ISSN 2810-0182 (Online)
ACITYA WISESA: Journal of Multidisciplinary Research
https://journal.jfpublisher.com/index.php/jmr
Vol. 5, Issue 1 (2026)
doi.org/10.56943/jmr.v5i1.927

Analysis of Water Demand and Availability in the Prumpung Watershed, Tuban

Rony Zakariya[1]*, Andi Patriadi[2], Esti Wulandari[3]
[1]ahmadronyzakariya17@gmail.com, [2]andipatriadi@untag-sby.ac.id,
[3]wulandariesti@untag-sby.ac.id
Universitas 17 agustus 1945 surabaya

*Corresponding Author: Rony Zakariya
E-mail: ahmadronyzakariya17@gmail.com

ABSTRACT

Water constitutes a vital natural resource supporting human life, agricultural activities, and regional development. Limited water availability coupled with continuously increasing water demand due to population growth and agricultural activities necessitates data-based water resource planning and management. This research aimed to analyze water demand and water availability in the Prumpung Watershed, Tuban Regency, for the 2025-2029 projection period. The research employed a descriptive quantitative approach utilizing population, land use, and rainfall data. Domestic water demand was calculated based on per capita consumption standards and population projections, while non-domestic water demand was calculated from rice field irrigation requirements based on land area and cropping intensity. Water availability was calculated based on surface runoff volume obtained from annual rainfall, runoff coefficient, and watershed area. The analysis results indicate that domestic water demand increases from 2,389,812 m^3 in 2025 to 2,491,776 m^3 in 2029. Non-domestic water demand increases from 91,034,789.98 m^3 to 92,943,134.36 m^3, bringing total water demand from 93,424,602.32 m^3 to 95,434,910.78 m^3. Meanwhile, average annual water availability amounts to 84,586,033.31 m^3. The comparison between water demand and water availability demonstrates that water demand exceeds water availability throughout all projection years. Therefore, efforts to improve water use efficiency, particularly in the irrigation sector, and catchment area conservation are required to maintain water resource sustainability in the Prumpung Watershed.

Keywords: *Irrigation, Projection, Runoff, Water Availability, Water Demand*

INTRODUCTION

Water constitutes a vital natural resource that underpins the sustainability of domestic activities, agricultural production, and economic development within a region (Shaibu et al., 2023). The demand for water continues to escalate in parallel with population growth and the advancement of economic and social sectors (Nahib et al., 2022). Water availability is influenced by the dynamics of land use patterns and climate change factors that can affect the capacity of a region to store and supply water sustainably, thereby rendering its management increasingly complex (Nahib et al., 2022).

Watersheds represent critical hydrological units in water resource analysis. Land use changes in watersheds frequently result in increased surface runoff and reduced infiltration, which leads to diminished water availability during dry seasons and deteriorates the water balance in those regions (Araswati et al., 2021). For instance, research conducted in the Citarum River Basin demonstrated that land use changes have resulted in decreased water supply while demand has increased progressively year by year (Nahib et al., 2022).

In numerous regions across Indonesia, water requirements for domestic and agricultural purposes tend to increase in conjunction with population growth and substantial irrigation water needs, thus necessitating more comprehensive and sustainable water planning and management (Farida et al., 2019; Telaumbanua et al., 2023). In the agricultural sector, water serves as a determining factor for productivity as the majority of required water is utilized for irrigation, while the imbalance between water supply and demand can threaten national food security (Farida et al., 2019).

Extreme climate phenomena such as prolonged dry seasons and unpredictable rainfall intensity also influence the variability of water supply in many regions, thereby increasing challenges in developing effective water resource management strategies. Consequently, research on water demand and water availability projections is essential as a basis for decision-making in long-term water resource management and to assist local governments in developing mitigation strategies for potential water shortages and future climate pressures (Naim et al., 2025).

Extreme climate phenomena such as prolonged dry seasons and unpredictable rainfall intensity also influence the variability of water supply in many regions, thereby increasing challenges in developing effective water resource management strategies. Consequently, research on water demand and water availability projections is essential as a basis for decision-making in long-term water resource management and to assist local governments in developing mitigation strategies for potential water shortages and future climate pressures (Naim et al., 2025).

Recent investigations have demonstrated the significance of comprehensive water balance assessments at the watershed scale, particularly in regions experiencing rapid land use transformation. Studies conducted in various watersheds globally have revealed that the integration of hydrological modeling with land use analysis provides critical insights into water supply-demand dynamics. Research by Luo et al. (2025) in the Jinghe River Basin, China, utilizing the InVEST model and scenario analysis for the period 2000-2020, found that water supply exhibited an initial decline followed by an increase trend, whereas water demand demonstrated an opposite pattern. Their findings indicated that water supply in vegetation restoration areas decreased by 47.4 million cubic meters, yet water demand decreased by 89 million cubic meters, suggesting that vegetation restoration contributed to mitigating basin water scarcity by reducing overall water demand. Similarly, investigations in agricultural watersheds have emphasized the critical role of irrigation practices in influencing streamflow dynamics, with recent studies noting that accurate representation of irrigation withdrawals in watershed models is essential for simulating low-flow periods and understanding water balance in agricultural regions (Brochet et al., 2024).

In the Indonesian context, several watershed studies have documented significant transformations in water availability resulting from land use changes. Nahib et al. (2022) examined the Citarum Watershed in West Java from 2000 to 2020, revealing that water supply decreased by 18.28 percent between 2000-2010 and by 15.27 percent between 2010-2020, while water demand increased by 23 percent and 47 percent in the respective periods. The research demonstrated that land use and land cover changes, particularly the expansion of bare land and agricultural areas coupled with forest decline, significantly affected ecosystem service values. Similarly, Ridwansyah et al. (2020) analyzed the Cimanuk Watershed, also in West Java, employing the SWAT model to assess the combined impacts of land use and climate change on surface runoff and groundwater. Their projections for 2075-2099 indicated substantial alterations in hydrological responses attributable to both land use modifications and climatic variations.

Furthermore, research by Hidayat et al. (2024) in the Upper Cisadane Sub-Watershed revealed that although total water availability of approximately 222.9 million cubic meters per year exceeded demand of 209.8 million cubic meters per year, resulting in a water surplus of 13.1 million cubic meters per year, the temporal distribution of water availability exhibited significant monthly variations, with critical shortages occurring during dry seasons. These studies collectively underscore the necessity of conducting comprehensive water balance assessments that account for both spatial and temporal variations in water supply and demand, particularly in agricultural watersheds where irrigation constitutes the primary water consumption activity.

Despite the substantial body of research on watershed water balance in Indonesia, considerable gaps remain in understanding the temporal dynamics of water supply and demand at the sub-district watershed scale, particularly concerning future projection scenarios. Previous studies have predominantly focused on historical assessments or single-year analyses, with limited emphasis on systematic multi-year projections that integrate population growth trends, agricultural expansion patterns, and hydrological variability. The Prumpung Watershed in Tuban Regency represents a critical case study area where agricultural activities dominate water consumption patterns, yet comprehensive assessments of future water balance conditions remain lacking. Therefore, this research aims to analyze water demand and water availability in the Prumpung Watershed over a five-year projection period (2025-2029), employing an integrated approach that combines demographic projections, land use-based agricultural water requirements, and rainfall-derived surface runoff calculations. The novelty of this study lies in its holistic assessment of the water balance by simultaneously analyzing domestic water needs based on per capita consumption standards, non-domestic water requirements derived from actual irrigated rice field areas and cropping intensity patterns, and water availability calculated from annual rainfall, runoff coefficients, and watershed characteristics. This research contributes methodologically by establishing a replicable framework for small to medium-scale watershed water balance assessments that can be adapted for similar agricultural watersheds in Indonesia, with findings expected to provide evidence-based recommendations for local water resource management authorities in addressing the emerging challenges of water scarcity in agricultural regions.

RESEARCH METHODOLOGY

This research employed a descriptive quantitative approach, commonly applied in hydrological studies, to analyze the relationship between population growth, water demand, and annual water supply capacity. This method was selected because it can describe the actual conditions of water demand and water supply availability based on measured data over a specific period. The quantitative descriptive approach enables researchers to analyze numerically collected data systematically, thus allowing an objective understanding of water demand and availability phenomena based on actual field conditions (Rohman et al., 2025). The data utilized in this research are presented as follows:

Table 1 Population Data

Year	Population (persons)
2020	62.078
2021	62.215
2022	62.419
2023	64.410
2024	64.794

Source: Author’s Database (2025)

Domestic water demand was calculated based on the Indonesian National Standard (SNI) for domestic water requirements, where consumption standards are determined according to regional categories (urban, suburban, or rural areas). This standard value was then multiplied by the population for each projection year to obtain domestic water demand in cubic meters per year.

Table 2 Domestic Water Requirements Based on City Category

City Category	Population	Water Requirement (L/capita/day)
Semi Urban	3.000-20.000	60-90
Small City	20.000-100.000	90-110
Medium City	100.000-500.000	100-125
Large City	500.000-1.000.000	120-150
Metropolitan City	>1.000.000	150-200

Source: Astani et al. (2022)

In this research, a standard of 100 L/capita/day was used, which was then converted to annual requirements. The water demand calculation employed the following equation:

$$Q_{daily} = \frac{P_t \ x \ q}{1000}$$

- Qdaily : daily domestic demand (m^3/day)
- Pt : population in year t
- Q : per capita consumption (L/capita/day)

Non-domestic water demand was analyzed through rice field irrigation requirements calculated based on land area, crop water requirements, and annual cropping intensity, following the irrigation requirement equation used in agricultural water resource planning (Yadi et al., 2022). The calculation was performed using:

$$Q_a = L \ x \ It \ x \ a$$

Where:

- Q_a = irrigation water use
- L = irrigation area (ha)
- It = cropping intensity in percent (%) season/year
- A = water use standard (1 L/s/ha) or 0.001 m^3/s/ha × 3600 × 24 × 120 days/season

Table 3 Annual Rainfall

Year	Rainfall (mm)
2015	925,93
2016	1.618,39
2017	1.572,84
2018	1.164,53
2019	1.578,73
2020	1.555,08
2021	1.643,99
2022	2.082,64
2023	1.203,24
2024	1.324,59

Source: Author's Analysis (2025)

Water availability in this research was calculated using the runoff method based on annual rainfall, runoff coefficient, and watershed area. This calculation was performed by multiplying the runoff coefficient value established according to land use characteristics in the study area with the annual rainfall magnitude and watershed area as the basis for estimating the volume of runoff entering the river system. This approach was chosen because it can provide an overview of the volume of water available in a watershed under conditions where daily river discharge data are not always available or complete, so that surface runoff is projected from rainfall and weighted runoff coefficients based on land use in the region (Juniati et al., 2021). Water availability was calculated based on runoff using the following equation:

$$R = C \times P \times A$$

Where:

- R = runoff volume
- C = runoff coefficient influenced by land use
- P = annual rainfall
- A = watershed area

The calculated water demand and water availability were then compared to assess the balance between supply and water requirements, thus determining water surplus or deficit during the projection period (Mauliana et al., 2022). This comparison serves as a basis for evaluating the capacity of water resources in the study area to meet current and future water needs.

RESULT AND DISCUSSION

Population Projection and Domestic Water Demand

Domestic water demand was calculated based on population with a five-year population projection using the geometric equation. The calculation results are as follows:

Table 4 Projected Population

Year	Population (persons)
2025	65.474
2026	66.162
2027	66.856
2028	67.558
2029	68.268

Source: Author's Analysis (2025)

The domestic water demand calculation based on city standards is as follows:

Table 5 Projected Domestic Water Demand

Year	Water Demand (m^3/year)
2025	2.389.812
2026	2.414.905
2027	2.440.262
2028	2.465.885
2029	2.491.776

Source: Author's Analysis (2025)

Non-Domestic Water Demand

Subsequently, non-domestic water demand was calculated based on irrigation water requirements because the dominant land use in the Prumpung Watershed is rice paddies. The calculation results of irrigation water requirements with a rice field area of 87,349,400 m^2 are as follows:

Table 6 Projected Non-Domestic Water Demand

Year	Water Demand (m^3/year)
2025	91.034.789,98
2026	91.508.170,89
2027	91.984.013,38
2028	92.462.330,25
2029	92.943.134,36

Source: Author's Analysis (2025)

Total Water Demand

After obtaining domestic and non-domestic water demand, the next step was calculating total water demand by summing domestic and non-domestic water requirements. The calculation results are as follows:

Table 7 Total Water Demand

Year	Water Demand (m^3/year)
2025	93.424.602,32
2026	93.923.076,26
2027	94.424.275,25
2028	94.928.214,87
2029	95.434.910,78

Source: Author's Analysis (2025)

Water Availability

Water availability in this research was calculated based on the magnitude of surface runoff generated from rainfall in the Prumpung Watershed area. This approach was used because surface runoff is one of the main components in the water balance that directly reflects the potential water available in a watershed region.

The runoff calculation was performed by applying the runoff coefficient (c), which is a value indicating the proportion of rainfall that becomes surface runoff. The runoff coefficient value was determined based on land use and land cover characteristics in the Prumpung Watershed, because each type of land use has different infiltration capacities. Built-up land, for instance, has a higher runoff coefficient value compared to vegetated areas or forests, which tend to increase infiltration and decrease runoff. Mathematically, water availability (R) was calculated using the equation:

$$R = C \times P \times A$$

Where:

- C = runoff coefficient
- P = annual rainfall (m)
- A = watershed area (m^2)

The annual water availability calculation results for the 2015-2024 period are as follows:

Table 8 Water Availability 2015-2024

Year	Water Availability (m³)
2015	47.477.225,15
2016	85.201.209,85
2017	84.958.749,81
2018	64.499.386,64
2019	89.604.148,72
2020	90.393.053,12
2021	97.814.236,78
2022	126.767.288,22
2023	74.888.500,02
2024	84.256.534,76
Rata-Rata	84.586.033,31

Source: Author's Analysis (2025)

For the 2025-2029 water availability projection, the average value of 84.59 million m³/year for the 2015-2024 period was used. This approach is based on three main considerations: the ten-year average represents natural climate variability in the Prumpung Watershed, accurate climate projections and land use change data at the local scale are not yet available, and this approach is conservative to avoid overestimation of water availability. The constant availability assumption provides a realistic and scientific basis for water balance analysis in medium-term planning.

Water Balance Analysis

Table 9 Comparison of Water Availability and Water Demand

Year	Water Demand (m³)	Water Availability (m³)	Difference (m³)
2025	93.424.602,32	84.586.033,31	-8.838.569,01
2026	93.923.076,26	84.586.033,31	-9.337.042,95
2027	94.424.275,25	84.586.033,31	-9.838.241,94
2028	94.928.214,87	84.586.033,31	-10.342.181,56
2029	95.434.910,78	84.586.033,31	-10.848.877,47

Source: Author's Analysis (2025)

Based on the comparison results between water demand and water availability in Table 9, the total water demand in the Prumpung Watershed during the 2025-2029 projection period increases from 93,424,602.32 m³/year in 2025 to 95,434,910.78 m³/year in 2029. This increase in water demand is primarily influenced by non-domestic requirements for irrigation, which reach more than 97 percent of total water demand. Meanwhile, annual water availability is projected to remain at 84,586,033.31 m³/year, based on the average rainfall runoff for the 2015-2024 period. This condition causes water deficits to occur throughout all projection years, with the deficit amounting to 8,838,569.01 m³ in 2025 and increasing to 10,848,877.47 m³ in 2029. These results indicate that the increase in water demand is not matched by available water supply, necessitating more effective water resource management measures, such as improving irrigation water use efficiency, implementing water-saving technologies, conserving catchment areas, and utilizing alternative water sources to reduce the magnitude of water deficits in the Prumpung Watershed in the future.

The findings of this research demonstrate a persistent water deficit condition in the Prumpung Watershed, where water demand consistently exceeds availability throughout the 2025-2029 projection period. The water balance deficit identified in this study exhibits both similarities and differences when compared to findings from other Indonesian watersheds. The research by Nahib et al. (2022) in the Citarum Watershed documented a progressive deterioration of water balance, with water supply decreasing by 18.28 percent between 2000-2010 and 15.27 percent between 2010-2020, while water demand increased by 23 percent and 47 percent in the respective periods. In contrast, the Prumpung Watershed demonstrates a more moderate demand increase of 2.15 percent over five years, yet still experiences a deficit condition. This difference can be attributed to the distinct characteristics of the two watersheds: while the Citarum serves a highly urbanized and industrialized region with diverse water use sectors, the Prumpung remains predominantly agricultural with irrigation accounting for over 97 percent of total water demand. Furthermore, while Nahib et al. (2022) attributed water supply decline primarily to land use changes including expansion of bare land and agricultural areas coupled with forest decline, the present study identifies the static nature of water availability coupled with increasing demand as the primary driver of water stress.

The temporal distribution patterns of water availability observed in this research warrant comparison with findings from other sub-watersheds in Indonesia. Hidayat et al. (2024) found that the Upper Cisadane Sub-Watershed exhibited an annual water surplus of 13.1 million cubic meters when comparing total annual availability of 222.9 million cubic meters against demand of 209.8 million cubic meters. However, Hidayat noted significant monthly variations in water availability, with critical shortages occurring during dry seasons despite the annual surplus. The Prumpung Watershed presents a more severe situation, as even the annual water balance indicates a deficit condition. This comparison underscores an important consideration: while annual water balance assessments provide valuable insights into overall supply-demand relationships, they may mask critical seasonal shortages that have immediate impacts on agricultural productivity. The Prumpung case thus extends the findings of Hidayat by demonstrating that watersheds with annual deficits face compounded challenges.

The role of land use characteristics and irrigation practices in shaping watershed water balance emerges as a critical factor. Research by Ridwansyah et al. (2020) in the Cimanuk Watershed employed the SWAT model to project combined impacts of land use and climate change on surface runoff and groundwater for the 2075-2099 period, revealing substantial hydrological alterations attributable to both factors. While the present study did not explicitly model future land use changes or climate change impacts, the adoption of a ten-year rainfall average for projecting future water availability implicitly assumes relative stability in these factors. The global perspective provided by Luo et al. (2025) in the Jinghe River Basin, which found that vegetation restoration decreased water supply by 47.4 million cubic meters but simultaneously decreased water demand by 89 million cubic meters, offers an important insight for the Prumpung context. This finding suggests that strategic vegetation management can yield net benefits if accompanied by corresponding reductions in water demand. For Prumpung, where irrigation dominates water consumption at over 97 percent, interventions that reduce irrigation demand through improved efficiency could provide substantial benefits.

CONCLUSION

Based on the comparison results between water demand and water availability, the total water demand in the Prumpung Watershed during the 2025-2029 projection period increases from 93,424,602.32 m^3/year in 2025 to 95,434,910.78 m^3/year in 2029. This increase in water demand is primarily influenced by non-domestic requirements for irrigation, which reach more than 97 percent of total water demand. Meanwhile, annual water availability is projected to remain at 84,586,033.31 m^3/year based on the average rainfall runoff for the 2015-2024 period. This condition causes water deficits to occur throughout all projection years, with the deficit amounting to 8,838,569.01 m^3 in 2025 and increasing to 10,848,877.47 m^3 in 2029.

These results indicate that the increase in water demand is not matched by available water supply. Therefore, more effective water resource management measures are required, such as improving irrigation water use efficiency, implementing water-saving technologies, conserving catchment areas, and utilizing alternative water sources to reduce the magnitude of water deficits in the Prumpung Watershed in the future.

Future research should focus on incorporating climate change projections and land use change scenarios to provide more comprehensive insights into water balance dynamics. Investigation of seasonal water balance variations is essential, as annual assessments may mask critical dry season shortages. Additionally, exploration of alternative water sources including groundwater potential and rainwater harvesting systems could contribute to developing more resilient water management strategies for the Prumpung Watershed.

REFERENCES

Araswati, F. D., Murtilaksano, K., & Hidayat, Y. (2021). Perencanaan Penggunaan Lahan Berbasis Sumber Daya Air di Hulu DAS Cisadane. *Jurnal Ilmu Pertanian Indonesia*, *26*(3), 343–353. https://doi.org/10.18343/jipi.26.3.343

Astani, L. P., Supraba,]Intan, & Jayadi, R. (2022). Analisis kebutuhan air domestik dan non domestik Di kabupaten kulon progo, daerah istimewa yogyakarta. *Teknologi Sipil: Jurnal Ilmu Pengetahuan Dan Teknologi*, *5*(2), 34–41.

Brochet, E., Grusson, Y., Sauvage, S., Lhuissier, L., & Demarez, V. (2024). How to account for irrigation withdrawals in a watershed model. *Hydrology and Earth System Sciences*, *28*(1), 49–64. https://doi.org/10.5194/hess-28-49-2024

Farida, F., Dasrizal, D., & Febriani, T. (2019). REVIEW: PRODUKTIVITAS AIR DALAM PENGELOLAAN SUMBER DAYA AIR PERTANIAN DI INDONESIA. *Jurnal Spasial*, *5*(3), 65–72. https://doi.org/10.22202/js.v5i3.3161

Hidayat, Y., Rachman, L. M., Wahjunie, E. D., Baskoro, D. P. T., Purwakusuma, W., Yusuf, S. M., & Araswati, F. D. (2024). Water Balance Prediction by Simulating Land Use Planning and Water Retention Infrastructure in Upper Cisadane Sub-Watershed, West Java, Indonesia. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *14*(2), 415. https://doi.org/10.29244/jpsl.14.2.415

Juniati, A. T., Kusratmoko, E., & Sutjiningsih, D. (2021). ESTIMATION OF POTENTIAL WATER AVAILABILITY AND WATER RESOURCES CARRYING CAPACITY FOR BOGOR CITY SPATIAL PLAN. *Jurnal Geografi Lingkungan Tropik*, *5*(1), 23–39. https://doi.org/10.7454/jglitrop.v5i1.98

Luo, Y., Wu, L., Wang, R., Wang, X., Du, B., & Pang, S. (2025). Will vegetation restoration affect the supply-demand relationship of water yield in an arid and semi-arid watershed? *Science of The Total Environment*, *959*, 178292. https://doi.org/10.1016/j.scitotenv.2024.178292

Mauliana, Y., Cambodia, M., Ariyanto, L., & Novilyansa, E. (2022). Analisis Ketersediaan dan Kebutuhan Air pada DAS Besai di Wilayah Sungai Tulang Bawang Berdasarkan Neraca Air. *Teknika Sains: Jurnal Ilmu Teknik*, *7*(2), 158–165. https://doi.org/10.24967/teksis.v7i2.2045

Nahib, I., Amhar, F., Wahyudin, Y., Ambarwulan, W., Suwarno, Y., Suwedi, N., Turmudi, T., Cahyana, D., Nugroho, N. P., Ramadhani, F., Siagian, D. R., Suryanta, J., Rudiastuti, A. W., Lumban-Gaol, Y., Karolinoerita, V., Rifaie, F., & Munawaroh, M. (2022). Spatial-Temporal Changes in Water Supply and Demand in the Citarum Watershed, West Java, Indonesia Using a Geospatial Approach. *Sustainability*, *15*(1), 562. https://doi.org/10.3390/su15010562

Naim, A., Zerlinda, A., Oktaviani, M. B., Abidin, P. V. P. F., Nurjani, E., Sekaranom, A. B., Setyaningrum, E., & Prabowo, A. A. (2025). Meteorological Water Scarcity Projection for 2021-2035 Based on CMIP6 (Coupled Model Intercomparison Project Phase 6) Scenario in Daerah Istimewa Yogyakarta. *Jurnal Meteorologi Dan Geofisika*, *25*(1), 57–68.

https://doi.org/10.31172/jmg.v25i1.1063

Ridwansyah, I., Yulianti, M., Apip, Onodera, S., Shimizu, Y., Wibowo, H., & Fakhrudin, M. (2020). The impact of land use and climate change on surface runoff and groundwater in Cimanuk watershed, Indonesia. *Limnology*, *21*(3), 487–498. https://doi.org/10.1007/s10201-020-00629-9

Rohman, H. A., Hidayati, N., & Farida, E. (2025). Strategi Perencanaan Jaringan Pipa Distribusi Air Bersih di Desa Pasiraman Kecamatan Wonotirto Kabupaten Blitar. *Briliant: Jurnal Riset Dan Konseptual*, *10*(4), 969–980. https://doi.org/10.28926/briliant.v10i4.1995

Shaibu, M., Clifford, O. C., Abdulahi, S. A., & Dikko, A. M. (2023). COMPARATIVE STUDY ON NUTRITIONAL AND ANTI NUTRITIONAL COMPOSITION OF FRESH AND DRIED OKRA OBTAINED FROM GUSAU MARKET NIGERIA. *Journal of Multidisciplinary Research*, 1–11. https://doi.org/10.56943/jmr.v2i1.230

Telaumbanua, E. P. O., Sinaga, M. U., Indrawan, I., & Sembiring, I. R. A. (2023). THE EVALUATION OF WATER LEVEL ELEVATION DESIGN OF SEI BATANG SERANGAN TOLL BRIDGE ON SEI BATANG SERANGAN RIVERSIDE. *Journal of Multidisciplinary Research*, *2*(3), 34–50. https://doi.org/10.56943/jmr.v2i3.405

Yadi, A. F., Suprayogi, I., Fauzi, M., & Bochari. (2022). Analisa Kebutuhan Air Bersih Berdasarkan Rencana Tata Ruang Wilayah. *Saintek*, *10*(2), 131–137.