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Comparison of Rain-Flow Models FJ Mock and NRECA

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ABSTRACT

This study compares two commonly used rainfall–runoff models in Indonesia, namely the F.J. Mock and NRECA models, for estimating river discharge in three main river basins (DAS) in West Java: Cisangkuy, Cibeet, and Ciwidey. The limited availability of observed discharge data has prompted the use of models as an alternative for discharge estimation in water resource planning. The F.J. Mock model is based on a monthly water balance, while the NRECA model is an empirical model that relies on soil moisture and daily rainfall parameters. The data used include rainfall from six stations and discharge data for the period 2013–2023, analyzed using HEC–HMS, CLIMWAT, and CROPWAT software. Rainfall data validation was performed using the Double Mass Curve and RAPS consistency tests, followed by discharge calculations using both models. Performance evaluation was conducted based on the Nash–Sutcliffe Efficiency (NSE), coefficient of determination (R^2), and Percent Bias (PBIAS). The results indicate that the NRECA model performs better, with higher NSE and R^2 values and lower PBIAS compared to the F.J. Mock model. Additionally, NRECA is considered more practical as it requires fewer data inputs while still producing accurate discharge estimates. Therefore, the NRECA model is recommended for use in watersheds with limited data, while the F.J. Mock model is more suitable for long-term analysis in watersheds with complete data. This study emphasizes the importance of selecting the appropriate rainfall–runoff model to support effective and adaptive water resource management.

Keywords: rainfall–runoff, F.J. Mock model, NRECA model, watershed (das), flow duration curve.

INTRODUCTION

The limited availability of river discharge data due to damaged measuring instruments or inadequate recording systems indeed poses a significant challenge for water resource planning and management (Bhaga et al., 2020; Chatrabhuj et al., 2024). In such contexts, rainfall–runoff modeling becomes an essential alternative for estimating river discharge, particularly in basins with sparse direct observations (Hidayat & Nugroho, 2025). Two frequently used models in Indonesia are the F.J. Mock and NRECA models—both conceptual rainfall–runoff models that estimate discharge based on rainfall inputs and watershed characteristics (Jayanti et al., 2023). The F.J. Mock model integrates components such as direct surface flow, subsurface flow, and groundwater contributions, making it suitable for areas with high rainfall variability (Permana, 2024). Meanwhile, the NRECA model simplifies runoff generation by representing surface runoff, evaporation, soil moisture, and groundwater storage, and has been successfully applied to estimate monthly synthetic discharge in data-deficient basins (Gampo et al., 2024; Bioflux study, 2024). Comparative studies, such as the one conducted in the Rukoh Reservoir catchment, reveal that the NRECA model often produces discharge estimates more closely aligned with observed data than the F.J. Mock model (Hidayat & Nugroho, 2025). These alternatives are therefore vital for ensuring reliable water availability assessments in contexts where direct discharge measurements are limited.

The F.J. Mock model operates on a monthly water balance principle that partitions rainfall into evapotranspiration, surface runoff, and infiltration—making it suitable for long-term hydrological analysis when relatively complete data are available (McCabe & Ayers, 1989; Jayanti et al., 2023). For instance, the application of the F.J. Mock method in the Leuwi Padjadjaran II catchment demonstrated its capability to assess water surpluses and deficits on a monthly basis (Soerya et al., 2025). In contrast, the NRECA model—developed originally for hydrological estimation in the U.S.—relies on empirical soil parameters such as moisture storage capacity, surface runoff fractions, baseflow, plus daily rainfall and PET data

(ResearchGate, 2016; Scribd schematic, 2018). The NRECA model's advantage lies in its simplicity and operational efficiency, which enable reliable runoff estimation under limited data conditions (Ishak et al., 2020; Jayanti et al., 2023). Comparative studies confirm that both models function as practical alternatives where discharge data are sparse, with NRECA often preferred due to its lower data demands (Jayanti et al., 2023).

The urgency of research comparing these models comes from the increasing need for reliable discharge estimates to ensure sustainable water management, mitigate flood risks, and secure water supplies during dry periods. These challenges are intensified by climate change, which introduces greater variability in hydrological conditions. Existing studies, such as by Widyaningsih et al. (2021) and Aditama (2015), have investigated these models but often focused on single watersheds or lacked validation across different hydrological and climatic settings. Consequently, a research gap remains in understanding model performance across multiple basins with varying characteristics, like those in West Java, which feature complex land use and climatic variability. Moreover, practical implementation challenges—such as data demands and computational complexity—are not comprehensively discussed in prior work.

To address these gaps, a multi-basin study was conducted comparing the F.J. Mock and NRECA models in West Java's three major watersheds: Cisangkuy, Cibeet, and Ciwidey. This approach provides a more robust model performance evaluation using multiple statistical accuracy metrics: Nash–Sutcliffe Efficiency (NSE), coefficient of determination (R^2), and Percent Bias (PBIAS). The study assesses how well simulation outputs match observed discharge, considers the computational complexity and data needs of each model, and seeks to provide actionable, practical recommendations.

In prior validations, such as in the Rukoh Reservoir catchment, the NRECA model often demonstrated superior performance relative to F.J. Mock, showing higher NSE and correlation coefficients and better discharge estimation under data-scarce conditions. While the F.J. Mock model is easier to apply for long-term analyses when comprehensive data are available, its simplicity means it may not capture temporal rainfall variability (e.g., intensity and duration) effectively, limiting its accuracy especially in small or heterogeneous catchments. Meanwhile, the NRECA model's simplicity also leads to some accuracy challenges, particularly in determining runoff coefficients, which vary with soil type, land use, and topography. Nevertheless, NRECA tends to perform better in heterogeneous watershed conditions and can integrate variables related to land use changes and human water use, which are relevant for dynamic water resource management.

The primary objectives of studies in this area are to (1) compare the accuracy of the F.J. Mock and NRECA models in estimating river discharge, (2) evaluate their practicality in terms of data requirements and ease of use, and (3) recommend the most suitable model depending on watershed-specific data availability and complexity. Such research supports evidence-based decision-making for more adaptive and effective hydrological planning in Indonesia and comparable regions facing data scarcity and climate variability.

The choice between the F.J. Mock and NRECA models should consider the specific watershed context, data availability, and the intended application (e.g., long-term planning versus adaptive management under limited data), with NRECA favored under limited data conditions and F.J. Mock suited where long-term comprehensive datasets exist.

RESEARCH METHOD

This study employs a quantitative-comparative approach to evaluate the performance of two rainfall-runoff models: the F.J. Mock and NRECA models. This study was conducted at three water gauge stations spread across West Java Province. The first location is the Cibeet – Siphon Water Gauge Station, located in Mulyajaya Village, Telukjambe Barat Subdistrict, Karawang Regency. This location is part of the Cibeet River Basin, which plays an important role in regulating water flow in the downstream area. The second location is the Ciwidey – Cibereum Water Estimation Post in Sadu Village, Soreang District, Bandung Regency. This post is located in the Ciwidey River Basin, which has characteristics of upstream flow with relatively steep terrain and is influenced by land use activities in the surrounding area. The third location is the Cisangkuy Water Monitoring Post, situated within the Cisangkuy River Basin, specifically in Kamasan Village, Banjaran Subdistrict, Bandung Regency.

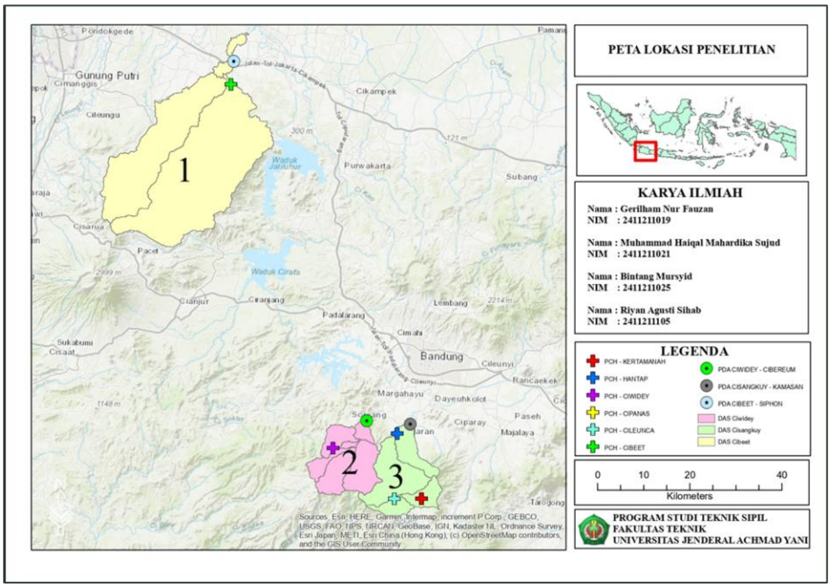

Figure 1. Research Location Map

Source: Processed by authors using ArcGIS v10.8.2 with base map from DEMNAS (National Digital Elevation Model, https://tanahair.indonesia.go.id)

The data used in this study are secondary data in the form of rainfall data and flow rate records. The secondary data used are:

1. Primary Data
   a. Cisangkuy Watershed Map, Cibeet Watershed Map, and Ciwidey Watershed Map analyzed using ARCGIS v10.8.2 software
   b. Watershed Characteristics Data obtained using HEC – HMS v4.12 software
   c. Climatological data obtained from analysis using Climwat v2.0 and CROPWAT v8.0 software
2. Secondary Data
   a. 11-year rainfall data obtained from the Citarum River Basin Management Agency (BBWS)
      a) Hantap Station with observations from 2013 to 2023.
      b) Cipanas Station with observations from 2013 to 2023.
      c) Cileunca Station with observations from 2013 to 2023.
      d) Kertamanah Station with observations from 2013 to 2023.
      e) Cisondari Station with observations from 2013 to 2023.
      f) Cibeet Station with observations from 2013 to 2023.
   b. 11-year discharge data obtained from the Citarum River Basin Management Agency (BBWS)
      a) Cisangkuy – Kamasan water level measurement points with observations from 2013 to 2023.
      b) Water level measurement points at Ciwidey – Cibereum with observations from 2013 to 2023.
      c) Water level measurement points at Cibeet – Siphon from 2013 to 2023.

c. DEMNAS (National Digital Elevation Model) data obtained from the website: https://tanahair.indonesia.go.id

The NRECA method is structured into two storage components: moisture storage and groundwater storage. The following is the concept of the NRECA method. There are three parameters that significantly influence the output of the NRECA method: Nominal Soil Moisture Capacity Index (Soil Moisture Storage Capacity Index) in the catchment area, PSUB (Percentage of Runoff) flowing through the subsurface pathway, which is the percentage of runoff moving out of the watershed through surface runoff, and GWF is the percentage of groundwater storage flowing into the river as baseflow (Saputri, 2023).

This calculation method is suitable for basin areas where water flow in rivers persists for several days after rainfall ceases. This condition occurs when the catchment area is sufficiently large. The principle of the NRECA method can be diagrammatically represented as follows:

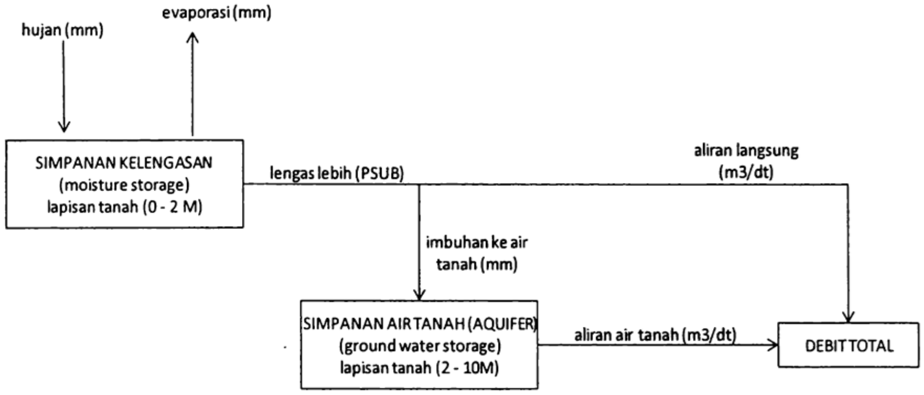

Figure 2. Simulation Diagram of Flow Rate Using the NRECA Method
Source: KP-01 Irrigation Network Planning

The calculation of inflow discharge into the reservoir using the NRECA method is performed column by column from column 1 to column 20 with the following steps:

1. Names of months from January to December each year of observation
2. 10-day period within a month.
3. Average rainfall over 10 days (Rb).
4. Potential evapotranspiration (PET or ETo)
5. Initial soil moisture storage value (Wo). This initial value should be tested and checked to ensure that the value in January is close to the value in December. If the difference exceeds 200 mm, the process must be repeated.
6. *Soil moisture storage* (Wi) is calculated using the following formula: the formula:

   $\mathrm{Wi} = \frac{Wo}{Nominal}$

   Nominal = 100 + 0.2 Ra

   Ra = annual rainfall (mm)
7. Rb/PET ratio
8. AET/PET ratio

   AET = Calculate the ratio between actual evapotranspiration and *potential evapotranspiration* using the formula:

   If the Storage Ratio is > 2, then AET/PET = 1;

   If PRECIP/PET > 1, then AET/PET = 1;

Otherwise, AET/PET = 0.5 × *STOR RATIO* + PRECIP/PET × (1 - 0.5 × *STOR RATIO*).

9. AET = (AET/PET) × PET × Reduction Coefficient
   The reduction coefficient is obtained from the slope function, as shown in the following table:

Table 1. Evaporation Reduction Coefficient

Kemiringan (m/Km)	Koef. Reduksi
0 - 50	0,9
51 - 100	0,8
101 - 200	0,6
> 200	0,4

Source: KP-01 Irrigation Network Planning

10. Water balance Rb – AET
11. *Excess moisture* ratio
    If the Water Balance ≤ 0, then the Excess Moisture Ratio = 0;
    If Wi ≥ 1, then Excess Moisture Ratio = 1 - (0.5 x $(2 - \text{Wi})^2$;
    Otherwise, Excess Moisture Ratio = 0.5 × $(\text{Wi})^2$;
12. Excess moisture = excess moisture ratio × water balance
13. Change in storage = water balance - excess moisture
14. Groundwater storage = PSUB × excess moisture ratio
    PSUB is a parameter describing the characteristics of surface soil (depth 0-2), with a value of 0.3 for water-impermeable soil and 0.9 for water-permeable soil.
15. Initial groundwater storage should be estimated with an initial value of 2
16. Final groundwater storage = groundwater storage + initial groundwater storage.
17. Groundwater flow = GWF × final groundwater storage
    GWF is a parameter describing the characteristics of surface soil (depth 2–10), with a value of 0.8 for water-impermeable soil and 0.2 for water-permeable soil.
18. *Direct runoff* = excess moisture - groundwater storage.
19. Total flow = direct runoff + groundwater flow in mm
20. Total flow in mm is converted to units of m^3/s. For the next month's calculation, the moisture storage value for the next month and the groundwater storage for the next month are required, which can be calculated using the following formula:
    a. Surface water storage = surface water storage from the previous month + total change in surface water storage from the previous month.
    b. Groundwater storage = final groundwater storage + total groundwater flow from the previous month.

Meanwhile, the volume of water that can fill the reservoir during the rainy season (Vb) can be calculated from the total surface water from the entire catchment area and the effective rainfall that directly falls on the reservoir surface. Thus, it can be expressed as follows:
Vb = Total Flow × Catchment Area × 1000 / (24 × 3600 × Days).
Where:
Vb = water volume (m^3/s)

The F.J. Mock method is used to estimate the average monthly discharge based on the water balance approach. This method relates rainfall to runoff by considering climatological data, land use, and the hydrological characteristics of the river basin (Irawan, 2024). The main components analyzed include rainfall, evapotranspiration, and soil moisture capacity. The accuracy of the calculation results improves if observed discharge data is available for comparison. However, due to data limitations at the study site, validation was conducted using water level records from observation stations.

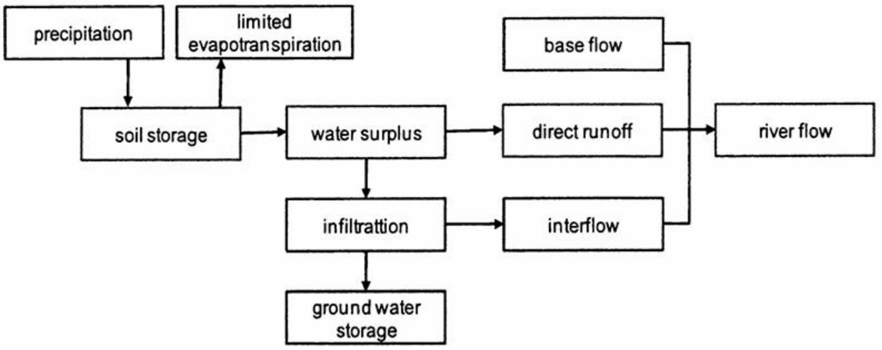

Figure 3. Flow Simulation Scheme Using the F.J. MOCK Method
Source: KP-01 Irrigation Network Planning

The data and assumptions required for the Mock method calculations are as follows: follow:

1. Rainfall Data
   The rainfall data used is 10-day rainfall. The rainfall station used is the station considered representative of rainfall conditions in the area.
2. Limited Evapotranspiration (Et)
   Limited evapotranspiration is actual evapotranspiration considering vegetation and soil surface conditions as well as rainfall frequency. To calculate limited evapotranspiration, the following data is required:
   a. 10-day rainfall (P)
   b. Number of rainy days (n)
   c. Number of 10-day dry periods (d) calculated assuming that the soil in a given day can only hold 12 mm of water and always evaporates 4 mm.
   d. *Exposed surface* (m%) estimated based on land use maps or assuming:
      0% for land with dense forest
      m 0% at the end of the rainy season and increasing by 10% each dry month for secondary land.
      m = 10%–40% for eroded land.
      M = 20% - 50% for cultivated agricultural land.
      Mathematically, limited evapotranspiration is formulated as follows:
      $Et = Ep - E$
      $E = Ep \times (\frac{m}{20}) \times (18 - n)$
      Where:
      E = Difference between potential evapotranspiration and limited evapotranspiration (mm)
      Et = Limited evapotranspiration (mm)
      Ep = Potential evapotranspiration (mm)
      M = Land exposure (*Exposed surface*)
      n = Number of rainy days
3. Hydrogeological Characteristics Factor Land Cover Factor

m = 0% for land with dense forest
m = 10 - 40% for eroded land
m = 30–50% for cultivated agricultural land

Based on field observations across the entire study area, which consists of cultivated agricultural land and eroded land, it can be assumed that the factor m is 30%.

4. Drainage Area
   The larger the drainage area of a stream, the greater the likelihood of available flow.
5. Soil Moisture Capacity (SMC)
   Soil Moisture Capacity is the water content capacity of the surface soil layer (*surface soil*) per ^{m2}. The SMC value for this water availability calculation is estimated based on the porosity of the surface soil layer from the DPS. The higher the soil porosity, the greater the SMC. In this calculation, the SMC value is taken between 50 mm and 200 mm. The equation used to determine the soil moisture capacity is:
   $SMC(n) = SMCcn - t) + IS(n)$
   $Wn = As - IS\ SMC$
   Explanation:
   SMC = Soil moisture S
   MC (n) = Soil moisture content at period n
   SMC(n-1) = Soil moisture content at period n-1
   IS = *Initial* storage (mm)
   As = Rainfall reaching the soil surface
6. Water balance at the soil surface
   Water balance at the soil surface is influenced by the following factors:
   a. Rainwater Soil water content
   b. soil water (*soil storage*)
   c. Soil moisture capacity (SMC)
7. Rainfall (As)
   Rainwater that reaches the soil surface can be formulated as follows:

   $As = P - Et$

   explanation:

   As = Rainfall reaching the soil surface

   P = Monthly rainfall

   Et = Evapotranspiration

8. Soil moisture content
   The soil moisture content depends on the value of As. If As is negative, the soil's moisture capacity decreases, and if As is positive, the soil moisture increases.
9. Groundwater flow and storage (*runoff and groundwater storage*)
   The values of runoff and groundwater depend on the water balance and soil conditions.
10. Infiltration coefficient
    The infiltration coefficient is estimated based on soil porosity and slope conditions. Porous soil has a high infiltration coefficient, while compacted soil has a low infiltration coefficient

because water has difficulty infiltrating into the soil. The infiltration coefficient ranges from 0 to 1.

11. Soil Flow Recession Factor (k)
    The recession factor is the ratio of groundwater flow in month n to groundwater flow at the beginning of that month. The soil flow recession factor is influenced by the geological properties of the DPS. In the FJ Mock method for calculating water availability, the value of k is determined through trial and error until the desired flow is achieved.
12. *Initial Storage* (IS)
    Initial Storage or initial storage volume is an estimate of the volume of water at the start of the calculation. IS at the study site is assumed to be 100 mm.
13. *Groundwater Storage*
    Groundwater storage depends on local geological conditions and time. As a starting point for the simulation, *the initial storage* must be determined first. The equation used in the calculation of groundwater storage is as follows:

    $Vn = k \times Vn - 1 + 0{,}5\ (1 + k)\ I$

    $DVn = Vn - Vn - 1$

    Where:

    Vn = Groundwater volume in period n

    K = qt/qo soil flow recession factor

    Qt = Groundwater flow at time period t

    Qo = groundwater flow at the beginning of the period (period 0)

    Vn-1 = groundwater volume at period (n-1)

    DVn = change in groundwater flow volume
14. River flow

    Base flow = Infiltration – change in water within the soil

    Surface flow = excess water volume – infiltration

    River flow = surface flow + base flow

    Discharge $= \frac{Aliran\ sungai\ X\ Luas\ DAS}{1\ bulan\ dalam\ detik}$

    The water flowing in a river is the sum of *direct runoff*, interflow, and *base flow*. The magnitude of each flow is as follows:

    a. *Interflow* = infiltration - groundwater volume
    b. *Direct runoff* = *water surplus* - infiltration
    c. *Base flow* = flow that is always present throughout the year
    d. *Runoff* = *Interflow* + *Direct runoff*+ *Base flow*

Next, a comparison of the simulation results with observed data was conducted using a model suitability test that included *Nash-Sutcliffe Efficiency* (NSE), correlation coefficient (R^2), and *Percent Bias* (PBIAS).

An example of the analysis of the suitability of the Cisangkuy watershed discharge method using the NRECA method is as follows:

Example calculation for January 2013

$Q_{obs} – Q_{(model)}$ = 45.00 - 100.43

= -55.43

$(Q_{obs} – Q_{model})^2$ = 3071.97

Result of the overall summation analysis:

$$\sum_{i=1}^{n}(Q_{obs} - Q_{model})^2 = 13{,}769.04$$

$$\sum_{i=1}^{n}(Q_{obs} - \overline{Q_{obs}})^2 = 16{,}690.77$$

$$\text{NSE} = 1 - \frac{\sum_{i=1}^{n}(Q_{obs}-Q_{model})^2}{\sum_{i=1}^{n}(Q_{obs}-\overline{Q_{obs}})^2}$$

$$= 1 - \frac{13769{,}04}{16690{,}77}$$

$$= 0.18$$

$$\text{R} = \frac{n\sum_{i=1}^{n}(Q_{obs}Q_{model}) - \sum_{i=1}^{n}(Q_{obs})\sum_{i=1}^{n}(Q_{model})}{\sqrt{(n\sum_{i=1}^{n}{Q_{obs}}^2 - (\sum_{i=1}^{n}(Q_{obs})^2)(n\sum_{i=1}^{n}{Q_{Model}}^2 - (\sum_{i=1}^{n}(Q_{model})^2)}}$$

$$= \frac{132\times34806{,}1 - 1561{,}8\times1768{,}6}{\sqrt{(35168{,}6-1561{,}8^2)(48212{,}7-1768{,}6^2)}}$$

$$= 0.69$$

$$\text{PBIAS} = \left(\frac{\sum_{i=1}^{n}(Q_{obs}-Q_{model})}{\sum_{i=1}^{n}(Q_{obs})}\right)\times 100\%$$

$$= \left(\frac{1561{,}8-(-206{,}82)}{1561{,}8}\right)\times 100\%$$

$$= -18.44\%$$

RESULTS AND DISCUSSION

Cisangkuy Watershed

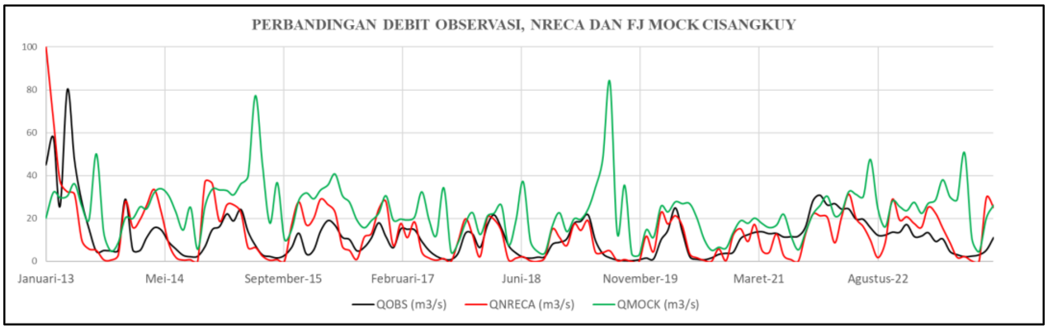

Figure 4. Comparison of NRECA, FJ Mock, and Observation Discharge of Cisangkuy Watershed

Source: Analysis results from HEC-HMS v4.12 software using data from BBWS Citarum (2013-2023)

Cibeet Watershed

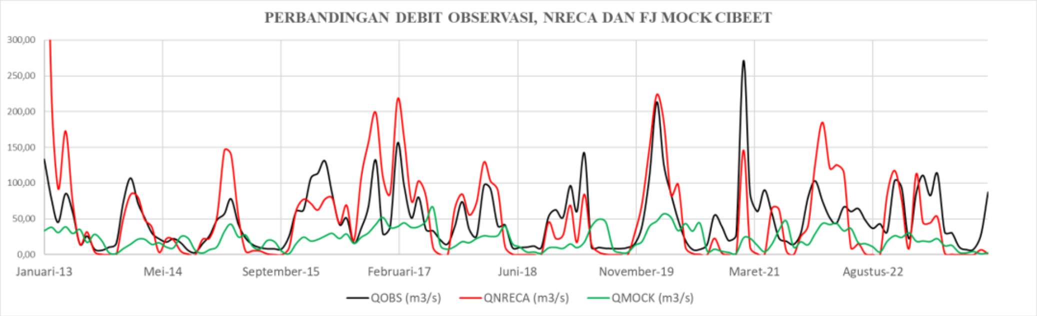

Figure 5. Comparison of NRECA, FJ Mock, and Observation Discharge in the Cibeet Watershed

Source: Model simulation results compared with observed data from Citarum River Basin Management Agency (BBWS).

Ciwidey Watershed

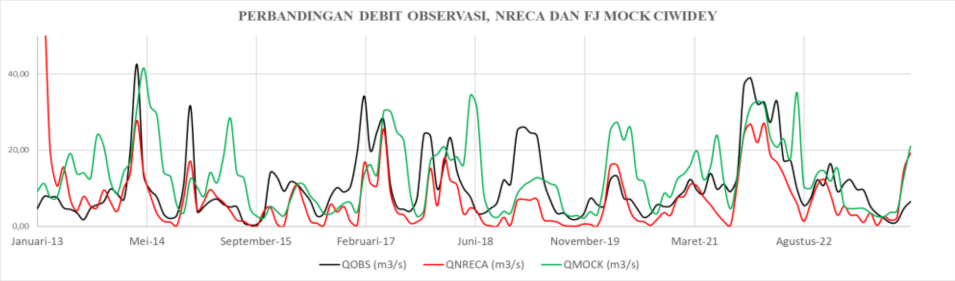

Figure 6. Comparison of NRECA, FJ Mock, and Observation Discharge of the Ciwidey Watershed

Source: Processed by authors using NRECA and F.J. Mock model outputs with validation data from BBWS.

Flow Duration Curve of the Cisangkuy Watershed

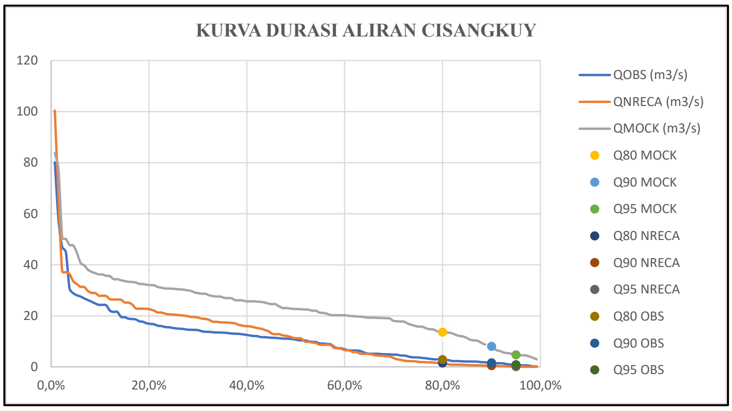

Figure 7. Duration Curve of Observed Discharge with FJ Mock and NRECA Model Discharge in the Cisangkuy Watershed

Source: Derived from model simulations and field measurements (BBWS Citarum, 2013-2023).

Flow Duration Curve of the Cibeet Watershed

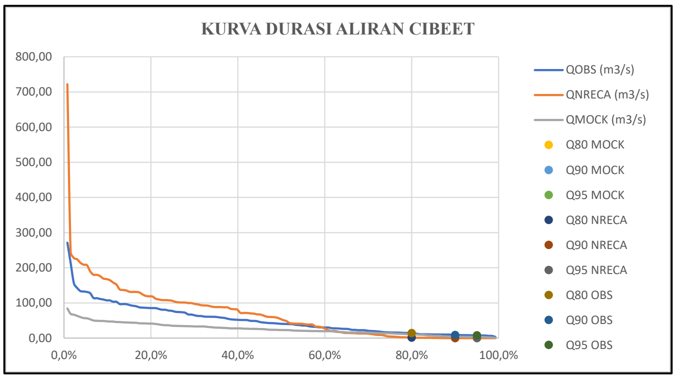

Figure 8. Observed Flow Duration Curve with FJ Mock and NRECA Model Flow in the Cibeet Watershed

Source: Analysis of 11-year discharge records (BBWS) and model outputs

Flow Duration Curve of the Ciwidey Watershed

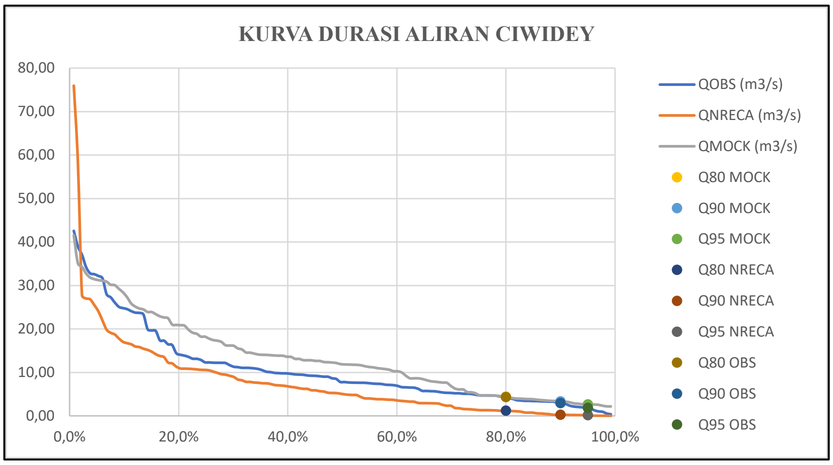

Figure 9. Observed Discharge Duration Curve with FJ Mock and NRECA Model Discharge in the Ciwidey Watershed

Source: Processed by authors using Python visualization tools with input data from BBWS monitoring stations

Method Suitability Test

Table 2. Results of Method Suitability Analysis with Observed Flow

Watershed	Parameter	Method	Calibration Value	Criteria
Cisangkuy	R^2	NRECA	0.69	Satisfactory
		FJ MOCK	0.19	Unsatisfactory
	NSE	NRECA	0.18	Unsatisfactory
		FJ MOCK	-1.95	Unsatisfactory
	PBIAS	NRECA	-18.44	Very Good
		FJ MOCK	-101.10%	Very Good
Ciwidey	R^2	NRECA	0	Unsatisfactory
		FJ MOCK	0.39	Unsatisfactory
	NSE	NRECA	-0.43	Unsatisfactory
		FJ MOCK	-0.32	Unsatisfactory
	PBIAS	NRECA	27.55	Unsatisfactory
		FJ MOCK	-23.32	Very Good
Cibeet	R^2	NRECA	0.62	Satisfactory
		FJ MOCK	0.21	Unsatisfactory
	NSE	NRECA	-1.58	Unsatisfactory
		FJ MOCK	-0.34	Unsatisfactory
	PBIAS	NRECA	-60.00	Very Good
		FJ MOCK	50.38	Unsatisfactory

Source: Calculated by authors using Nash-Sutcliffe Efficiency (NSE), R^2, and PBIAS metrics from model validation.

The analysis results indicate that both the F.J. Mock and NRECA models are not yet fully capable of accurately representing river discharge in the Cisangkuy, Cibeet, and Ciwidey watersheds. However, the NRECA model shows relatively better performance compared to the F.J. Mock model, as indicated by higher correlation coefficients (r) and lower relative errors. The negative *Nash–Sutcliffe Efficiency* (NSE) values and significant deviations in both models are likely caused by limitations in the quality of input data, particularly observed discharge data.

This data inaccuracy is likely influenced by manual recording methods prone to reading errors, extreme weather conditions, and limited observation time. Discontinuous recording processes and disruptions during the rainy season or drought can result in unrepresentative discharge data. Therefore, improving data quality through automated recording systems and routine calibration is crucial for enhancing the accuracy of rainfall–runoff modeling in the future.

Rainfall-Runoff Model Evaluation

Simulations of base flow in the Cisangkuy, Cibeet, and Ciwidey watersheds indicate that the NRECA model provides the most stable results. Simulation results also show that the NRECA model produces better estimates of base flow than the more complex F.J. Mock model.

Table 3. Model evaluation matrix for basic rainfall-runoff in the sub-basins of the

No.	Criteria	Evaluation Variables	xml-ph-0000@deepl.internal Rainfall-baseline flow model evaluation matrix for the		
				FJ Mock	**NRECA**
1	Ease of Use	Number of Parameters		3	9
		Processing Time		3	10
		Accessibility		5	8
2	Minimum Data Requirements	Models Requiring Little Data		7	10
3	Model Analysis Results	Cisangkuy	R^2	1	6
			NSE	0	3
			PBIAS	0	3
		Cibeet	R^2	3	3
			NSE	2	3
			PBIAS	10	3
		Ciwidey	R^2	1	6
			NSE	0	0
			PBIAS	0	10

Source: Comparative analysis based on parameters from KP-01 Irrigation Network Planning standards and model outputs

Of the two models, the NRECA model is most recommended for simulating base flow, considering that in addition to the reliability of the simulation results, this model is also relatively easy to work with, having fewer parameters and assumptions compared to other models.

Table 4. Rainfall-runoff model evaluation matrix Sub-watershed

No	Criteria	Score	
		FJ Mock	**NRECA**
1	Ease of Use	4	9

No	**Criteria**	**Score**	
		FJ Mock	**NRECA**
2	Minimum Data Requirements	7	10
3	Model Analysis Results	2	4

Source: Scoring system developed by authors based on model performance and practicality assessment

CONCLUSION

This study evaluated the performance of two rainfall–runoff models, *F.J. Mock* and *NRECA*, in estimating river discharge across three major watersheds in West Java: Cisangkuy, Cibeet, and Ciwidey. The *NRECA* model consistently outperformed *F.J. Mock* in accuracy, as measured by Nash–Sutcliffe Efficiency (NSE), coefficient of determination (R^2), and Percent Bias (PBIAS), delivering discharge estimates closer to observed data. Additionally, *NRECA*'s simpler data requirements, relying mainly on daily rainfall and basic soil moisture parameters, make it more practical and efficient for watersheds with limited data, whereas *F.J. Mock* demands more extensive climatological and watershed information, making it better suited for long-term analyses in data-rich environments. Therefore, model choice should be aligned with watershed data availability and planning needs. For future research, exploring hybrid models that combine the strengths of both approaches, performing detailed sensitivity analyses, and integrating climate change scenarios would enhance modeling robustness. Policy-wise, improving data quality through automated monitoring, developing standardized model selection guidelines, and building technical capacity in hydrological modeling are essential steps to improve river discharge estimation and bolster adaptive water resource management in Indonesia.

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