



## Analysis Of Rainfall Distribution Using Log-Pearson Type III

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### ABSTRACT

*Rainfall frequency analysis is essential for determining design rainfall and flood discharge in hydraulic structure planning. In this study, annual maximum rainfall data were evaluated using statistical parameters—including the coefficient of variation, skewness coefficient, and kurtosis coefficient—to determine the most suitable probability distribution. The Log-Pearson Type III distribution was selected as it best represented the historical data patterns. Design rainfall values for various return periods were subsequently computed to construct Intensity-Duration-Frequency (IDF) curves. Watershed delineation was performed to identify the physical characteristics of the river basin, allowing the transformation of design rainfall into peak flood discharges. The results demonstrate that longer return periods consistently yield higher rainfall intensities and peak discharges. Ultimately, this study provides critical hydrological parameters required for effective drainage design and regional flood control.*

**Keywords :** Rainfall Frequency Analysis, Log-Pearson III, Design Rainfall, Watershed, Peak Flood Discharge.

### ABSTRAK

*Analisis frekuensi curah hujan sangat penting untuk menentukan curah hujan desain dan debit banjir dalam perencanaan struktur hidraulik. Dalam penelitian ini, data curah hujan maksimum tahunan dievaluasi menggunakan parameter statistik—termasuk koefisien variasi, koefisien kemiringan, dan koefisien kurtosis—untuk menentukan distribusi probabilitas yang paling sesuai. Distribusi Log-Pearson Tipe III dipilih karena paling baik mewakili pola data historis. Nilai curah hujan desain untuk berbagai periode kembalinya kemudian dihitung untuk membuat kurva Intensitas-Durasi-Frekuensi (IDF). Delineasi daerah aliran sungai dilakukan untuk mengidentifikasi karakteristik fisik daerah aliran sungai, sehingga memungkinkan transformasi curah hujan desain menjadi debit banjir puncak. Hasilnya menunjukkan bahwa periode kembalinya yang lebih lama secara konsisten menghasilkan intensitas curah hujan dan debit puncak yang lebih tinggi. Pada akhirnya, penelitian ini memberikan parameter hidrologi penting yang diperlukan untuk desain drainase yang efektif dan pengendalian banjir regional.*

**Kata kunci:** Analisis Frekuensi Curah Hujan, Log-Pearson III, Curah Hujan Desain, Daerah Aliran Sungai, Debit Puncak Banjir

## INTRODUCTION

Rainfall is a hydrological parameter that plays a crucial role in civil engineering planning, particularly in the design of drainage systems, weirs, reservoirs, irrigation canals, and flood control structures [3], [10], [13]. The amount of rainfall directly affects surface runoff, so an understanding of its occurrence patterns is necessary in the design of water infrastructure [5], [14].

Rainfall is unpredictable and varies by time and location. Extreme rainfall events—which occur infrequently but have significant impacts on the hydrological system—require a statistical approach to determine the probability of rainfall of a specific magnitude [15], [8], [2].

In practice, rainfall frequency analysis generally utilizes annual maximum rainfall data obtained from observation stations to represent

extreme events. The results of this analysis are probabilistic in nature; therefore, the concept of return periods is used—a measure indicating the average probability of an extreme rainfall event occurring within a specific time interval, such as 2, 5, 10, 15, 25, 50, 100, 200, and 1000 years [12], [4].

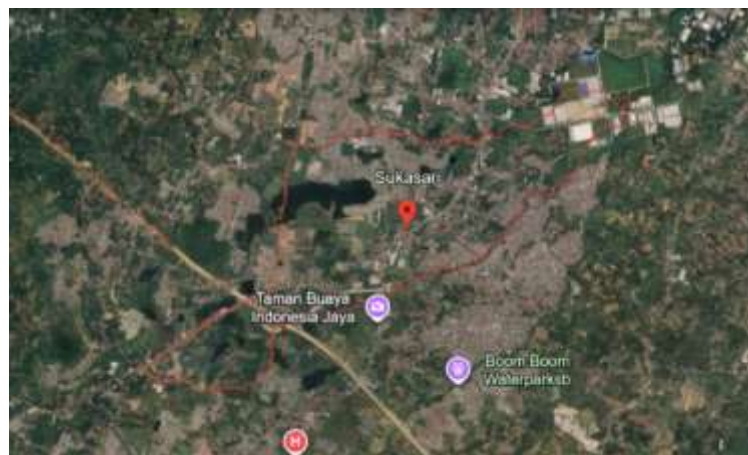
The use of probability distribution methods in rainfall analysis is important because each region has unique rainfall characteristics. An error in method selection can lead to inaccurate design rainfall estimates, which directly impact the safety, reliability, and efficiency of hydrological infrastructure planning and drainage systems [5], [15].

Additionally, rapid regional development and changes in land use heavily increase the risk of surface runoff and flooding. These evolving conditions make precise design rainfall analysis crucial in supporting effective engineering efforts to mitigate hydrological risks [13], [14].

## METHOD

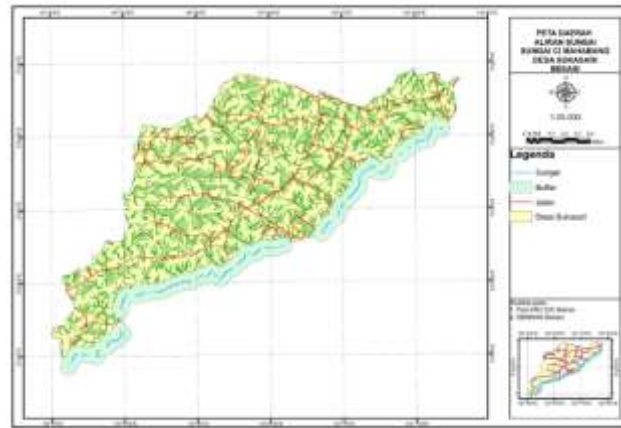
In this application of rainfall frequency analysis, the study area is Sukasari Village, Bekasi Regency, West Java Province, Indonesia. This location was selected due to rapid land-use development in the area, which has increased

vulnerability to flooding and surface runoff driven by extreme rainfall events. These dynamic conditions make the region highly relevant for a statistical hydrology study, specifically in determining design rainfall. Figure 1 displays the administrative location and general conditions of Sukasari Village within Bekasi Regency.



**Figure 1.** Administrative Location of Sukasari Village

From a hydrological perspective, regional analysis relies not only on administrative boundaries but also on natural boundaries such as watersheds (DAS), which directly govern surface runoff processes [10], [7]. The physical characteristics of a watershed—including its total area, land slope, land use, and soil conditions—significantly influence the volume and behavior of runoff resulting from rainfall events [13], [11].



**Figure 2.** Map of the Cimahabang River Watershed, Sukasari Village

An understanding of the spatial conditions of the study area and the characteristics of the watershed makes the results of the rainfall frequency analysis using the Log-Pearson Type III

distribution more contextually relevant, as the design rainfall values obtained can be linked to the potential for runoff and the capacity of both natural and artificial drainage systems in the area ([8], [9] ).

**Table 1.** Requirements for the Pearson Log-Transformation Method III

| Distribution Type    | Pattern                                |
|----------------------|--|
| Normal               | $C_s \approx 0$<br>$C_k = 3$           |
| Gumbel Type I        | $C_s \leq 1,1396$<br>$C_k \leq 5,4002$ |
| Log Pearson Type III | $C_s \neq 0$                           |
| Log Normal           | $C_s = 3C_v + C_v^3$                   |

## RESULTS AND DISCUSSION

### Annual Maximum Rainfall Data

The data used in this study consists of annual maximum rainfall data from the area surrounding Sukasari Village, Bekasi Regency, West Java Province. This data was used as the basis for a

frequency analysis to determine design rainfall for various return periods. The collected data was then sorted from the smallest to the largest values as the initial step in the statistical analysis.

**Table 2.** Data on Annual Maximum Rainfall in Sukasari Village, Bekasi Regency  
**Rainfall Data**

| No | Year | Maximum Rainfall |
|----|------|------------------|
| 1  | 2019 | 61,97            |
| 2  | 2017 | 74,19            |
| 3  | 2018 | 81,97            |
| 4  | 2013 | 111,32           |
| 5  | 2016 | 112,21           |
| 6  | 2015 | 114,94           |
| 7  | 2014 | 119,87           |

**Average**

96,64

**Static Rainfall Data Parameters**

Prior to conducting the probability distribution analysis, statistical parameters of the rainfall data were calculated, including the mean, standard deviation, coefficient of

variation, and skewness coefficient. These parameters were used to determine the characteristics of the data distribution and as a basis for applying the Log-Pearson Type III distribution.

**Table 3.** Static Parameters of Rainfall Data

| No | Parameter                     | Value for Data Xi |
|----|-------------------------------|-------------------|
| 1  | Mean                          | 96.64             |
| 2  | Median                        | 111.32            |
| 3  | Standard Deviation (Sd)       | 23.28             |
| 4  | Coefficient of Variation (Cv) | 0.24              |
| 5  | Skewness Coefficient (Cs)     | -0.56             |
| 6  | Kurtosis Coefficient (Ck)     | 3.57              |

**Log Pearson III Distribution Analysis**

Frequency analysis was performed using the Pearson Type III logarithmic method, after first transforming the rainfall data into logarithmic form. Next, the logarithmic mean, logarithmic standard

deviation, and logarithmic skewness coefficient were calculated to obtain the frequency factor (K) for each return period and to determine the value of c from the statistical distribution calculations, which was then used to estimate the design rainfall amount.

**Table 4.** Frequency Analysis Data with Log-Pearson III

| No             | Year Rank | log Xi   | log Avr     | (log Xi-log Avr) | (log Xi-log Avr) <sup>2</sup> | (log Xi-log Avr) <sup>3</sup> | (log Xi-log Avr) <sup>4</sup> |
|----------------|-----------|----------|-------------|------------------|-------------------------------|-------------------------------|-------------------------------|
| 1              | 2019      | 1,792181 | 1,973138323 | -0,180956827     | 0,032745373                   | -0,005925499                  | 0,001072259                   |
| 2              | 2017      | 1,870345 | 1,973138323 | -0,102792952     | 0,010566391                   | -0,001086151                  | 0,000111649                   |
| 3              | 2018      | 1,913655 | 1,973138323 | -0,059483388     | 0,003538273                   | -0,000210468                  | 1,25194E-05                   |
| 4              | 2013      | 2,046573 | 1,973138323 | 0,073434875      | 0,005392681                   | 0,000396011                   | 2,9081E-05                    |
| 5              | 2016      | 2,050032 | 1,973138323 | 0,076893239      | 0,00591257                    | 0,000454637                   | 3,49585E-05                   |
| 6              | 2015      | 2,060471 | 1,973138323 | 0,08733287       | 0,00762703                    | 0,00066609                    | 5,81716E-05                   |
| 7              | 2014      | 2,078711 | 1,973138323 | 0,105572182      | 0,011145486                   | 0,001176653                   | 0,000124222                   |
| <b>Total</b>   |           | 13,81197 | 13,81196826 | -1,77636E-15     | 0,076927804                   | -0,004528727                  | 0,00144286                    |
| <b>Average</b> |           | 1,973138 | 1,973138323 |                  |                               |                               |                               |

From the data above, we obtained the values for the log standard deviation and the log skewness, as shown in Table 5 below.

**Table 5.** The Values of Sd Log and Cs

|                                 |              |
|---------------------------------|--------------|
| <b>Standar Deviasi (Sd Log)</b> | 0,113231183  |
| <b>Skewness Log (Cs)</b>        | -0,727871574 |

Therefore, the value of K used must be adjusted based on the obtained Cs, which is -0,727871574.

**Table 6.** K Value for Each Renewal Period (Year)

| Skewness Log | Renewal Period (Years) |        |        |        |        |        |        |        |        |
|--------------|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
|              | 2                      | 5      | 10     | 15     | 25     | 50     | 100    | 200    | 1000   |
|              | Probability (%)        |        |        |        |        |        |        |        |        |
| -1,0         | 0.1204                 | 0.8567 | 1.1783 | 1.4769 | 1.6471 | 1.7857 | 1.9013 | 2.1180 | 0.1204 |

### Physical Factors of the Watershed

The characteristics of a watershed are physical factors that influence a region's hydrological response to rainfall; for example, watershed area, main channel length, land slope, land use, and soil conditions all play a role in determining the amount of runoff. Land

use data is also used to determine the runoff coefficient (C). Therefore, the identification of physical factors within the watershed is necessary as a basis for linking the results of design rainfall analysis with runoff potential and the capacity of the drainage system in the study area.

**Table 7.** Roughness Coefficient Value (n)

| Land use  | n    |
|---|------|
| Watertight  | 0,02 |
| Soil deposits   | 0,1  |
| Food crops/open fields with sparse grass on bare ground | 0,2  |
| Grasslands  | 0,4  |
| Rough, bare ground with foliage                         | 0,6  |
| Forests and some shrubbery                              | 0,8  |

| No | Type of Region           | C coefficient |
|----|--------------------------|---------------|
| 1  | Commercial Areas         |               |
|    | - Urban                  | 0,70 – 0,90   |
|    | - Suburban               | 0,50 – 0,70   |
| 2  | Residential Areas        |               |
|    | - Single-family housing  | 0,30 – 0,50   |
|    | - Detached housing       | 0,40 – 0,60   |
|    | - Townhouses             | 0,60 – 0,75   |
|    | - Suburban               | 0,25 – 0,40   |
|    | - Apartment complexes    | 0,50 – 0,70   |
| 3  | Industrial               |               |
|    | - Light industrial areas | 0,50 – 0,80   |
|    | - Heavy industrial areas | 0,60 – 0,90   |
| 4  | Parks, cemeteries        | 0,10 – 0,25   |
| 5  | Playgrounds              | 0,20 – 0,35   |
| 6  | Railway station areas    | 0,20 – 0,45   |
| 7  | Undeveloped areas        | 0,10 – 0,30   |
| 8  | Roads                    | 0,70 – 0,95   |
| 9  | Brick                    |               |
|    | - Roads, pavements       | 0,75 – 0,85   |
|    | - Roofs                  | 0,75 – 0,95   |

**Table 8.** Runoff Coefficient (C)

The value of n used in this study, namely 0.2, is consistent with the land use patterns typical of the Sukasari area.

The C value used in this study—ranging from 0.40 to 0.60—is consistent with the land use patterns typical of the Sukasari area. ArcGIS can then be used to calculate the length, slope, and area of the river.



**Figure 3.** Length of the Cimahabang River

| Buffer |            |         |              |            |          |
|--------|------------|---------|--------------|------------|----------|
|        | OBJECTID * | SHAPE * | SHAPE_Length | SHAPE_Area | Luas ha  |
|        | 1          | Polygon | 0,120737     | 0,000102   | 1,249477 |

**Figure 4.** River Area Values Obtained from ArcGIS

**Design Rainfall and Flood Discharge Estimation**

Based on the results of the Log-Pearson Type III distribution analysis, design rainfall values ( $X_t$ ) were obtained for various return periods. These values indicate the maximum rainfall depth likely to occur once during a

specific time interval. By factoring in the watershed characteristics (Length = 6.6 km, Slope = 3.18 km), these design rainfall values were then utilized to calculate the planned peak flow rate ( $Q$ ). The complete calculation results are presented in Table 9.

**Table 9.** Calculation of Planned Flow Rate

| Calculation of Planned Flow Rate |        |         |         |         |         |         |         |         |          |
|----------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|----------|
| Repetition                       | 2      | 5       | 10      | 15      | 25      | 50      | 100     | 200     | 1000     |
| <b>K</b>                         | 0.1204 | 0.8567  | 1.1783  | 1.4769  | 1.6471  | 1.7857  | 1.9013  | 2.1180  | 0.1204   |
| <b>Log Avr</b>                   | 1.9731 | 1.9731  | 1.9731  | 1.9731  | 1.9731  | 1.9731  | 1.9731  | 1.9731  | 1.9731   |
| <b>Xt</b>                        | 97.000 | 117.529 | 127.808 | 131.167 | 138.156 | 144.425 | 149.739 | 154.321 | 163.291  |
| <b>C</b>                         | 0,5    | 0,5     | 0,5     | 0,5     | 0,5     | 0,5     | 0,5     | 0,5     | 0,5      |
| <b>Xeff</b>                      | 48.500 | 58.764  | 63.904  | 65.584  | 69.078  | 72.212  | 74.870  | 77.160  | 81.645   |
| <b>Tc</b>                        | 0.444  | 0.444   | 0.444   | 0.444   | 0.444   | 0.444   | 0.444   | 0.444   | 0.444    |
| <b>I</b>                         | 109.32 | 132.467 | 144.053 | 147.839 | 155.716 | 162.781 | 168.771 | 173.935 | 184.045  |
| <b>Q</b>                         | 1898.0 | 2299.7  | 2500.9  | 2566.64 | 2703.39 | 2826.05 | 2930.05 | 3019.70 | 3195.228 |

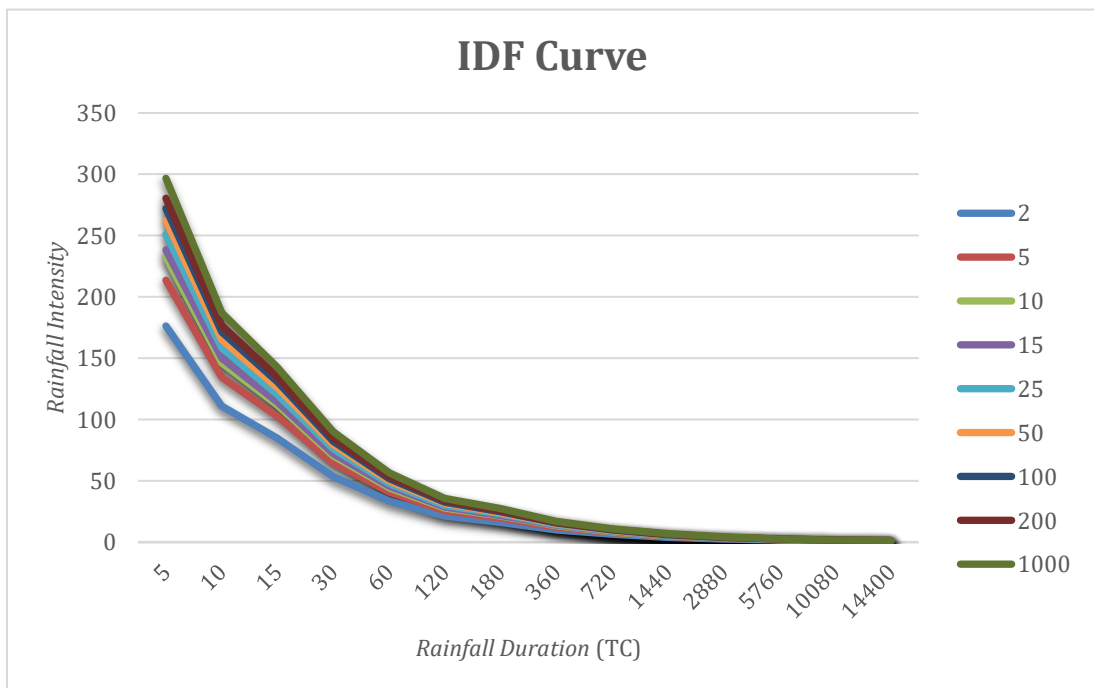
**Rainfall Intensity and IDF Analysis**

To determine the relationship between rainfall intensity, duration, and return period, an Intensity-Duration-Frequency (IDF) analysis was conducted. Rainfall intensity was calculated based on the derived design rainfall

by factoring in the catchment concentration time ( $T_c$ ). The results of this analysis were subsequently used to construct the IDF curves, illustrating the hydrological behavior of the watershed across different durations.

**Table 10.** Calculations for the Construction of an IDF Curve

| Manufacturing of IDF Curves |            |         |         |         |         |         |         |         |         |
|-----------------------------|------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Repetition                  | 2          | 5       | 10      | 15      | 25      | 50      | 100     | 200     | 1000    |
| <b>Xt</b>                   | 97.000     | 117.529 | 127.808 | 131.167 | 138.156 | 144.425 | 149.739 | 154.321 | 163.291 |
| Tc (min)                    | I(mm/hour) |         |         |         |         |         |         |         |         |
| 0                           | 0          | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |
| 5                           | 176,26     | 213,56  | 232,24  | 238,34  | 251,04  | 262,43  | 272,09  | 280,42  | 296,71  |
| 10                          | 111,03     | 134,53  | 146,30  | 150,14  | 158,14  | 165,32  | 171,40  | 176,63  | 186,92  |
| 15                          | 84,737     | 102,67  | 111,65  | 114,58  | 120,69  | 126,16  | 130,80  | 134,81  | 142,64  |
| 30                          | 53,381     | 64,678  | 70,336  | 72,184  | 76,030  | 79,480  | 82,405  | 84,926  | 89,862  |
| 60                          | 33,628     | 40,745  | 44,309  | 45,473  | 47,896  | 50,069  | 51,912  | 53,500  | 56,610  |
| 120                         | 21,184     | 25,668  | 27,913  | 28,646  | 30,173  | 31,542  | 32,702  | 33,703  | 35,662  |
| 180                         | 16,167     | 19,588  | 21,301  | 21,861  | 23,026  | 24,071  | 24,957  | 25,720  | 27,215  |
| 360                         | 10,184     | 12,340  | 13,419  | 13,772  | 14,505  | 15,164  | 15,722  | 16,203  | 17,144  |
| 720                         | 6,416      | 7,774   | 8,453   | 8,676   | 9,138   | 9,552   | 9,904   | 10,207  | 10,800  |
| 1440                        | 4,042      | 4,897   | 5,325   | 5,465   | 5,756   | 6,018   | 6,239   | 6,430   | 6,804   |
| 2880                        | 2,546      | 3,085   | 3,355   | 3,443   | 3,626   | 3,791   | 3,930   | 4,051   | 4,286   |
| 5760                        | 1,604      | 1,943   | 2,113   | 2,169   | 2,284   | 2,388   | 2,476   | 2,552   | 2,700   |
| 10080                       | 1,104      | 1,338   | 1,455   | 1,494   | 1,573   | 1,644   | 1,705   | 1,757   | 1,859   |
| 14400                       | 0,871      | 1,055   | 1,147   | 1,177   | 1,240   | 1,296   | 1,344   | 1,385   | 1,466   |



**Figure 5.** Calculations for the Construction of an IDF Curve

## CONCLUSION

Based on the results of the rainfall frequency analysis using annual maximum rainfall data, it can be concluded that the historical data analyzed is capable of describing the characteristics of extreme rainfall in the study area. The calculated statistical parameters, including the mean, standard deviation, coefficient of variation (Cv), skewness coefficient (Cs), and kurtosis coefficient (Ck), indicate that the Log Pearson Type III distribution is the most appropriate method for representing the distribution of the rainfall data [8], [12], [15].

The analysis results show that an increase in the return period is directly proportional to an increase in the design rainfall amount. This condition reflects that rainfall events with lower probabilities have the potential for greater intensity and directly influence an increase in the design flood discharge. The design rainfall obtained is

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subsequently used in the Intensity–Duration–Frequency (IDF) analysis to determine the relationship between rainfall intensity, duration, and return period.

The physical characteristics of a watershed, such as catchment area, land slope, and land use, also influence the region's hydrological response to rainfall. Therefore, integrating the results of rainfall frequency analysis with the physical conditions of the watershed yields hydrological parameters that can serve as a basis for planning drainage systems and flood control structures.

Overall, this study demonstrates that the Log Pearson Type III method is effective for analyzing extreme rainfall in hydrological planning because it aligns with the characteristics of rainfall data and can generate design rainfall values for various return periods.

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## REFERENCES

- [1] Agustriyanto, D., Zakaria, A., & Khotimah, S. N. (2021). Performance method of maximum daily rainfall frequency analysis using correlation. *Jurnal Rekayasa Sipil dan Desain*, 8(1), 147–156. <https://doi.org/10.23960/jrsdd.v8i1.1277>
- [2] Anghel, C.-G., & Ianculescu, D. (2025). An in-depth statistical analysis of the Pearson Type III distribution behavior in modeling extreme and rare events. *Water*, 17(10), 1-15. <https://doi.org/10.3390/w17101539>
- [3] Basuki, I., Winarsih, I., & Adhyani, N. L. (2009). Analisis periode ulang hujan maksimum dengan berbagai metode. *Agromet*, 23(2), 76–92. <https://doi.org/10.29244/j.agromet.23.2.76-92>
- [4] Bobée, B., & Robitaille, R. (1987). The generalized method of moments as applied to problems of flood frequency analysis: Some practical results for the log-Pearson type 3 distribution. *Journal of Hydrology*, 90(3–4), 199–217. [https://doi.org/10.1016/0022-1694\(87\)90067-9](https://doi.org/10.1016/0022-1694(87)90067-9)
- [5] Budiman, F. A., Putra, S. S. U., & Fadhil, M. (2025). Analisis curah hujan rencana dengan menggunakan distribusi Gumbel dan Log Pearson III untuk wilayah Kota Padang Panjang. *Jurnal Teknik SILITEK*, 5(1), 67–70. <https://doi.org/10.51135/zqj6zt17>
- [6] Departemen Pekerjaan Umum Republik Indonesia. (2010). *Pedoman Analisis Frekuensi dan Hujan Rencana*. Jakarta: Direktorat Jenderal Sumber Daya Air.

- [7] Linsley, R. K., Franzini, J. B., Freyberg, D. L., & Tchobanoglous, G. (1992). *Water-Resources Engineering* (5th ed.). New York: McGraw-Hill.
- [8] Phien, H. N. (1984). Applications of the log Pearson type-3 distribution in hydrology. *Journal of Hydrology*, 73(3-4), 359-372. [https://doi.org/10.1016/0022-1694\(84\)90008-8](https://doi.org/10.1016/0022-1694(84)90008-8)
- [9] Singh, A. K., & Chavan, S. R. (2026). LH-moment framework for regional flood frequency analysis based on Log-Pearson Type III distribution. *Hydrological Sciences Journal*. <https://doi.org/10.1080/02626667.2025.2604258>
- [10] Singh, V. P. (1992). *Elementary Hydrology*. New Delhi: Prentice Hall of India.
- [11] Soemarto. (1999). *Hidrologi Teknik*. Jakarta: Erlangga.
- [12] Srikanthan, R., & McMahon, R. A. (1981). Log Pearson III distribution — Is it applicable to flood frequency analysis of Australian streams?. *Journal of Hydrology*, 52(1-2), 139-147. [https://doi.org/10.1016/0022-1694\(81\)90100-1](https://doi.org/10.1016/0022-1694(81)90100-1)
- [13] Subramanya, K. (2013). *Engineering Hydrology* (4th ed.). New Delhi: McGraw-Hill Education.
- [14] Suripin. (2004). *Sistem Drainase Perkotaan yang Berkelanjutan*. Yogyakarta: Andi.
- [15] Yong, S. L. S., Ng, J. L., Huang, Y. F., & Ang, C. K. (2021). Assessment of the best probability distribution method in rainfall frequency analysis for a tropical region. *Malaysian Journal of Civil Engineering*, 33(1), 55-64. <https://doi.org/10.11113/mjce.v33.16253>