeneity of watershed conditions (Permana & Susetyaningsih, 2022).
3. Calculation of Water Balance Components:
   - Infiltration: The process of water entering the soil.
   - Runoff: Surface flow that occurs due to rainfall.
   - Actual Evapotranspiration: The amount of water lost through the process of evaporation and transpiration of plants.
   - Storage Changes: Changes in the volume of water in the soil and water bodies.
4. Preparation of Water Balance Equation:

- The general water balance equation can be written as follows Zahrani et al. (2025).

$$P = ET + Q + \Delta S$$

Where:

P = Precipitation (rainfall)
ET= Actual evapotranspiration
Q = Runoff
ΔS= Changes in water storage in the system

5. Model Calibration:
   - The process of adjusting model parameters so that the results of the model simulation match the observation data.
   - The values of the calibration parameters that are often used are PSUB, GFW, and groundwater storage capacity.
   - Calibration could be done by comparing the results of the discharge simulation with the observation discharge data.
6. Simulation:
   - After the model was calibrated, simulations were carried out to predict future hydrological conditions.
   - Simulations could be performed for a variety of scenarios, such as climate change or land-use change.
7. Results Analysis:
   - The results of the simulation were analysed to determine water availability, water deficit, and water surplus.
   - This analysis could be used for better water resource management planning.

The NRECA method calculated water availability based on rainfall and runoff coefficients, but plant evapotranspiration (*ET*) played an important role in determining how much water is actually available for surface *runoff* (Wijanarto et al., 2025). In the NRECA equation, the *ET* affects the effective precipitation (*Peff*) used to calculate the flow discharge (Permana & Nawawi, 2022):

$$Peff = P - ET - I$$

where:

P = Total rainfall (mm/month),
ET= Actual evapotranspiration (mm/month),
I = Infiltration into the soil (mm/month).

The higher the ET, the smaller the P_{eff} and the resulting flow discharge (Q) (Trilita et al., 2021). Although NRECA did not directly calculate water needs, the results of its simulations could provide important information that can be used to estimate water needs (Alnino et al., 2022). Model steps with NRECA:

1. Flow Simulation:
   - Use the NRECA model to simulate river flows based on rainfall data and watershed characteristics.
   - The results of the simulation will provide an overview of the availability of water in the watershed under various conditions.
2. Water Availability Analysis:
   - Deficit and Surplus: Identify periods of deficit (water shortage) and surplus (excess water) based on the simulation results.
   - Average Availability: Calculate the annual or seasonal average water availability.
3. Estimated Needs:
   - Land Use: A land use analysis in watersheds to estimate water needs for agriculture, industry, and domestic use.
   - Population: An estimate of domestic water demand based on the number of population.
   - Economic Growth: Consider economic growth and changes in water consumption patterns in the future.

4. Comparison:
    - Compare the results of the water availability simulation with the estimated water demand.
    - If the need for water is greater than the availability of water, then there is a water deficit. On the other hand, if the availability of water is greater, then there is a surplus of water.

The Van der Weert model is one of the approaches used in water resource management and hydrology, especially related to annual flow estimation and inflow-outflow influences. Here is a comparison between Van der Weert's model and several other commonly used models in the field of hydrology and water management (Handayani et al., 2024) :

- Characteristics: Simple, based on the concept of annual inflow and outflow, with a specific ratio to estimate the average outflow of inflows.
- Advantages: Easy to understand and implement, suitable for rough estimation, macro-scale water resource management.
- Limitations: Doesn't consider seasonal or daily variability, lacks detail for detailed analysis.

This model is used to check the reliability of discharge data; Van der Weert recommends Double Mass Analysis (cumulative plots of discharge vs. rainfall or discharge of reference watersheds) to detect anomalies or trend changes (Sabri et al., 2024). The equations used were:

$$R = 155x\left(\frac{P}{1000}\right)^{2.5} \quad \text{for P < 1800 mm/yr}$$

$$\text{R} = 0.94\text{xP} - 1018 \quad \text{for p > 1800 mm/yr}$$

Where :

R = average runoff (mm/yr)

P = average rainfall (mm/yr)

To calculate the Mainstay Discharge, the SNI standard (Calculation of the mainstay discharge of rivers with discharge duration curves) was used. This standard stipulates that water discharge data with a probability of success greater than 0.9 requires 20 years of data logging (Kawet et al., 2024). The discharge data used (e.g., monthly or 10-day data) must be of good quality and have gone through validation (uniformity, non-dependency, and outlier tests) (Putri et al., 2023). This Mainstay Water discharge calculation can use the Weibull probability formula with the water discharge duration curve method (Mursyid et al., 2025).

$$P(X > x) = \frac{m}{(n + 1) + 100\%}$$

Irrigation water needs in conjunction with water balance analysis are taken based on the planting pattern plan. Irrigation water needs for rice paddy plants require a lot of water and want stagnation to suppress weed growth. In general, the height of the waterlogging is around 50 - 75 mm for rice; the maximum inundation is about 15 cm, and local varieties are between 100 - 120 mm. Water needs of rice plants:

- Tillage and seedling period
- Water needs at various stages of plant growth:
    - Early clash (seedling or juvenile period):
    - Germination, radicle, and plumule
    - Vegetative growth period,
    - Reproductive or generative periods, and
    - Ripening period

Irrigation water (IR) requirements were calculated based on the plant's water requirements (ETc), irrigation efficiency, and other factors such as effective rainfall & percolation.

- Calculate Plant Evapotranspiration (ETc)
- Calculate Effective Rainfall (Re)
- Calculate Clean Irrigation Water Needs

- Calculate Irrigation Water Needs in the Field
- Convert to Water discharge (Q)

RESULTS AND DISCUSSION

Watersheds (watersheds)

The Kobi Watershed is located in Central Maluku Regency and covers several sub-districts such as North Seram District, East Seti, North Seram, East Kobi and Telutih. Geographically, the Kobi Watershed is located at 3°13'51.299 S and 29°45'10.241"E. The total area of the watershed is 112.34 km^2 (Fig.1). The Kobi watershed has characteristics in the collection building from bending kobi, including: water distribution is carried out through deliberation; there is no priority area; dividing on the right of the system; high sedimentation occurs in the weir; and water is used only for irrigation.

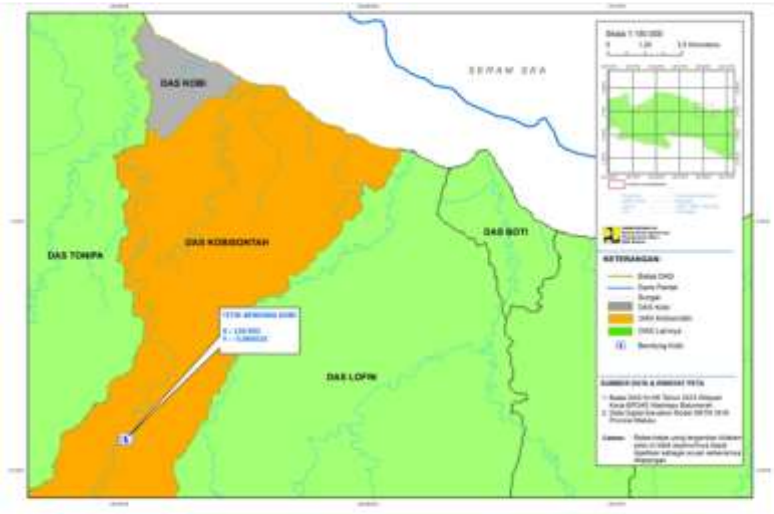

Fig. 1 *Kobi Watershed*

In the NRECA Model, the relationship between rainfall data and potential evapotranspiration (ET_0) is critical to accurately determine the irrigation water requirement used to calculate water deficit/supply. The results of the partial analysis of average rainfall data and climatological data to calculate the actual evapotranspiration rate from 2010-2014 can be seen in Fig. 2.

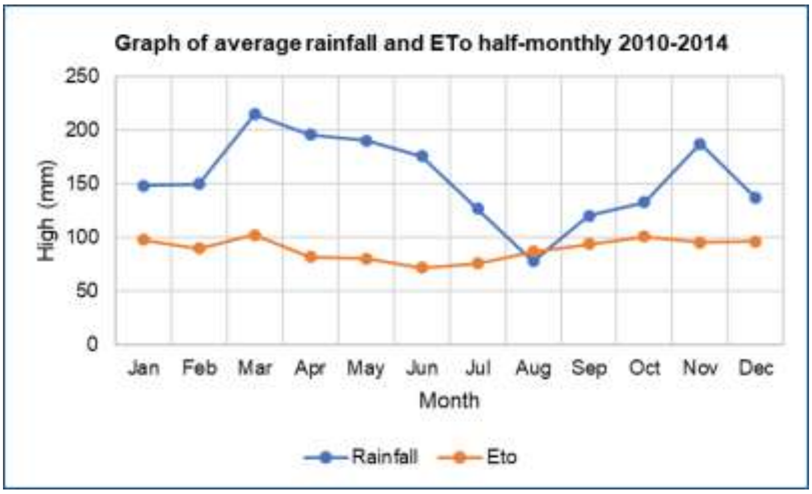

Fig. 2 *Relationship of Rainfall and ET_0*

To determine the parameters of the NRECA model to obtain accurate simulated discharges, a systematic approach was required that combines hydrological data, watershed characteristics (watersheds), and model calibration. The hydrological parameters are;

Watershed Name : KOBI
Watershed Area : 112.34 Km^2
Annual average rainfall : 2384.93 mm
Nominal : 696.23
Plant coefficient (c) : 0.25
Rain factor : 1

From the results of the simulation based on NRECA parameters, which were analysed on the soil storage capacity index (nominal), Per cent Subsurface (PSUB) and Ground Water Flow (GWF) were carried out by trial and error based on the specified boundary conditions, where the PSUB value is 0.4, and GWF is 0.2 for the storage value of 200, and the IGWS (Irrigation Water Supply System) value is 400. The accuracy of the model was evaluated by comparing the simulated water discharge with the measured water discharge. The results showed a correlation of 0.647 (moderate) and an RMSE value of 0.858, which indicates that the model was quite good. Due to limitations of discharge data, Rob Van Der Weert's model was used to estimate streamflow. The advantage of this model is that it only requires simple data such as rainfall, potential evapotranspiration, and watershed characteristics. This model is particularly useful for estimating low-flow discharge or dry discharge, as shown in a previous study at the Rejoso Watershed under the same conditions (Putri et al., 2025).

Table 1. Relationship between Rainfall Qest and Total Flow

Year	Rainfall (mm/yr)	Qest (mm/yr)	Total Flow (mm/yr)
2010	1687.71	568.44	424.23
2011	2863.16	1673.37	1612.71
2012	3405.67	2183.33	2400.34
2013	2356.16	1196.79	1353.24
2014	2787.44	1602.19	1678.28
2015	2814.41	1627.54	1804.03
2016	1661.15	543.48	775.24
2017	2692.56	1513.00	1601.84
2018	2209.18	1058.63	1229.33
2019	2776.76	1592.16	1899.38
2020	1740.34	617.92	794.98
2021	3062.52	1860.77	1964.82
2022	1879.71	748.93	1032.42
2023	1525.70	416.16	606.17
2024	2311.42	1154.73	1143.17

Due to limited discharge measurement data, the NRECA model was used to simulate surface flow at the Kobi Watershed. This simulation used daily rainfall data and available evapotranspiration analysis. The result is daily water discharge data for 15 years (2010-2024), which can be seen in Fig. 3.

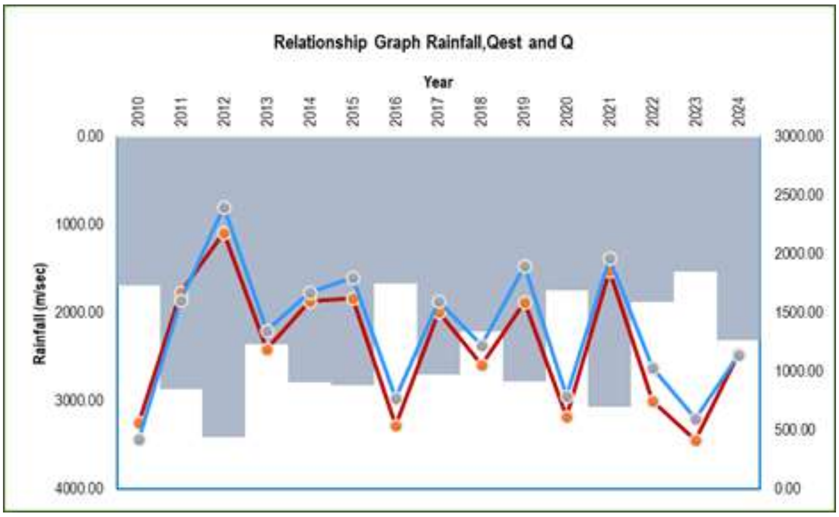

Fig. 3 *Relationship of Rainfall Qest and Total Flow*

Mainstay Water Discharge Calculation

The water availability in the Kobi Watershed is the amount of water that the Kobi Watershed can provide. To calculate it, a hydrological simulation was carried out that converted rain data into surface flows. The rain data used comes from CHIRPS (Climate Hazards Centre Infrared Precipitation with Stations). It is a high-resolution global rainfall dataset available from 1981 to the present (Table 2 and Table 3).

Table 2. Half-Month Discharge on the Kobi Watershed

	Debit m^3/det											
Year	Jan 1	Jan 2	Peb 1	Peb 2	Mar 1	Mar 2	Apr 1	Apr 2	Mei 1	Mei 2	Jun 1	Jun 2
2010	7.02	5.21	5.21	5.83	7.21	2.73	7.20	6.24	2.71	1.69	5.43	3.75
2011	6.52	4.58	10.17	5.78	13.24	6.09	22.73	13.78	15.18	8.96	11.78	7.11
2012	13.85	9.12	20.30	13.91	22.03	14.86	12.59	5.81	18.31	8.53	17.36	10.21
2013	14.89	9.51	20.68	13.96	21.43	9.97	14.91	11.53	10.62	6.57	6.15	5.06
2014	30.67	12.89	24.40	19.89	17.79	11.18	16.95	10.01	14.88	6.33	11.74	3.87
2015	8.43	2.01	8.57	9.86	20.49	15.83	19.91	8.87	10.18	6.41	18.24	10.05
2016	6.25	3.05	6.96	5.06	3.28	1.75	28.56	18.14	5.57	3.37	2.87	2.30
2017	6.81	4.35	1.42	1.31	3.99	2.89	16.87	17.08	36.06	19.00	6.47	4.78
2018	6.52	2.65	2.16	1.99	6.37	2.21	4.69	1.38	37.00	22.37	8.74	5.15
2019	7.99	2.75	5.40	3.72	34.24	18.63	7.90	4.26	20.93	11.89	5.08	3.50
2020	6.58	3.16	7.36	4.26	7.46	4.74	2.38	1.69	18.86	15.26	4.14	2.83
2021	18.09	14.92	8.83	8.13	15.34	8.04	11.84	3.41	16.55	6.20	19.03	10.41
2022	4.90	2.15	4.43	1.97	8.50	5.08	6.32	2.06	1.49	1.12	38.14	30.76
2023	1.96	0.90	0.94	0.73	12.44	11.75	17.12	3.21	2.56	1.92	1.84	1.33
2024	0.99	0.49	0.42	0.36	0.94	0.26	18.34	5.06	1.81	1.35	33.78	27.39

	Debit m^3/det											
Year	Jul 1	Jul 2	Ags 1	Ags 2	Sep 1	Sep 2	Okt 1	Okt 2	Nop 1	Nop 2	Des 1	Des 2
2010	4.22	3.32	1.33	1.00	0.85	0.68	0.54	0.41	3.81	3.53	5.14	4.56
2011	17.89	13.16	9.62	3.79	9.67	3.11	13.60	7.03	6.65	2.82	9.74	3.32
2012	17.37	10.86	7.43	4.02	11.11	5.55	14.96	6.21	16.68	15.94	26.23	20.49
2013	7.90	2.47	2.24	1.59	4.79	1.41	6.36	1.42	9.03	6.07	15.77	6.75
2014	8.58	6.56	5.56	2.36	1.99	1.59	12.82	3.07	5.26	2.00	8.98	5.95
2015	10.84	3.51	10.52	7.19	9.79	3.90	6.13	2.17	15.98	13.86	16.37	10.37
2016	2.53	1.44	3.10	1.09	0.93	0.74	10.64	5.55	2.74	1.36	6.11	1.26
2017	5.21	2.99	10.83	3.08	2.30	1.84	12.27	11.22	28.20	6.72	9.90	3.57
2018	3.68	2.76	2.36	1.77	4.63	1.50	9.80	6.93	23.45	11.62	5.05	2.84
2019	2.80	2.10	3.62	1.51	24.86	25.55	4.70	3.52	34.08	24.83	6.10	4.57
2020	15.05	3.30	3.28	1.92	1.64	1.31	3.83	2.65	7.89	2.94	3.67	1.20
2021	17.62	14.16	13.40	9.94	19.20	10.61	10.04	4.80	12.98	5.42	9.33	4.63
2022	9.36	4.80	4.04	3.03	7.44	3.43	2.77	1.64	2.94	1.26	5.65	2.23
2023	1.07	0.80	0.68	0.51	7.96	3.81	10.81	1.68	1.98	1.20	0.96	0.72
2024	29.89	6.53	6.37	4.09	8.35	4.61	3.79	2.14	2.48	1.67	1.23	0.92

Table 3. Half-Month Mainstay Discharges on the Kobi Watershed

Mainstay Debit (m3/sec)	Half a month											
	OCT_1	OCT_2	NOV-1	NOV-2	DEC_1	DEC_2	JAN_1	JAN_2	PEB_1	PEB_2	MAR_1	MAR_2
Q30	11.10	5.68	16.12	7.70	9.77	4.90	9.51	6.00	9.10	8.48	18.33	11.29
Q50	9.80	3.07	7.89	3.53	6.11	3.57	6.81	3.16	6.96	5.06	12.44	6.09
Q80	3.80	1.65	2.78	1.42	3.94	1.21	5.17	2.03	1.57	1.45	4.47	2.32

Mainstay Debit (m3/sec)	Half a month											
	APR_1	APR_2	MEI_1	MEI_2	JUN_1	JUN_2	JUL_1	JUL_2	AGS-1	AGS-2	SEP_1	SEP_2
Q30	17.37	10.31	18.42	9.54	17.54	10.08	15.51	6.53	7.87	3.84	9.70	4.04
Q50	14.91	5.81	14.88	6.41	8.74	5.06	8.58	3.32	4.04	2.36	7.44	3.11
Q80	6.50	2.29	2.59	1.74	4.33	2.96	2.98	2.17	2.27	1.17	1.71	1.33

In the Kobi Watershed for wet conditions (Q30%), the maximum discharge was 18.33 m³/s in March (1), the minimum discharge was 3.84 m³/s in August (2), and the average discharge was 10.36 m³/sec. Under normal conditions (Q50%), the maximum discharge was 14.91 m³/sec in April (1), the minimum discharge was 2.36 m³/sec in August (2), and the average discharge was 6.63 m³/sec. For dry conditions (Q80%), the maximum discharge was 6.50 m³/s in April (1), the minimum discharge was 1.17 m³/s in July (2), and the average discharge was 2.26 m³/sec (Fig. 4).

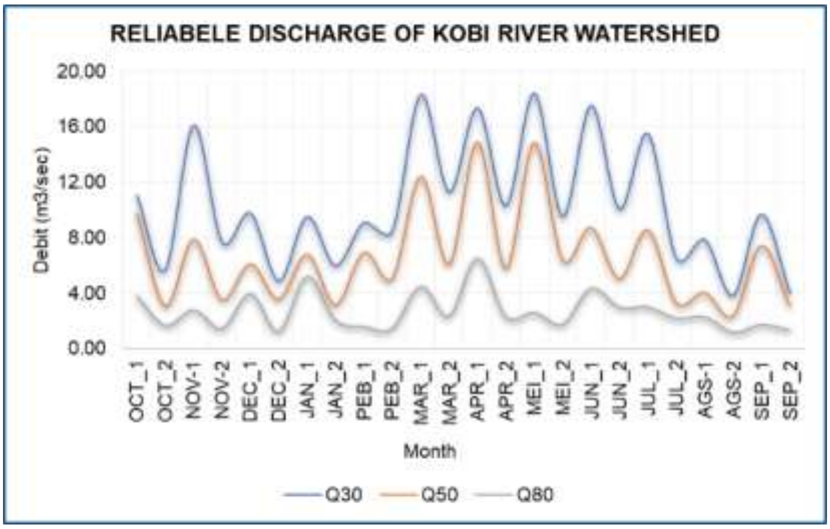

Fig. 4 *Way Kobi's Flagship Discharge Curve*

Calculation of Plant Water Requirements Kobi Irrigation District

The Kobi Irrigation Area has a total service area of 3,150 hectares. Of these, 670 hectares are used to plant rice three times a year. To calculate water needs, mainstay rainfall data and evapotranspiration values measured by the Penman Modification method were used. The results show normal water requirements for each planting pattern (Table 4).

Table 4. Irrigation Planting Pattern

HALF-MOON	October		November		December		Januari		February		March	
	1	2	1	2	1	2	1	2	1	2	1	2
	Planting Season_1								Planting Season_2			
Cropping Pattern: Rice-Rice	1.07	1.36	1.02	0.62	0.71	0.81	0.31	0.17	1.15	1.23	0.79	0.46
Cropping Pattern: Secondary Crops_ Horticulture_not planted	0.00	0.00	0.00	0.09	0.00	0.03	0.00	0.30	0.00	0.00	0.00	0.23
Total DR	1.07	1.36	1.02	0.71	0.71	0.84	0.31	0.47	1.15	1.23	0.79	0.69

HALF-MOON	April		Mey		June		July		Agustus		September	
	1	2	1	2	1	2	1	2	1	2	1	2
	Planting Season_2				Planting Season_3							
Cropping Pattern: Rice-Rice	0.31	0.61	0.56	0.23	0	0	0	0	0	0	0	0
Cropping Pattern: Secondary Crops_ Horticulture_not planted	0.00	0.32	0.19	0.91	0	0	0	0	0	0	0	0
Total DR	0.31	0.93	0.75	1.14	0	0	0	0	0	0	0	0

Water Balance Calculation

To determine the potential balance of water resources, the potential availability and demand for water in the Way Kobi River Area are calculated first (Fig. 5).

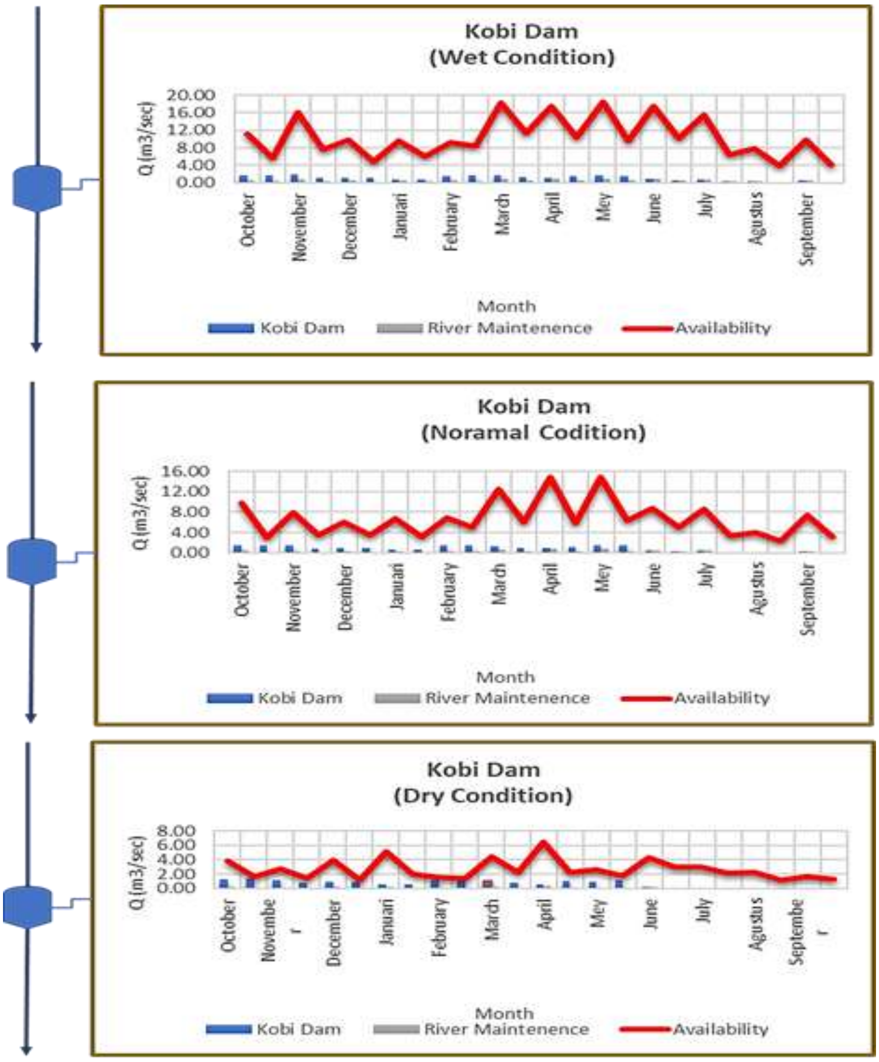

Fig. 5 Water Balance Graph

Based on the results of the water balance analysis on water availability in the Kobi Irrigation Area as seen below, for wet conditions (Q30%), the maximum discharge was 18.42 m^3/s in May (1). Average discharge was 10.36^{m3}/sec, and minimum discharge was 3.84^{m3}/s in August (2). For Normal Conditions (Q50%), maximum discharge was 14.91 m^3/s in April (1), average discharge was 6.63 m^3/sec, and minimum discharge was 2.36 m^3/s in August (2).

For Dry Conditions (Q80%), the maximum discharge was 6.50 m^3/s in April (1), the average discharge was 2.90 m^3/sec, and the minimum discharge was 1.17 m^3/s in May (2). For the Kobi watershed's water balance against wet conditions (Q30%), the maximum discharge was 16.75 m^3/s in May (2), the minimum discharge was 3.65 m^3/s in August (1), and the average discharge was 9.28 m^3/sec. For normal conditions (Q50%), the maximum discharge was 13.85 m^3/sec in April (1), the minimum discharge was 2.36 m^3/sec in August (2), and the average discharge was 6.63 m^3/sec. For dry conditions (Q80%), the maximum discharge was 5.86 m^3/s in April (1), the minimum discharge was 0.15 m^3/s in May (2), and the average discharge was 1.97 m^3/sec. In general, the minimum water discharge tends to occur in August and the maximum discharge in April or May.

The result of allowable discharge is acceptable compared to the previous studies of the other watersheds that are also categorised as small rivers. For example, the Kedunggaleng Watershed managed to provide allowable discharge (Q80%) 0,58 m^3/s (Puspitasari et al., 2025). Moreover, the Pekalen watershed that conduct 5,46 m^3/s as Q80% (Humau et al., 2025) and the Ciloseh Watershed has Q80% equal 5,30 m^3/s (Irawan et al., 2024). Not only does the catchment area affect the result, but also it depends to the other river morphology and meteorology parameter.

The water allocation plan scenario is an assumption about possible future conditions, such as climate change. The water allocation plan in the Kobi Watershed uses water discharge and availability data using a mainstay discharge. The results of the analysis of the calculation of the water allocation plan in the Kobi Watershed under normal conditions (Q50) can be seen in Fig. 6.

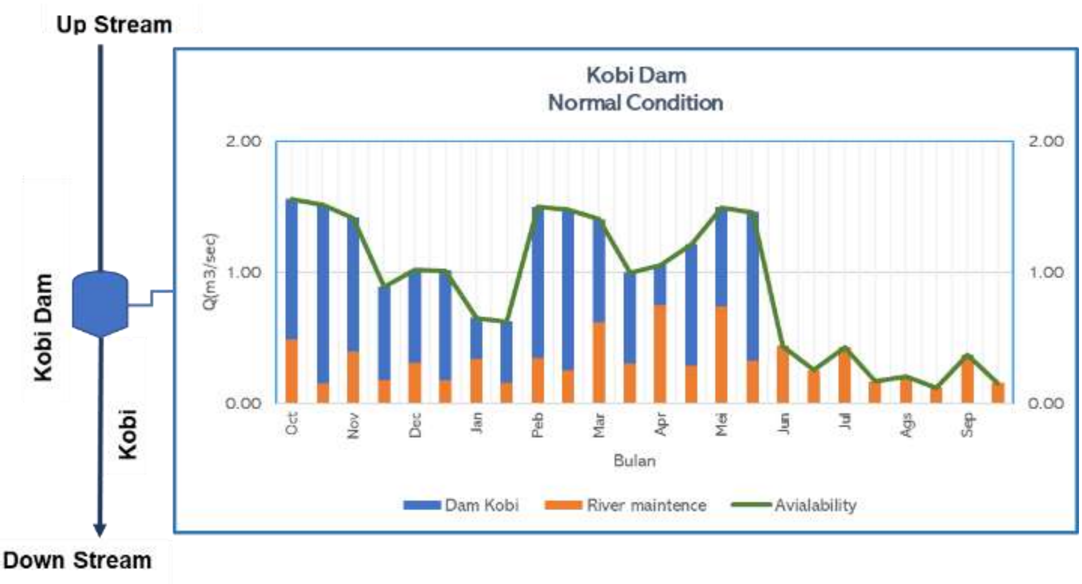

Fig. 6 *Water allocation planning scenario*

CONCLUSIONS

This study's results consist of: (1) the correlation (r) between the measured discharge data and the simulated results is 0.647, which indicates a moderate relationship. The RMSE (mean error) is 0.858, which indicates that this model is quite good; (2) the analysis results conduct variations of water discharge of each scenario for Kobi Irrigation Area and Kobi River Watershed; (3) in the Kobi Irrigation

Area: the highest discharge occurred in wet conditions, which was 18.42 m^3/s in May and the lowest discharge occurred in dry conditions, which was 1.17 m^3/s in May; (4) in the Kobi watershed: the highest discharge occurred in wet conditions, which was 16.75 m^3/s in May and the lowest discharge occurred in dry conditions, which was 0.15 m^3/s in May.

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