JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Volume 5 No. 2 February 2026
P-ISSN: 2828-8726
E-ISSN: 2828-9307

Soka River Flood Modelling Using HEC – RAS (Case Study of Kedungsana Village)

Gusti Suryana Putra, Vier Andrean, Putri Karina Febiani, dan Sulistijo Edhy Purnomo
Universitas Swadaya Gunung Jati, Cirebon, Indonesia
Email: gusti19juli@gmail.com, vierandrean@gmail.com, putrikarina20022002@gmail.com, sulistiyobbwscc@gmail.com

ABSTRACT
Cirebon Regency is experiencing rapid development, which has led to significant changes in land use. Improperly managed land-use changes have resulted in a reduction of water catchment areas, decreasing the soil's capacity to absorb rainfall and increasing the potential for flooding. Along with the expansion of residential areas and the growing intensity of human activities, river management problems—such as flooding and erosion—have become more frequent. Therefore, an effective river management system is needed to minimize these negative impacts. The purpose of this study is to evaluate the flood potential of the Soka River in Kedungsana Village, Cirebon Regency, using HEC-RAS hydraulic modeling. This analysis was conducted using annual maximum rainfall data from several rain stations, discharge calculations, and flood plan simulations based on the Nakayasu method and HEC-RAS modeling. The results show that parts of the Soka River's cross-section are unable to accommodate flow discharge during the planned flood recurrence period, which may lead to overflow. It is hoped that this research will serve as the basis for recommendations to mitigate flooding in the study area.
Keywords: Flood, HEC – RAS, Sungai Soka. Flood Discharge, Rainfall

INTRODUCTION

Indonesia is a country rich in water resources, including rivers that play an important role in people's lives (Angriani et al., 2018; Kardono, 2018; Pambudi & Kusumanto, 2023; Pawitan, 2018; Umami et al., 2022). Rivers not only serve as sources of clean water but also function as transportation routes, recreation areas, and ecosystems that support biodiversity (Alan Yeakley et al., 2016; Khosrovyan, 2024; Lynch et al., 2023). However, along with the development of settlements and human activities, problems related to river management, such as flooding and erosion, have become increasingly common. Therefore, effective river management is needed to minimize these negative impacts (Pashmchi et al., 2022; Wood, 2024).

A river is defined as a natural or artificial water flow consisting of a network of water bodies and its flow, starting from the upper reaches and ending at the mouth, with boundaries on its right and left banks (PP No. 38 of 2011). Another definition states that water flowing from its source on land to the sea, a lake, or a larger river is called a river (Mount, 2023; Schmidt et al., 2023). Rivers have destructive power, yet they also hold potential. One of the factors causing flood damage is the use of land in floodplain areas that is inconsistent with spatial designation.

The Soka River is one of the rivers located in Kedungsana Village, Cirebon Regency, West Java Province, which often experiences flooding, especially during the rainy season (Rivaldy et al., 2025; Satriyono et al., 2025). The floods not only disrupt the daily activities of the surrounding community but also cause damage to infrastructure and property. One factor influencing flooding is the river's cross-sectional capacity. When a river cross-section cannot accommodate the inflow, the water overflows into surrounding areas (Hu et al., 2023; Sumitro et al., 2025).

River overflows frequently occur in Cirebon Regency due to water runoff exceeding the drainage capacity. Many factors can influence this overflow, including both physical and social conditions. Overflow occurs when the volume of flowing water exceeds the soil's absorption rate and rainfall intensity. Flooding is one of the most frequent hydrometeorological disasters in Indonesia. In Cirebon Regency, the main triggers of flooding include the gentle slope of the riverbed toward the downstream area, sediment deposition at the river mouth that blocks water flow to the sea, and erosion combined with uncontrolled sediment movement. Floods often inundate agricultural and residential areas.

The Soka River, located in Kedungsana Village, Cirebon Regency, frequently overflows due to high rainfall and the river's limited cross-sectional capacity. Therefore, hydrological analysis and hydraulic modeling are needed to determine flood potential and mitigation strategies. A model is a way to simulate or form a representation of real-world conditions. Modeling helps identify problems and implement solutions on a manageable scale before field application (Siregar and Indrawan, 2017). One-dimensional modeling considers only one direction—the flow along the main channel—while two-dimensional modeling involves two directions: the main flow and its surrounding area.

The purpose of this study is to develop a flood inundation model for the Soka River, which can later serve as an additional reference for development planning in the area. Hydrological analysis was conducted to obtain flood discharge with a recurrence period of 25 years using the Nakayasu Synthetic Unit Hydrograph. Hydraulic modeling for current conditions was performed using HEC-RAS two-dimensional flow analysis through unsteady flow simulation. Meanwhile, flood control planning was based on a 25-year recurrence period discharge, implemented through embankment construction and river normalization using the channel modification feature in RAS-Mapper.

METHOD

In this study, a quantitative approach was applied, which is a research method that involves numbers and statistics to collect, analyze, and interpret data in a structured manner. The analysis includes hydrological analysis, where hydrology is a branch of science that examines the characteristics and movement of water on the Earth's surface. This includes analyzing average rainfall, calculating basic statistical parameters, conducting randomness tests, analyzing rainfall recurrence periods, and calculating rainfall discharge.

The data sources used in this study consist of primary and secondary data. Primary data were obtained through direct surveys or field observations for identification and documentation purposes. This primary data includes location survey results in the form of photographic documentation from various site points aimed at understanding the condition of the Soka River. Meanwhile, secondary data were obtained from other individuals or documents. The secondary data collected for this study include information from related agencies and literature sources such as rainfall data, topographic maps, and location maps.

A research framework was also developed to make the research flow easier to understand. This framework represents a sequence of systematically arranged activities that describe the research process from the initial stage through to the provision of technical recommendations.

The method applied in this study is quantitative, with a focus on hydrological and hydraulic analyses. The data used include annual maximum rainfall data from the Cangkring, Karang Asem, and Klangen Stations, as well as river geometry data. Rainfall analysis was conducted using frequency analysis, while planned flood discharge was calculated using the Nakayasu method. Flood flow and overflow modeling were performed using HEC-RAS software.

The study area selected is the Soka River, located in Kedungsana Village, Plumbon District, Cirebon Regency, West Java, at coordinates (-6.680484, -108.486347).

Figure 1. Location of Soka River
Source: Google Maps. (2025).

RESULTS AND DISCUSSION

1. Rainfall Calculation

Table 1. Combined Rainfall

Tahun	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des	Rata-rata
2010	66,3	68,7	41,3	75,7	75,3	47,3	53,0	49,3	32,7	43,0	29,7	81,7	206
2011	25,7	41,7	50,0	72,3	29,7	41,3	14,0	0,0	0,0	14,0	37,3	137,7	190
2012	53,0	78,3	67,3	17,0	19,0	5,0	0,0	0,0	0,0	25,7	18,7	64,0	182
2013	73,7	56,0	55,7	58,0	46,0	45,7	60,0	2,7	0,0	25,0	52,3	72,0	197
2014	66,0	39,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	163
2015	73,3	39,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	71,0	169
2016	91,3	105,3	57,7	35,3	31,3	38,3	43,7	35,3	34,3	94,0	51,7	86,0	209
2017	96,0	106,0	52,0	45,0	56,0	38,3	43,7	35,3	34,3	94,0	51,7	0,0	205
2018	38,0	92,0	104,3	0,0	0,0	9,0	0,0	0,0	0,0	0,0	22,3	57,0	180
2019	67,7	85,7	58,3	66,7	46,7	0,0	0,0	0,0	0,0	4,3	6,7	14,0	182
2020	95,0	112,3	98,3	66,3	57,3	34,7	27,3	4,3	11,7	45,0	46,7	90,7	208
2021	140,0	100,7	67,3	28,7	35,3	35,3	3,7	14,7	27,0	29,0	60,0	103,3	205
2022	78,3	37,0	61,7	82,7	65,3	57,7	61,0	0,0	8,7	101,3	44,7	96,7	209

Sumber: BMKG Stasiun Curah Hujan

2. Thiessen Polygon Average Rainfall

The Thiessen *Polygon method* takes into account the special distribution factors of the rain stations and the extent of the influence of each station on the study area. This method is more accurate and realistic in calculating average rainfall for regions that are not homogeneous in terms of rainfall distribution and observation station location. The formula is as follows:

$$d = \frac{A1.d1 + A2.d2 + A3.d3 + \cdots An.dn}{A} = \frac{\Sigma Ai.di}{A} + \cdots 1$$

Description:
A = Area (km2)
d = Average rainfall height of the area
$d1, d2, d3, \ldots\ dn$ = High rainfall in posts 1, 2, 3, ... n.
$A1, A2, A3, \ldots An$ = Area of influence of posts 1, 2, 3, ... n.

Table 2. Thiessen Polygon Method Average Rainfall Table

Tahun	Cangkring (mm)	Luas Thiessen Cangkring (Ha)	Karang Asem (mm)	Luas Thiessen Karang Asem (Ha)	Klangenan (mm)	Luas Thiessen Klangenan (Ha)	Rerata (mm)
2010	83	3192	70	926	100	9446	94,0
2011	91		55		160		136,6
2012	78		85		87		84,7
2013	72		64		124		107,7
2014	68		60		70		68,8
2015	68		60		92		84,2
2016	120		108		137		131,0
2017	130		100		137		132,8
2018	87		91		135		120,7
2019	93		95		98		96,6

Tahun	Cangkring (mm)	Luas Thiessen Cangkring (Ha)	Karang Asem (mm)	Luas Thiessen Karang Asem (Ha)	Klangenan (mm)	Luas Thiessen Klangenan (Ha)	Rerata (mm)
2020	115		114		135		128,9
2021	160		148		141		146,0
2022	95		105		167		145,8

Based on the table, it shows that each rainfall at the three stations varies from year to year. This reflects climate fluctuations and weather conditions. The highest rainfall occurred in 2021 with 146 mm while the lowest was 68.8 mm which occurred in 2014.

3. Frequency Analysis

Table 3. Sagittic Parameters

No	Tahun	Xi	Xi – Xr	(Xi – Xr)²	(Xi – Xr)³	(Xi – Xr)⁴
1	2010	93,95	-19,72	389,01	-7.672,69	151.331,75
2	2011	136,60	22,92	525,31	12.040,00	275.953,14
3	2012	84,75	-28,93	836,91	-24.211,20	700.414,58
4	2013	107,67	-6,01	36,09	-216,85	1.302,82
5	2014	68,85	-44,83	2.009,58	-90.086,23	4.038.417,79
6	2015	84,17	-29,51	870,68	-25.691,61	758.091,54
7	2016	131,02	17,35	300,86	5.218,39	90.513,92
8	2017	132,83	19,15	366,81	7.025,30	134.550,99
9	2018	120,70	7,03	49,36	346,82	2.436,67
10	2019	96,62	-17,06	290,91	-4.961,89	84.630,95
11	2020	128,86	15,19	230,59	3.501,65	53.173,65
12	2021	145,95	32,27	1.041,67	33.619,58	1.085.066,55
13	2022	145,83	32,15	1.033,58	33.228,98	1.068.290,31
Jumlah		**1477,78**	**0,00**	**7.981,38**	**-57.859,76**	**8.444.174,67**
Rata-rata (Xr)				**113,68**		

Table 4. Statistical Dispersion

No	Data	Nilai
1	Xr	113,676
2	Sx	25,790
3	Cs	-0,332
4	Cv	0,227
5	Ck	-1,295

Table 5. Parameters and Similarities

Parameter	Persamaan
Rata-rata	$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$
Deviasi Standar	$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{(n-1)}}$
Koefisien Variasi	$C_v = \frac{S}{\bar{X}}$
Koefisien Skewness	$C_s = \frac{n\sum_{i=1}^{n}(X_i - \bar{X})^3}{(n-1)(n-2)S^3}$
Koefisien Kurtosis	$C_k = \frac{n^2\sum_{i=1}^{n}(X_i - \bar{X})^4}{(n-1)(n-2)(n-3)S^4}$

Table 6. Determination of Distribution

No	Metode	Syarat	Hasil Perhitungan	Kesimpulan
1	Normal	Cs ≈ 0	-0,332	Tidak Memenuhi
		Ck = 3	-1,295	Tidak Memenuhi
2	Log Normal	Cs = 3	-0,332	Tidak Memenuhi
		3Cv + Cv² = 3	0,157	Tidak Memenuhi
		Ck = 5,383	-0,791	Tidak Memenuhi
3	Gumbel	Cs ≤ 1,1396	-0,332	Memenuhi
		Ck ≤ 5,4002	-1,295	Memenuhi
4	Log Pearson III	Cs ≠ 0	-0,610	Memenuhi

Table 7. Results of Determination of Gumbel Dispersion

No	Data	Nilai
1	Xr	113,676
2	Yn	0,5070
3	Sn	0,9971
4	Sx	25,790
5	Cs	-0,332
6	Cv	0,227
7	Ck	-1,295

Next, calculate the value of K from the results of determining the values of Yt, Yn and Sn by entering the formula as follows:

$$K = \frac{Yt - Yn}{Sn}$$

Description:
K = Frequency Factor
Yt = *Reduced Variated*
Yn = *Reduce Mean*
Sn = *Reduce Standard Deviation*

Then determine the annual plan rain period, for example, 2 years, 4 years, 6 years, 8 years and 10 years. Calculate the annual average rainfall plan with the following formula:

$$X_T = Xr + (K.Sx)$$

Description:
X_T = Planned rainfall with a period of T years
Xr = Average maximum rainfall
K = Frequency factor
Sx = Standard Deviation

Table 7. Gumbel Output Results

Kala Ulang (Tahun)	X rata-rata	Yn	Yt	K	Xi
2			0,367	-0,141	110,042
5			1,500	0,996	139,358
10			2,250	1,748	**158,768**

Kala Ulang (Tahun)	X rata-rata	Yn	Yt	K	Xi
20	113,676	0,5070	2,970	2,470	177,386
25			3,199	2,699	183,292
50			3,902	3,405	201,485
100			4,600	4,105	219,544

Table 8. Logarithmic Statistical Dispersion

No	Data	Nilai	
1	Log Xr	2,044	
2	Sx Log x	0,105	
3	Cs	**-0,610**	
4	Cv	0,052	2,22465
5	Ck	-0,791	167,744

Table 9. Repeat Time

Koef. G	Kala Ulang						
	2	**5**	**10**	**20**	**25**	**50**	**100**
	Presentase Ulang Terlampaui (%)						
	50%	**20%**	**10%**	**5%**	**4%**	**2%**	**1%**
-0,5	0,083	0,856	1,216	1,450	1,567	1,777	1,955
-0,610	**0,101**	**0,857**	**1,198**	**1,415**	**1,524**	**1,714**	**1,872**
-0,6	0,099	0,857	1,200	1,419	1,528	1,720	1,880

Table 10. Pearson Type III Log Output

Kala Ulang (Tahun)	X rata-rata	Log Xr	Gt	S Log X	Log Xt	Xt
2			0,101		2,055	113,502
5			0,857		2,135	136,378
10			1,198		**2,171**	**148,154**
20	113,676	2,044	1,415		2,194	156,170
25			1,524		2,205	160,339
50			1,714		2,225	167,913
100			1,872		2,242	174,483

Table 11. Rain Intensity Mononobe Method

Kala Ulang (Tahun)	Tinggi Hujan (mm)
2	110,04
5	139,36
10	**158,77**
20	177,39
25	183,29
50	201,49
100	219,54

The formula used is as follows:

$$I = \frac{T}{t^n}$$

Where:

I = Rainfall intensity (mm/h)

R = Total rainfall over a given period of time (mm)

t = Duration of rain (hours)

n = Exponential factors, usually ranging from 0.6 to 0.8, depending on local geographical and climatological conditions. In general, the n-value used in the Mononobe method is 2/3 (0.67).

Table 12. Hydrograph ABM

Distribusi Hujan Rencana Jam-Jaman Priode Ulang 10 Tahun (Gumbel)							
Durasi t (jam)	**Δt (jam)**	**I (mm/jam)**	**I × t (mm)**	**Δp (mm)**	**Δp (%)**	**X25 (mm)**	**Δp Hidrograf (mm)**
						Δp (%) Hidrograf	
1	0–1	55,042	55,042	55,042	55,03	6,75	10,710
2	1–2	34,674	69,348	14,306	14,30	10,03	15,931
3	2–3	26,461	79,384	10,036	10,03	55,03	87,373
4	3–4	21,843	87,373	7,989	7,99	14,30	22,710
5	4–5	18,824	94,120	6,747	6,75	7,99	12,682
6	5–6	16,670	100,017	5,897	5,90	5,90	9,362
Jumlah				**100,00**	**100%**	**100%**	**158,768**

Table 13. Hydrograph Chart 10 Year Period Plan

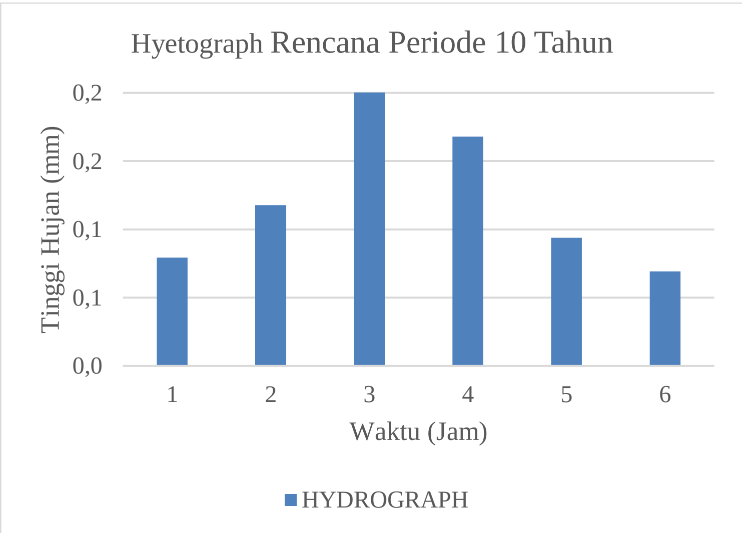


Table 14. Nakayasu Parameters

Parameter		
Luas DAS (A)	135,63874	km²
Panjang Sungai (L)	15,75	km
Ro	1	mm

Table 15. Concentration Time Value

Keterangan	Nilai		Satuan	
Tg	1,31		Jam	Waktu Konsentrasi
α	**1,50**		–	
α	1,5		–	
α	2,43		–	
Tr	0,657	0,657 – 1,31	Jam	
T0,3	**1,970**		Jam	**20% hujan**
Tp	1,839		Jam	
0,5 × T0,3	0,985		Jam	
1,5 × T0,3	2,955		Jam	
2 × T0,3	3,941		Jam	
2,5 × T0,3	4,926		Jam	
(Tp + T0,3)	3,809		Jam	
(Tp + T0,3 + 1,5 T0,3)	6,765		Jam	
Qp	14,940		m³/s	Debit Puncak

Formula:

Peak time: Tp = tg + 0.8 tr

With:

L < 15 km tg = 0.21 L0.7

L > 15 km tg = 0.4 + 0.058 L

L = Length of the main river (km)

Tg = Concentration Time (hours)

T0.3 = α tg (hours)

α = 2 for a normal watershed

= 1.5 for slow rising hydrographs

= 3 for fast rising hydrographs

Figure 1. Hydrograph Discharge Plan

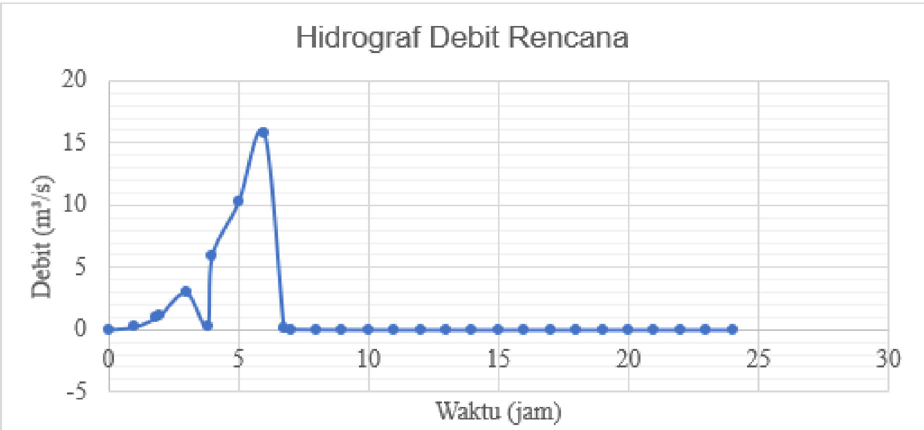


Table 16. Calculation Results of the 25-Year Renewal Period

Waktu	**Debit**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**Q (Debit Banjir Rencana)**
(t)	**(m³/detik)**	**(10,710)**	**(15,931)**	**(87,373)**	**(22,710)**	**(12,682)**	**(9,362)**	
0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
1	0,215	2,297	0,000	0,000	0,000	0,000	0,000	2,512
2	1,132	12,126	3,417	0,000	0,000	0,000	0,000	16,676
3	2,996	32,088	18,038	18,743	0,000	0,000	0,000	71,865
4	5,976	64,002	47,730	98,929	4,872	0,000	0,000	221,509
5	10,209	109,340	95,203	261,783	25,714	2,721	0,000	504,969
6	15,814	169,361	162,642	522,148	68,043	14,360	2,008	954,376
7	0,040	0,423	251,923	892,027	135,717	37,998	10,600	1.328,728
8	**0,021**	**0,230**	**0,629**	**1.381,697**	**231,857**	**75,791**	**28,049**	**1.718,274**
9	0,012	0,125	0,342	3,452	359,132	129,479	55,945	548,487
10	0,006	0,068	0,185	1,874	0,897	200,555	95,576	299,162
11	0,003	0,037	0,101	1,017	0,487	0,501	148,041	150,187
12	0,002	0,020	0,055	0,552	0,264	0,272	0,370	1,535
13	0,001	0,011	0,030	0,300	0,143	0,148	0,201	0,833

Waktu (t)	**Debit (m³/detik)**	**R1 (10,710)**	**R2 (15,931)**	**R3 (87,373)**	**R4 (22,710)**	**R5 (12,682)**	**R6 (9,362)**	**Q (Debit Banjir Rencana)**
14	0,001	0,006	0,016	0,163	0,078	0,080	0,109	0,452
16	0,000	0,003	0,009	0,088	0,042	0,043	0,059	0,245
17	0,000	0,002	0,005	0,048	0,023	0,024	0,032	0,133
18	0,000	0,001	0,003	0,026	0,012	0,013	0,017	0,072
19	0,000	0,001	0,001	0,014	0,007	0,007	0,009	0,039
20	0,000	0,000	0,001	0,008	0,004	0,004	0,005	0,021
21	0,000	0,000	0,000	0,004	0,002	0,002	0,003	0,012
22	0,000	0,000	0,000	0,002	0,001	0,001	0,002	0,006
23	0,000	0,000	0,000	0,001	0,001	0,001	0,001	0,003
24	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,002

Figure 2. HSS Discharge Plan

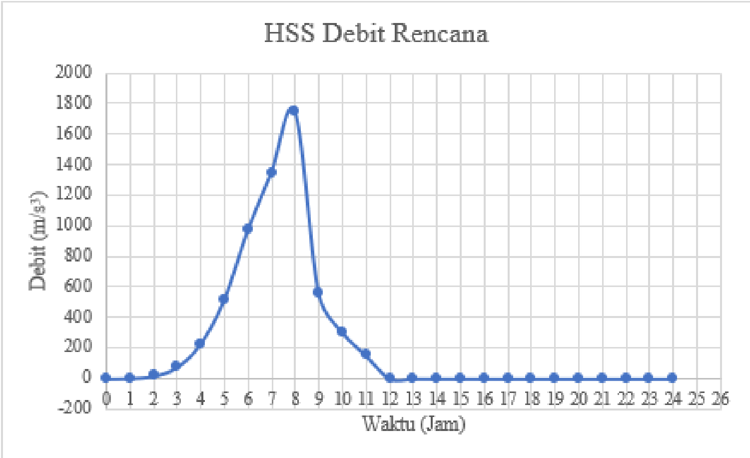


Figure 3. Flood Simulation Modeling with HEC – RAS 2D

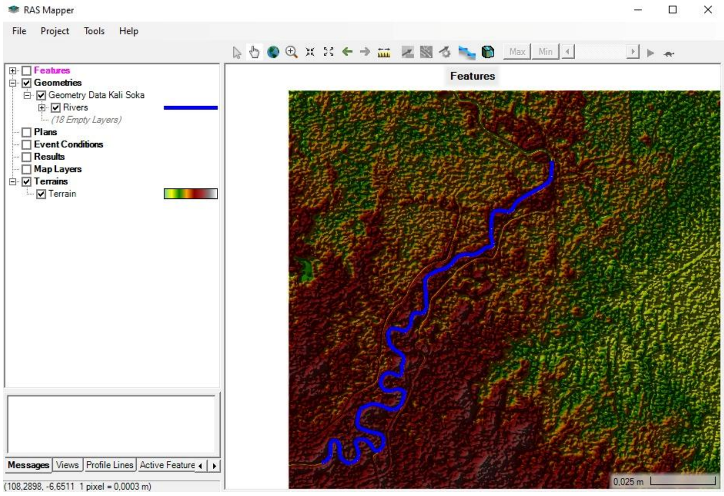


Figure 4. Flood Simulation Modeling with HEC – RAS 2D

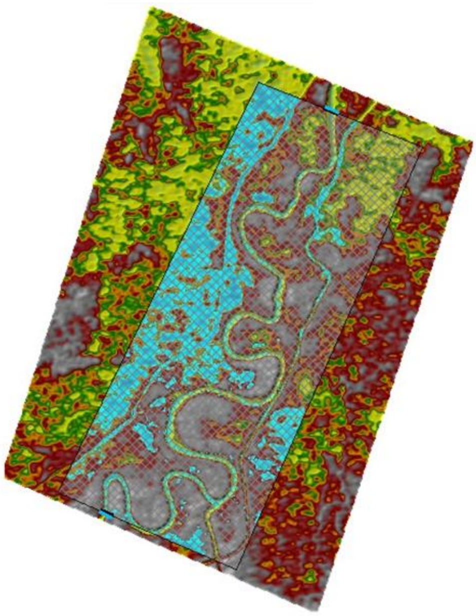


Figure 5. Water Surface Elevation

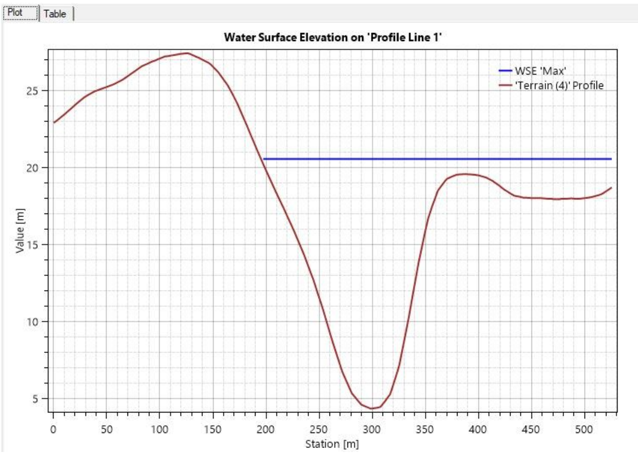
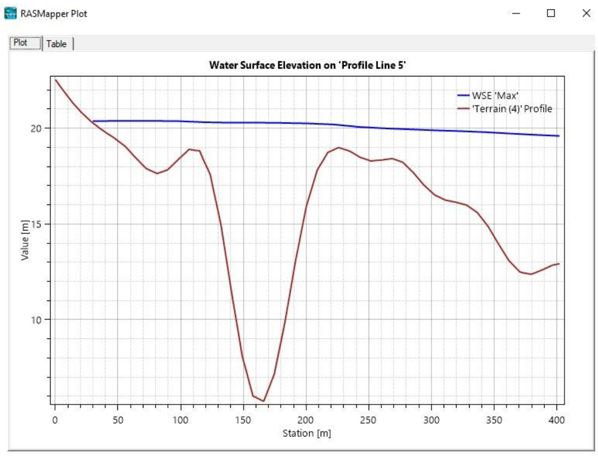


Figure 6. Water Surface Elevation



The results of the analysis show that the amount of planned flood discharge increases along with the increase in the re-release period. The HEC-RAS simulation shows that there is an overflow in several segments of the Soka River due to insufficient cross-sectional capacity. This condition causes inundation in the area around the river, especially during the large re-enactment period.

CONCLUSION

Based on the rainfall analysis carried out, annual rainfall in the Kedungsana Village area shows significant variation from year to year. The highest rainfall was recorded in 2021, with an average annual value of 1,460 mm, while the lowest was 688 mm in 2014. This indicates that the area has the potential to experience flooding, especially during the rainy season with high rainfall intensity.

From the discharge calculation results using the frequency distribution method, the planned discharge for the Soka River is 1,718.274 m³/second. This discharge reflects a substantial potential water flow that must be anticipated in flood mitigation planning.

Based on the results of the analysis and modeling, the Soka River has the potential to overflow during certain planned discharges. HEC-RAS modeling proved effective in identifying flood-prone areas. Mitigation efforts such as river normalization or increasing cross-sectional capacity are necessary to reduce the risk of flooding.

REFERENCES

Alan Yeakley, J., Ervin, D., Chang, H., Granek, E. F., Dujon, V., Shandas, V., & Brown, D. (2016). Ecosystem services of streams and rivers. *River Science: Research and Management for the 21st Century*, 335–352.

Angriani, P., Ruja, I. N., & Bachri, S. (2018). River management: The importance of the roles of the public sector and community in river preservation in Banjarmasin (A case study of the Kuin River, Banjarmasin, South Kalimantan–Indonesia). *Sustainable Cities and Society*, *43*, 11–20.

Hu, J., Shen, H., Zhang, J., Meng, Z., Zhang, Y., & Han, W. (2023). Influence of multi-cross structures on the flood discharge capacity of Mountain Rivers in the Yellow River Basin. *Water*, *15*(15), 2719.

Kardono, K. (2018). Condition of water resource in Indonesia and its environmental technology. *Jurnal Air Indonesia*, *3*(2), 245430.

Khosrovyan, A. (2024). Biodiversity and ecosystem services in rivers. In *Water* (Vol. 16, Issue 15, p. 2091). Multidisciplinary Digital Publishing Institute.

Lynch, A. J., Cooke, S. J., Arthington, A. H., Baigun, C., Bossenbroek, L., Dickens, C., Harrison, I., Kimirei, I., Langhans, S. D., & Murchie, K. J. (2023). People need freshwater biodiversity. *Wiley Interdisciplinary Reviews: Water*, *10*(3), e1633.

Mount, J. F. (2023). *California rivers and streams: the conflict between fluvial process and land use*. Univ of California Press.

Pambudi, A. S., & Kusumanto, T. (2023). Water resources governance in Indonesia towards environmental sustainability along with social and economic development. In *Environmental Governance in Indonesia* (pp. 289–311). Springer.

Pashmchi, P., Taheriyoun, M., & Asghari, K. (2022). Integrated river water quality and quantity management based on undesirability and cost-effectiveness. *River Research and Applications*, *38*(10), 1843–1859.

Pawitan, H. (2018). Climate change impacts on availability and vulnerability of Indonesia water resources. *IOP Conference Series: Earth and Environmental Science*, *200*(1), 12003.

Rivaldy, M., Sutisna, S., Puto, R. A. P., Kurniadi, A., Kusuma, K., & Wilopo, W. (2025). The Role of Pentahelix in Flood Disaster Risk Reduction in Cirebon City to Achieve Regional Security. *MOVE: Journal of Community Service and Engagement*, *5*(1), 1–14.

Satriyono, R. D. A. P., Setiawan, E., Chasanah, Y. N., & Astuti, S. P. (2025). Building Resilient Agricultural Communities through Sustainable Farming in the Flood-Prone Bengawan Solo Delta. *IOP Conference Series: Earth and Environmental Science*, *1556*(1), 12091.

Schmidt, J. C., Yackulic, C. B., & Kuhn, E. (2023). The Colorado River water crisis: Its origin and the future. *Wiley Interdisciplinary Reviews: Water*, *10*(6), e1672.

Sumitro, R. H., Dewi, C. T., & Abi Rafdi, M. (2025). Assessment of Urban Heritage Potential and Flood Resilience in the Colonial Tourism Area of Cirebon City: A Case Study of Lemahwungkuk Subdistrict. *Journal of World Science*, *4*(9), 1249–1265.

Umami, A., Sukmana, H., Wikurendra, E. A., & Paulik, E. (2022). A review on water management issues: potential and challenges in Indonesia. *Sustainable Water Resources Management*, *8*(3), 63.

Wood, T. R. (2024). River management. In *British Rivers* (pp. 170–195). Routledge.