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# Analysis of the Effect of the use of Sudetan Pipe Tunnels on the Water Level of the Ciliwung River and Cipinang River, East Jakarta

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## ABSTRACT

Ciliwung River is one of the 13 major rivers in Jakarta that causes flooding, especially in the East Jakarta area. In an effort to reduce flooding along the Ciliwung River in the DKI Jakarta area, efforts were made to divert part of the Ciliwung River flow during floods to the East Flood Canal channel through the construction of a double pipe tunnel commonly called a sudetan in the Bidara Cina Village area, where the tunnel also passes through the Cipinang River as a diversion of discharge from the Cilwung River. The purpose of this study is to determine the effect of the sudetan pipe tunnel on the water level of Ciliwung River and Cipinang River. In this study, we will model the water level of Ciliwung River and Cipinang River to see the diversion of discharge into the sudetan pipe tunnel to reduce the overflow of water around Ciliwung River and Cipinang River. The method of this research is done by quantitative descriptive method to the value of water level in Ciliwung River and Cipinang River before the sudetan tunnel and after the sudetan tunnel and looking for comparison by using rating curve. The results of this study are based on the modeling analysis of the maximum flood discharge that can be accommodated by the ciliwung river before the existence of the sewer pipe tunnel in Q1 of 323 m3 / s there is an increase after the sewer pipe tunnel which is 539 m3 / s. It can be seen that the use of a sewer pipe tunnel can reduce the flood water level by 4 meters. It can be seen that the use of tunnel pipes can reduce the elevation of flood water up to 4 meters. Obtained for the ciliwung discharge of the return period Q1=323 $m^3$/det Q2=377.66 $m^3$/det Q5=433 $m^3$/det Q10=462.45 Q25=493.52 $m^3$/det Q50=518.83 $m^3$/det Q100=539.62 $m^3$/det.

**Keywords:** Ciliwung; flooding; Cipinang; tunnel; sudetan.

## INTRODUCTION

Flooding is a natural event that cannot be prevented but can be controlled. Floods that occur in Jakarta are no longer extraordinary for the people of Jakarta. DKI Jakarta Province has complex disaster problems. With an area of 661.52 km2, 40% or 24,000 hectares is lowland with an average elevation below sea level. DKI Jakarta is also a confluence of rivers from the South with high slope and rainfall. There are 13 rivers that pass through and drain into Jakarta Bay (BPBD DKI Jakarta, 2013). High rainfall, small water storage capacity and the conversion of river boundaries have resulted in adverse impacts on river ecosystems. The Ciliwung River has its headwaters in Bogor Regency and empties into Pluit, Jakarta. The Ciliwung River with the source of Gunung Parangro spring has a length of 109 km and a watershed area of 387 km2, passing through Bogor Regency, Bogor City, Depok, Condet, Manggarai, Gunung Sahari, Pantai Indah Kapuk and empties into the north coast of DKI Jakarta, experiencing overflowing floodwaters. (Vissy, 2023)

The province of D.K.I. Jakarta is divided into 5 parts. In the northern part of Jakarta, there is a beach which is the estuary for 13 rivers and 2 canals. The Ciliwung River is the main river that affects life in the city of Jakarta. The Ciliwung River flows into the BKT. In the area of MT. Haryono - Manggarai Sluice Gate, which is located downstream of the Ciliwung River, is one of the areas that routinely experiences flood disasters, one of which is caused by the overflow of the Ciliwung River. Whereas in this area there are floodgates that function to control water discharge. Floods that occur inundate roads and residential areas. This affects the lives of the surrounding community (Syafullah Fattah et al., 2023). In an effort to reduce the occurrence of flooding along the Ciliwung River in the

DKI Jakarta area, efforts were made to divert part of the Ciliwung River flow at during flooding to the East Flood Canal channel through the construction of a double pipe tunnel commonly called a sudetan in the Bidara Cina Village area. The construction of a sudetan or double pipe tunnel of the Ciliwung River to the East Flood Canal will reduce the peak flood load by diverting part of the Ciliwung River flood discharge of 60m3 /second to the East Flood Canal (KBT) through the Cipinang River. (PT.Indah Karya, 2013). The construction of this sudetan was initially built starting from the KBT towards the Cipinang River and stopped until Jl. Otista towards the ciliwung river in 2013 (PT.Indah Karya, 2013). This is in line with research conducted by (Nakamura and Oosawa, 2021) which explains that the development of underground facilities such as tunnels will be effective and economical to overcome flooding in urban areas. The advantages of using tunnels for flood mitigation in Tokyo have two advantages, namely related to the cost aspect and the land acquisition aspect. It is certain that this type of underground infrastructure has significant advantages in both aspects. The advantages of underground water diversion systems prove to be an ideal solution for flooding due to excessive rainfall due to their excellent sound insulation, seismic, fire resistance, and such flood management methods also offer the possibility of water reuse after proper treatment (Shaji, 2020).

One of the critical features of a good river path is sufficient width and depth to accommodate varying volumes of water, particularly during the rainy season when discharge increases. This requires continuous assessment and, when necessary, dredging or reshaping to prevent sediment buildup that could narrow the channel. The riverbanks should be stabilized using natural materials such as vegetation, bioengineering techniques, or permeable structures that absorb water while holding the soil in place. This approach helps to prevent collapse and erosion while encouraging natural filtration and biodiversity (Ashari RJ & Heryansyah A, 2021; Barid B & Okta AB, 2022).

In addition to channel design, integrating floodplains and retention basins along the river’s course is vital. These areas temporarily store excess water during peak flow events, releasing it slowly back into the river once the flood risk subsides. Such features reduce the pressure on the main channel and protect downstream areas from sudden surges. Green infrastructure like wetlands and vegetated swales along the river path can also help manage stormwater, filter pollutants, and enhance overall resilience to extreme weather (Immamuddin M & Priyo AWD, 2023; Arif EJ et.al, 2024).

Urban rivers should be buffered from development by establishing set-back zones where construction is limited or prohibited. This creates space for the river to shift naturally and reduces the risk of property damage during floods. In dense cities, where space is limited, elevated walkways, green corridors, or multifunctional public spaces can serve dual purposes—allowing rivers to flow freely while providing recreational and aesthetic benefits to the community (Lutfi M et.al, 2023; Adi HP et.al, 2023).

Another essential component of a good river path is an effective drainage network that directs runoff from streets and buildings into the river system without causing pollution or overwhelming capacity. This system must be regularly maintained to remove debris, sediments, and other obstructions that could cause water to back up. Community engagement and regular monitoring are also vital in maintaining river health. When local residents understand the importance of keeping river paths clear and free from waste, they are more likely to participate in conservation efforts and report issues before they escalate (Barid B & Okta AB, 2022).

## RESEARCH METHODS

### Data Analysis

1. Research Design

This research uses an experimental quantitative approach with the hydrological simulation method to analyze the effect of the use of the sudetan pipe tunnel on the water level in the Ciliwung River and Cipinang River, East Jakarta. This research design aims to predict the water level changes that occur after the sudetan tunnel is operated using historical hydrological data and river flow modeling software.

2. Research Location

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The research location is the flow area of Ciliwung River and Cipinang River in East Jakarta. The focus of this research is on the area where the sudetan pipe tunnel will transfer some of the water discharge from Ciliwung River to Cipinang River, especially during the rainy season when the water discharge is high.

3. Data Used

Water discharge data of Ciliwung River and Cipinang River: Discharge data for the last 5 years of the Ciliwung-Cisadane River Basin Center (BBWS). Rainfall Data: Rainfall data from BMKG (Badan Meteorologi, Klimatologi, dan Geofisika) during the same period. Topography and River Profile Data: Detailed data on the topography of the area, cross-sectional profiles of the rivers, as well as data on the sewer tunnels. Flood Data: Historical flood data, including time, water level, and affected area, to analyze the impact of flooding around Ciliwung River and Cipinang River before and after the tunnel. Hydrological Modeling: Using hydrological simulation software, such as HEC-RAS (Hydrologic Engineering Center's River Analysis System) to model the water flow in Ciliwung River and Cipinang River. Water discharge and rainfall data will be used as inputs in this simulation model. Simulation of Before and After Conditions: Two simulation scenarios were conducted: Condition before the use of the sudetan tunnel: The simulation is conducted based on discharge data and river water level before the sudetan tunnel operates. Conditions after the use of the sudetan tunnel: The simulation was conducted by integrating the parameters of the sewer tunnel, including pipe dimensions and flow capacity.

4. Data Analysis

The simulation data will be analyzed quantitatively using descriptive and inferential statistical methods. This research will evaluate the reduction of water levels in both rivers and measure how much influence the sudetan tunnel has on flood control.

5. Model Validation

To ensure the accuracy of the simulation model used, validation is carried out with historical flood data recorded. Simulation results will be compared with field observation data to test the suitability of the model in predicting changes in water levels. Figure 1 shows the research location, and Figure 2 shows the flowchart of this research.


**Figure 1.** Research location

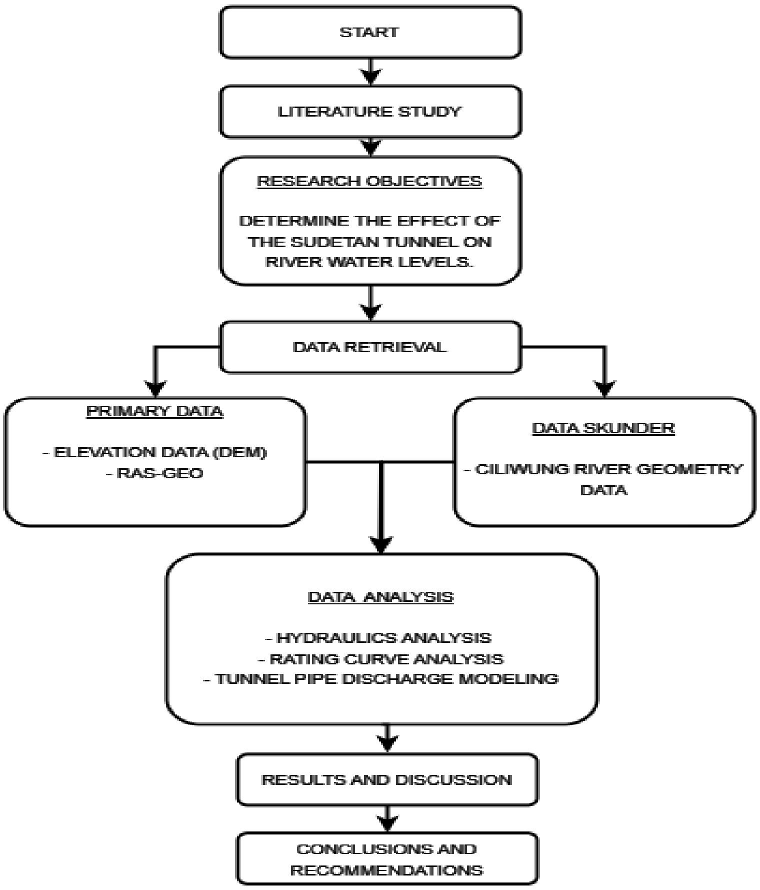


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**Figure 2.** Research flowchart

## RESULTS AND DISCUSSION

Modeling is done by creating the geometry of Ciliwung River in HEC-RAS 6.3 which includes river reach, cross section, and long section.

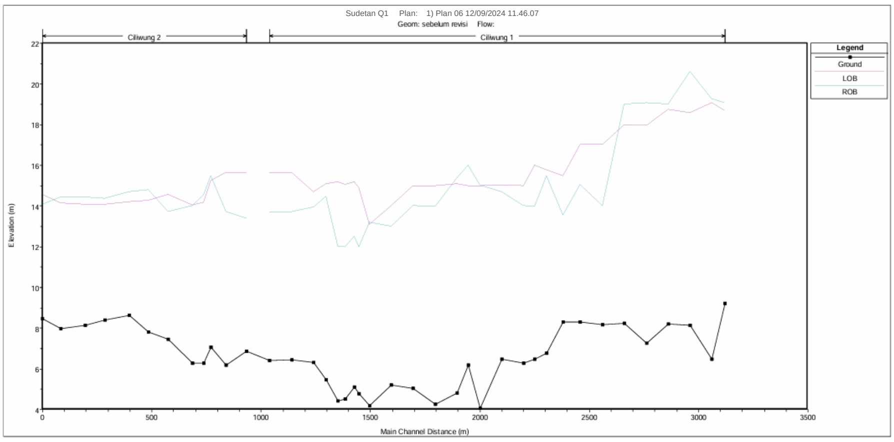


**Figure 3**. Longitudinal section of the ciliwung river before the sudetan tunnel

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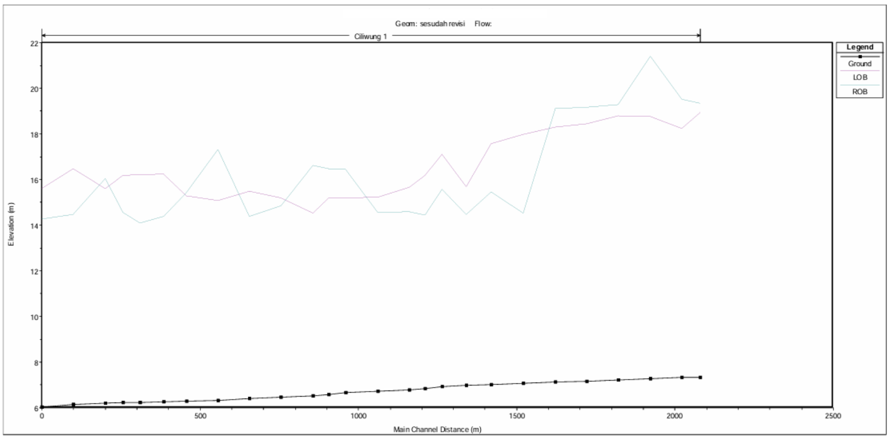


**Figure 4.** Longitudinal section of the ciliwung river after the sudetan tunnel

In the two pictures above is the appearance of the ciliwung river before and after the existence of the sudetan pipe tunnel, it can be seen a change in distance where the flow or discharge of water has been divided into sudetan.


**Figure 4.** The ciliwung river after the sudetan tunnel

Selanjutnya yaitu permodelan geometri sudetan hinggan cipinang dengan menyatukan kedua sungai dan sudetan menggunakan *junction* sehingga dapat dilihat pada tampilan *long section* sudetan seperti gambar dibawah menggunakan *inline structure* dengan penampang memanjang.

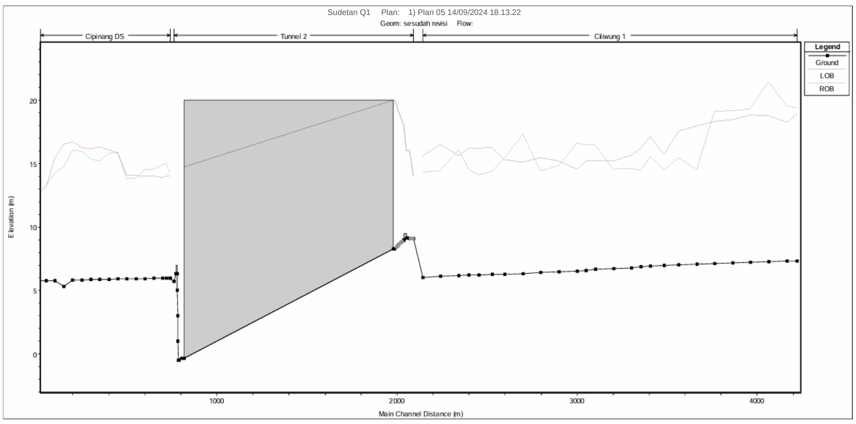


**Figure 5.** The ciliwung river after the sudetan tunnel

## Hydraulics Analysis Results

From the modeling results of the ciliwung river before the sudetan pipe tunnel, the flood results were obtained with a planned flood discharge at Q1 of 323 m3 / s. Bank full conditions at cross section 224 in the ciliwung river with a water level of 14.21 m. Bank full conditions on cross section 224 in the ciliwung river with a water level of 14.21 m. While in the conditions after the tunnel pipe sudetan, ciliwung river experiencing full bank conditions at cross section 225 with a water level of 12.96 m can be seen in the cross-sectional image of ciliwung river after the tunnel sudetan.

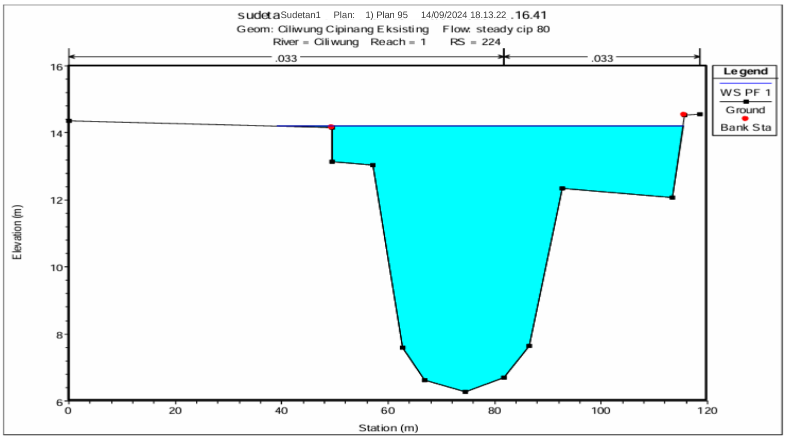


**Figure 6**. Condition of Ciliwung River when the bank is fully discharged 323 $m^3/s$

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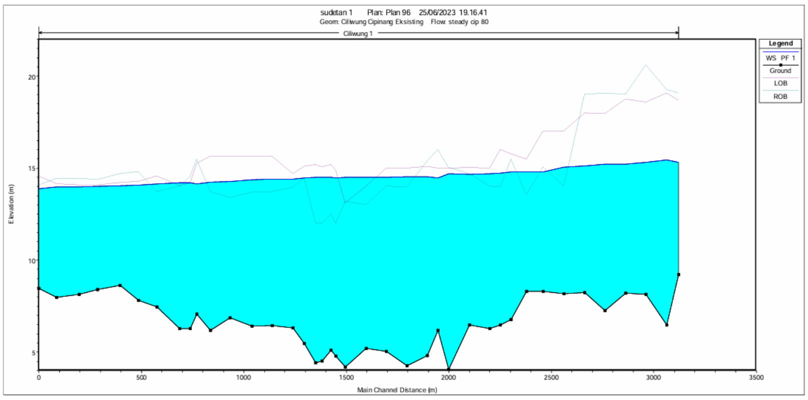


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**Figure 7.** Longitudinal cross-section before the tunneling of the pipeline

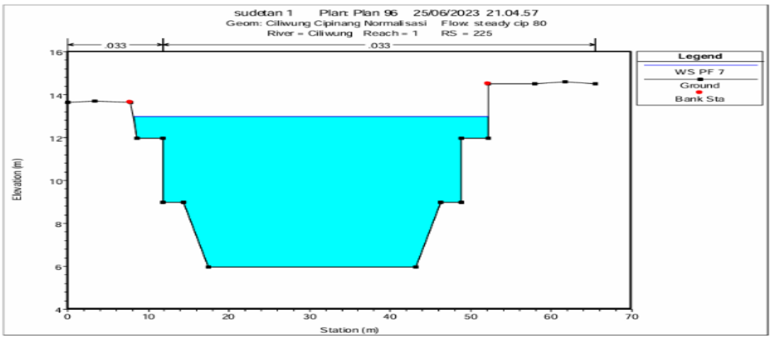


**Figure 8.** Cross Section of ciliwung river before the tunnel pipe sudetan

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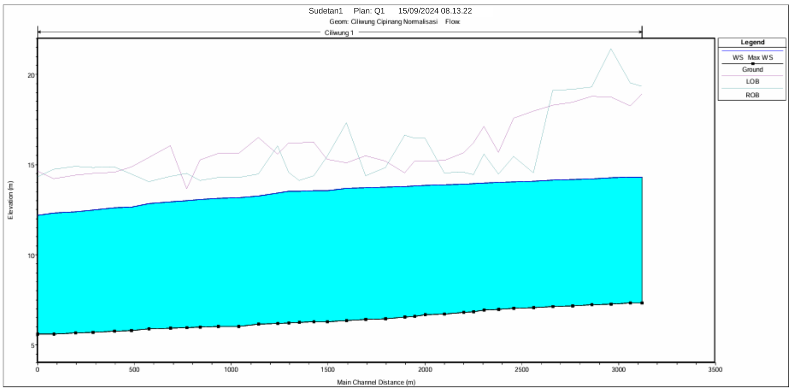


**Figure 9.** Cross Section of ciliwung river before the tunnel pipe sudetan

**Rating Curve Analysis Results**

The rating curve itself is a graph between the water level and flood discharge at a certain river cross section. The calculation of the rating curve uses the logarithmic method. With flood discharge data obtained from processing rainfall data and water level data obtained from HEC-RAS running results. After running the ciliwung river with 2 conditions, namely before and after normalization, the rating curve calculation is carried out. So that the equation $Q$ = 17.387($H$ -7.34)1.76 is obtained before normalization and $Q$ = 0.889($H$ - 9.21)2.837 after normalization.

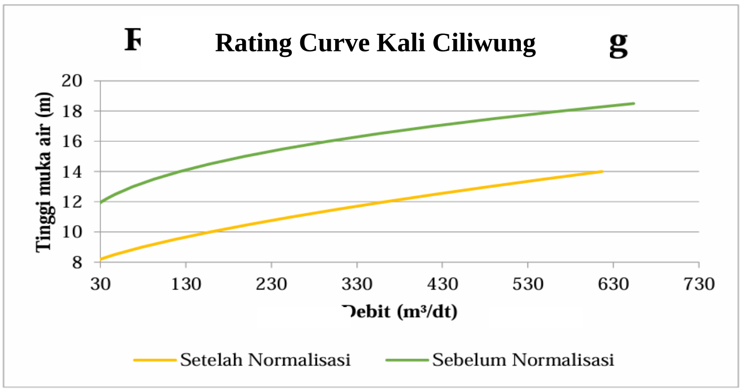


**Figure 10.** Rating Curve of Ciliwung River

It can be seen that the existence of a sudetan pipe tunnel that drains the Ciliwung River water discharge can reduce the flood water level by up to 4 meters. The capacity of the river before that is Q1 of 323 m3 / s, has increased until it can accommodate the Q100 plan flood discharge of up to 539 m3 / s. In Cipinang River, it can be seen that the results of the rating curve after the existence of the sewer pipe tunnel can be seen that the Sta 0 cross section does not experience flooding after the water level is 10.77 m.

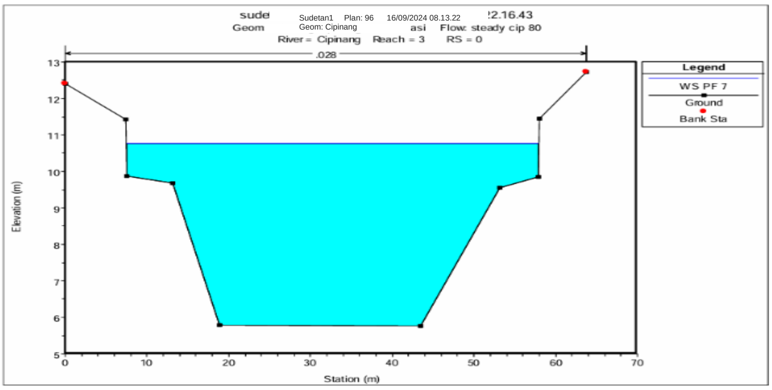


**Figure 11.** Cross Section of Cipinang River After the tunnel pipe sudetan

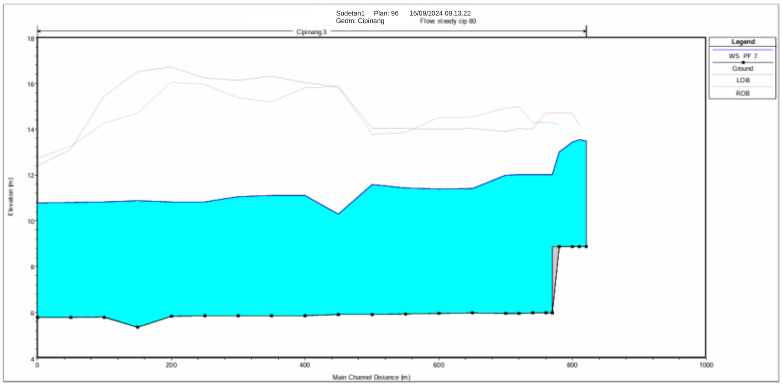


**Figure 12.** Long Section of Cipinang River After the tunnel pipe sudetan

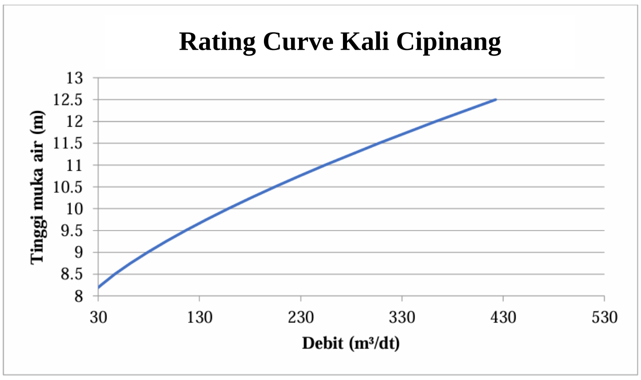


**Figure 13.** Rating Curve of Cipinang River After the existence of the sudetan pipe tunnel

In the rating curve graph, the equation $Q = 9.996(H - 5.97)1.945$ is obtained based on the recap results of the two rivers, the water level elevation is obtained at the time of the planned flood discharge at the location of inlet and outlet so that it can be recapitulated according to table 1 Water Level Elevation Based on the Plan Debit

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**Table 1.** Water Level Elevation Based on the Discharge of the Plan Flood

| Repeat Time (Year) | Ciliwung Discharge (m3/det) | Elevation | Cipinang Discharge (m3/det) | Elevation |
|---|---|---|---|---|
| 1 | 323 | + 5.37 | 124.7 | + 3.66 |
| 2 | 377.66 | + 5.77 | 165.42 | + 4.17 |
| 5 | 433.2 | + 6.15 | 196.06 | + 4.62 |
| 10 | 462.45 | + 6.35 | 215.7 | + 4.97 |
| 25 | 493.52 | + 6.55 | 247.13 | + 5.27 |
| 50 | 518.83 | + 6.71 | 271.08 | + 5.50 |
| 100 | 539.62 | + 6.85 | 323.01 | + 5.81 |

### Results of Analysis of Tunnel Discharge Modeling of Sudetan Pipe

Discharge modeling of the tunnel pipe sudetan using Qmax = 100th to see the discharge flowed into the tunnel pipe sudetan with a return period of Q1-Q100.

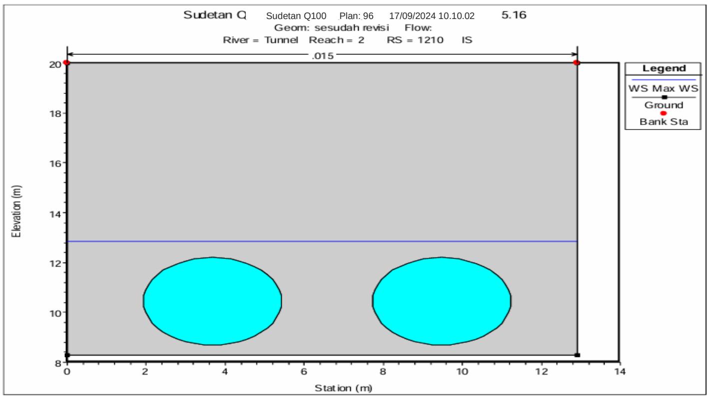


**Figure 14.** Tunnel cross section using inline structure

| Repeat Time (Year) | Ciliwung Discharge (m3/det) | Cipinang Discharge (m3/det) | Sudetan Discharge (m3/det) | Reduced Percentage (%) |
|---|---|---|---|---|
| 1 | 323 | 124.7 | 34.85 | 10.79% |
| 2 | 377.66 | 165.42 | 45.91 | 12.16% |
| 5 | 433.2 | 196.06 | 47.42 | 10.95% |
| 10 | 462.45 | 215.7 | 49 | 10.60% |
| 25 | 493.52 | 247.13 | 49.72 | 10.07% |
| 50 | 518.83 | 271.08 | 51.77 | 9.98% |
| 100 | 539.62 | 323.01 | 52.45 | 9.72% |

**Figure 2.** Recap of the Flow Discharge Entering the Sudetan

Based on the table above, it can be seen that the amount of discharge entering the sudetan is increasing according to the return period, which is 34.85 ($m3\ /det$) to 52.45 ($m3\ /det$) these conditions can be known as the percentage of flood discharge reduced in the Ciliwung River.

## CONCLUSION

The conclusions of this study are based on the modeling analysis of the maximum flood discharge that can be accommodated by the ciliwung river before the tunnel pipe in Q1 of 323 m3 / s, there is an increase after the tunnel pipe is 539 m3 / s. It can be seen that the use of tunnel pipes can reduce the flood water level by 4 meters. It can be seen that the use of tunnel pipes can reduce the elevation of flood water up to 4 meters. Obtained for the ciliwung discharge of the return period Q1 = 323 m3 / d Q2 = 377.66 m3/d Q5 = 433 m3 / d Q10 = 462.45 Q25 = 493.52 m3 / d Q50 = 518.83 m3 / d Q100 = 539.62 m3/d.

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## REFERENCES

Anastasya Lidya. (2022). Studi Alternatif Pengendalian Banjir Sungai Welang dengan Pendekatan Pemodelan Banjir Aliran 2D. 13(2), 245–257. https://doi.org/10.21776/ub.pengairan.2022.013.02.10

Brunner, G. W. (2024). HEC-RAS HEC-RAS Hydraulic Engineering Center. U.S. Army Corps of Engineers, 6.5(May), 1–477. https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest/introduction

Indrawan, I., & Siregar, R. I. (2018). Pemodelan Penerapan Terowongan Air (Tunnel) dalam Mengatasi Banjir Akibat Luapan Sungai Deli. Jurnal Teknik Sipil, 25(2), 113. https://doi.org/10.5614/jts.2018.25.2.4

Leon, A. S., & Goodell, C. (2016). Controlling HEC-RAS using MATLAB. Environmental Modelling and Software, 84(October 2016), 339–348. https://doi.org/10.1016/j.envsoft.2016.06.026

Restu Wigati. (2016). Analisis Banjir Menggunakan Software Hec - Ras 4.1.0 Jurusan Teknik Sipil Universitas Sultan Ageng Tirtayasa |. 5(2), 51–61.

Shaji. (2020). *SISTEM PENGALIHAN AIR BAWAH TANAH SEBAGAI PENANGGULANGAN BANJIR METODE ; TINJAUAN*. 3605–3614.

Syafullah Fattah, R., Irwan, A., & Yunus, I. (2023). Analisis Debit Banjir Dan Tinggi Muka Air Sungai Cipondoh Di Kota Tangerang. *Inter Tech*, *1*(2), 51–62. https://doi.org/10.54732/i.v1i2.1064

Vissy. (2023). *Permodelan reduksi banjir sungai ciliwung akibat adanya sudetan*.

Zamroni, F., Sholichin, M., & H., A. P. (2015). Analisa Pengendalian Banjir Kali Ciliwung Ruas Jembatan MT. Haryono – Pintu Air Manggarai. Jurnal Teknik Pengairan, 6(1), 1–13.

Utama, I. W. W., & Wirawibawa, I. B. G. (2023). Natural Resource Potential on Tukad Unda River as Sustainable Tourism in Paksebali Village, Klungkung. ASTONJADRO, 12(2), 480–487. https://doi.org/10.32832/astonjadro.v12i2.8961

Ashari, R. J., & Heryansyah, A. (2021). ANALYSIS AND EVALUATION OF THE DRAINAGE NETWORK SYSTEM IN THE HOUSING AREA OF VILA RIZKI ILHAMI 2 SAWANGAN, DEPOK-WEST JAVA. ASTONJADRO, 11(1), 1–12. https://doi.org/10.32832/astonjadro.v11i1.2904

Barid, B., & Okta Afanda, B. (2022). Increasing Peak Flow of Snyder Synthetic Hydrograph Units in the Serenan Sub-Watershed of Bengawan Solo Watershed. ASTONJADRO, 11(3), 616–626. https://doi.org/10.32832/astonjadro.v11i3.7456

Imammuddin, M., & Priyo Andi Wicaksono, D. (2023). Ciliwung River Normalization Analysis using HEC-RAS Application (TB. Simatupang Bridge to Bidara Cina). ASTONJADRO, 12(1), 86–100. https://doi.org/10.32832/astonjadro.v12i1.7796

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Arif, E. J., Sinaga, L., Kristiyanto, K., Barri, A., & Ator, W. T. (2024). Modeling the Implications Green Retrofitting River Conservation was Validated using (SEM) Analysis . ASTONJADRO, 13(3), 858–869. https://doi.org/10.32832/astonjadro.v13i3.15922

Lutfi, M., Chayati, N., Rulhendri, R., Taqwa, F. M. L., & Ramadan, F. R. (2023). Analysis of Cantilever Retaining Wall as Landslide Mitigation on a Tributary of Cisadane River Bogor City. ASTONJADRO, 12(3), 687–697. https://doi.org/10.32832/astonjadro.v12i3.7013

Adi, H. P., Wahyudi, S. I., & Wahyudi, R. S. (2023). Selection of Alternative Locations for Rubber Weirs to Fulfill Clean Water needs in Rembang Regency. ASTONJADRO, 12(3), 709–716. https://doi.org/10.32832/astonjadro.v12i3.8523

Barid, B., & Okta Afanda, B. (2022). Increasing Peak Flow of Snyder Synthetic Hydrograph Units in the Serenan Sub-Watershed of Bengawan Solo Watershed. ASTONJADRO, 11(3), 616–626. https://doi.org/10.32832/astonjadro.v11i3.7456