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## River Capacity for Sectoral Water Pollution Loads (Case Study: Cilamajang River) City of Tasikmalaya

To cite this article: P. Irawan *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **477** 012022

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# River Capacity for Sectoral Water Pollution Loads (Case Study: Cilamajang River) City of Tasikmalaya

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**Abstract.** The increasing population in the city of Tasikmalaya has an impact on increasing the pace of development in various sectors. population growth and changes in land use have resulted in current environmental conditions in a number of areas in the city of Tasikmalaya showing a decline in quality. This is due to the increased use of natural resources including the use of surface water sourced from river water. Cilamajang River is a Ciwulan sub-basin located in the city of Tasikmalaya. The area of the Cilamajang watershed reaches 29.53 km<sup>2</sup>. Simulation of discharge using 15-year FJ Mock series method data provide a minimum discharge of the Cilamajang River of 474.95 Liters/second. Simulation of discharge and loading of pollution in 2018 has exceeded water quality standards according to PP 82 of 2001, BOD parameters are 131.72 mg/L, the COD parameter is 1.41 mg/L and the TSS parameter is 91.41 mg/L. This condition must receive serious attention for the local government in managing the water environment. Keyword : water quality, BOD, COD, TSS, minimum discharge, FJ Mock, River pollution load capacity

## 1 Introduction

Activities of using water for living needs produce residues for the water environment, increasing human population, causing changes in land use. This change has caused changes in the quality of water in the river that will accommodate pollution loads [1]. Cilamajang River is located in the city of Tasikmalaya and is a Ciwulan watershed. As a developing city, changes in land use continue to occur. In addition, in the Cilamajang watershed there are various industrial activities, agriculture and other activities. Existing industrial activities are home industry activities that do not have a wastewater treatment plant. While the domestic sector generally does not yet have household wastewater treatment. This condition causes a large potential pollution load. On the other hand, land use change causes the minimum discharge for river ecological life to decline. This study aims to find a model of the Cilamajang River water pollution load. The water quality parameters studied were BOD, COD and Total Coliform. This model is expected to be the basis of environmental management policies in the City of Tasikmalaya.



## 2 Water Quality

### 2.1 Indicator of Water Source Pollution

In identifying pollutant sources in a watershed for locations from pollutant sources, it can be identified based on various types of maps, including: land use, (thematic) potential and distribution: population, industry, agriculture, livestock and mining. The key parameters of pollution as an indicator of water source pollution are various water quality parameters that cause pollution with a probability of occurrence > 80%. Based on the results of monitoring of water quality in almost all of Indonesia in the context of research and development carried out by the Research and Development Centre for Water Resources.

#### 2.1.1 Dissolved Oxygen (DO)

The DO level in water is the level of freshness of water that is very important for water life, if the river is not polluted or the pollution that occurs is relatively low, the DO level is quite high, so that fish and other water organisms that need oxygen can live in the water. The maximum DO concentration is in water (or called saturated oxygen level) which depends on temperature, for example for temperatures of 20 °C, oxygen saturated levels will approach 9.2 mgO<sub>2</sub> / L, while at 30 °C, oxygen saturation will drop to around 7.6 mgO<sub>2</sub>/L. Biodegradable pollutants will also absorb oxygen during the decomposition process, this will cause a reduction in DO levels in the waters. High levels of pollution, DO concentrations will drop, become very low even close to zero or become anaerobic conditions, which results in water that will smell unpleasant and cloudy [2][6].

#### 2.1.2 Biochemical Oxygen Demand (BOD)

BOD is one parameter to assess the level of water pollution. BOD is the amount of oxygen needed to oxidize pollutants in water by bio-chemistry, which naturally occurs in water where pollutants are broken down into smaller molecules through an oxidation process. BOD testing in the laboratory, which measures how much oxygen is lost for 5 days in a water sample with a temperature of 20 °C [3][6].

#### 2.1.3 Chemical Oxygen Demand (COD)

Like BOD, COD is also a parameter for assessing pollution. COD is the amount of oxygen needed to oxidize all organic components in water by chemically becoming carbon dioxide and water. COD measurement can be done faster, which is only about 2-3 hours. In general, the value is around 1.2 to 5 times the BOD value [2][6].

#### 2.1.4 Bacteria

The next parameter is bacteria which is used as an indicator of pollution, namely: Fecal Coliform (Koli Feces) and / or Total Coliform (Total Koli). The presence of fecal coli in water is an indication that the water has been contaminated by household wastewater or human waste, while the total Koli is an indicator of discharge from animal waste or warm-blooded animals [2][6].

#### 2.1.5 Nutrien

Other parameters are nutrients, namely water quality parameters in the form of N compounds (ammonia, nitrite, nitrate, N-organic) and P (phosphate, organic-P and Tot-P) which are used as indicators of a water source's fertility. This parameter is an indication of pollution originating from human waste or other types of activities such as the N compound from the urea fertilizer plant [2][6].

#### 2.1.6 Analysis of River Water Quality Status

The status of river water quality shows the level of pollution of a water source in a certain time, compared to the specified water quality standard. The river is said to be polluted if it cannot be used according to its normal setting [4]

## 2.2 Domestic Wastewater Pollution

The amount of indeterminate water pollutants is estimated by first determining the emission factors that are specific to each category of activity, given the limitations in direct measurement for each source of irregular water pollutants in the inventory area. The following sub-sections present methods for estimating quantities for each group of activities that have the potential to produce waste water which are categorized as uncertain water sources. Calculating the estimate for pollutant sources from domestic waste is multiplying the emission factor directly with the population, which is like the following formula [6]:

$$PDPL = \beta \times \Upsilon \times NP \times PE_i$$

where:

- PBPd : Potential domestic pollution load (kg/day)
- $\beta$  : Unit Conversion (0.001)
- $\Upsilon$  : Distance Load Transfer Coefficient (0.3 - 1.0)
- NP : Number of Population (people)
- $PE_i$  : Pollutant emissions (g/person /day)

## 2.3 Source of Industrial Wastewater Pollution

the potential for industrial pollution in general is in accordance with the formula, for this the need for simplification is as follows [6]:

$$PIPL = \beta \times \Upsilon \times \delta \times Dk \times PE_i$$

where:

- PBPi : Potential Industrial Pollution Load (kg/day)
- $\beta$  : Unit Conversion (0.0864)
- $\Upsilon$  : Distance Load Transfer Coefficient (0.3 - 1.0)
- $\delta$  : Load Transfer Coefficient of discharge ratio (0.1 - 1.0)
- Dk : Discharge (L/s)
- $PE_i$  : Pollution emissions (mg/L)

## 2.4 Agricultural Wastewater Pollution

When viewed from the location of the source of the pollution, livestock waste is an indirectly related system of water, but if in the rainy season this waste is carried by the flow of water into the river or other water sources. The characteristics of livestock wastewater derived from the next feaces of livestock are influenced by livestock waste management activities. For types of livestock that are home or traditional scale livestock roam outside the cage and only enter their cages in the afternoon, while others are employed and instead livestock systems are grounded so that the feaces of waste can be controlled properly and the livestock waste is made into liquid or powdered fertilizer [5].

## 3 Methodology

The methodology used is to calculate the potential pollution load of each sector. The sector includes the domestic, industrial and agricultural sectors. The study was started by determining the centralized pollution load and pollution load spread in the Cilamajang watershed. The study was conducted in October - December 2018. The study was conducted by taking water samples at the specified sampling point. In addition, a hydraulic cross section analysis is also carried out to determine the existing river discharge.

Hydraulics analysis is needed to determine the sampling point in the river, so that sampling parameters can be determined. In addition, debit calculations were also carried out using the FJ method. Mock to get a debit simulation. This discharge simulation is used to determine the pollution load that can be accommodated by rivers with minimum discharge conditions. The flow chart and location of the study are presented in Figure 1 and Figure 2.

The principle of the Mock method states that rain falling in the catchment area, some will be lost due to evapotranspiration, some will directly become direct runoff and some will enter the soil or infiltrate [7], [8], [9]. This infiltration will first saturate the soil surface, then percolation into the ground water and will come out as the base flow. There is a balance between falling rainwater and evapotranspiration, direct runoff and infiltration, wherein the infiltration is in the form of soil moisture and ground water discharge. Flow in the river is the amount of flow directly at the ground and base flow[8], [9], [10].

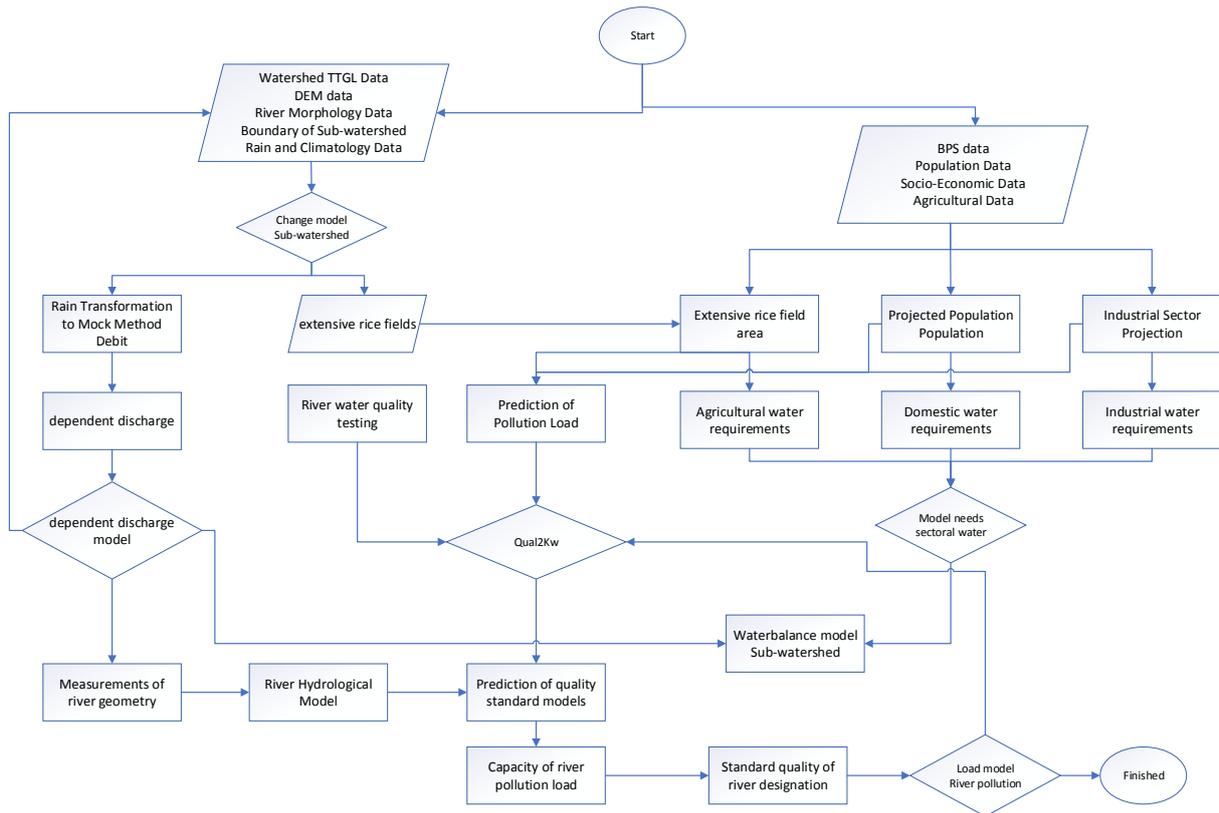


Figure 1. Research Flowchart

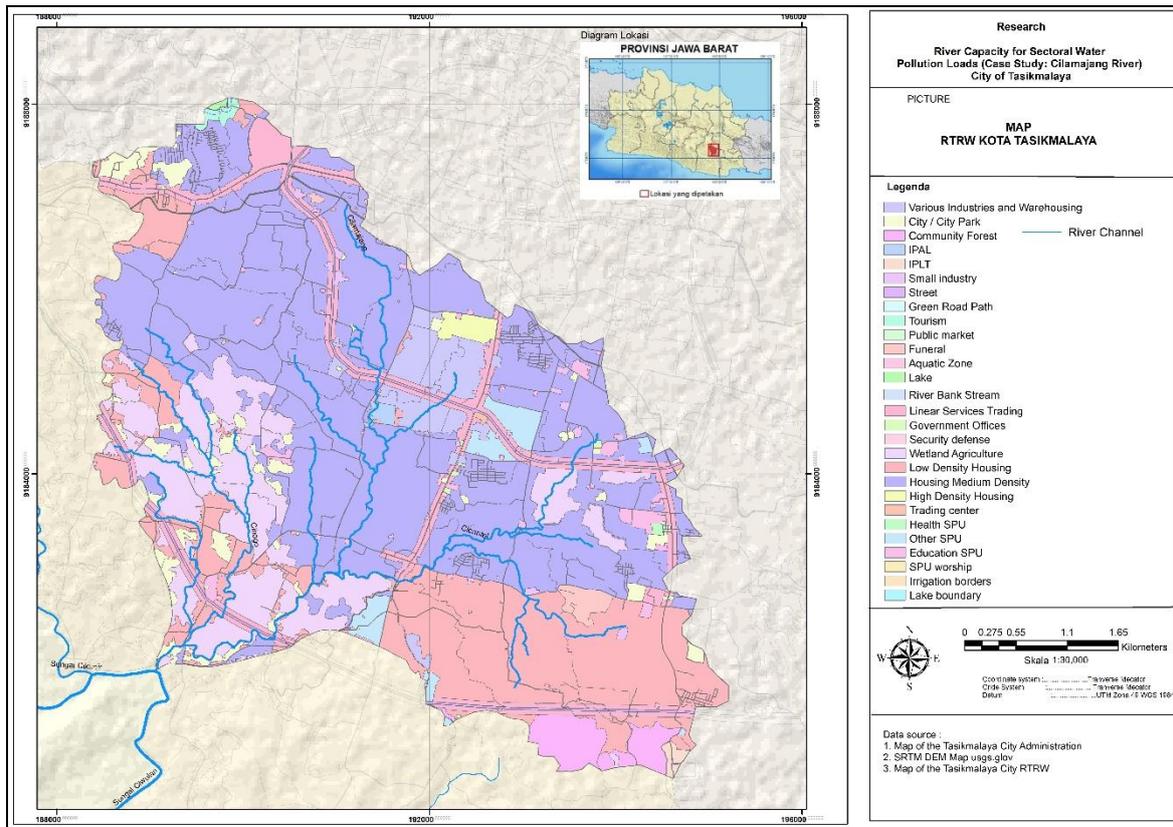


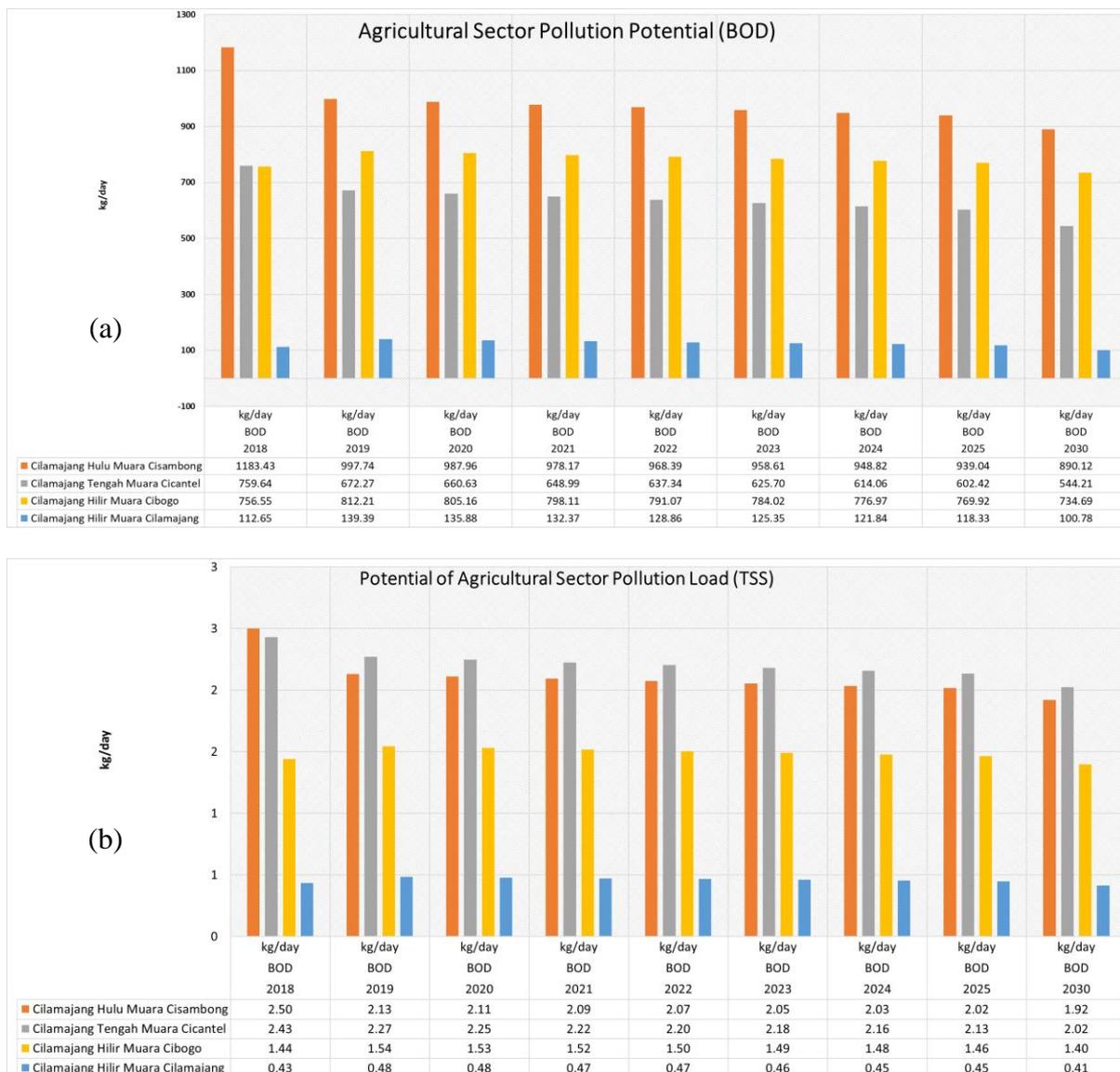
Figure 2. RTRW Cilamajang Watershed

The method of river water sampling carried out directly using the grab sampling method is the instant sampling method that shows the characteristics of water only at that time [5]. Then the pollution data is simulated with the series of years to get the potential of the year series pollution load. Calculation of potential load is presented in the distribution map of potential pollution loads.

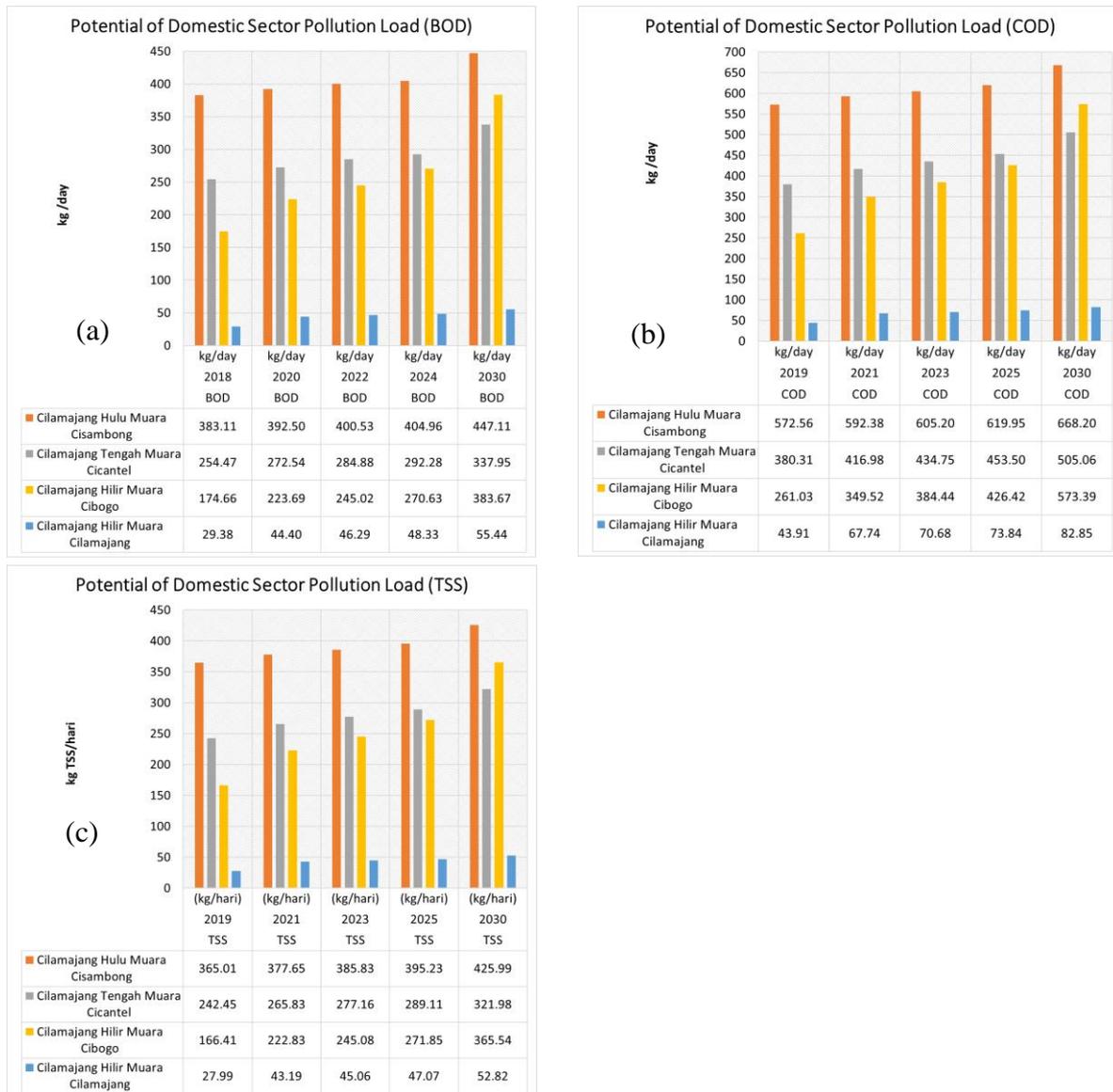
### 4 Results and Discussion

#### 4.1 Potential of Water Pollution Load

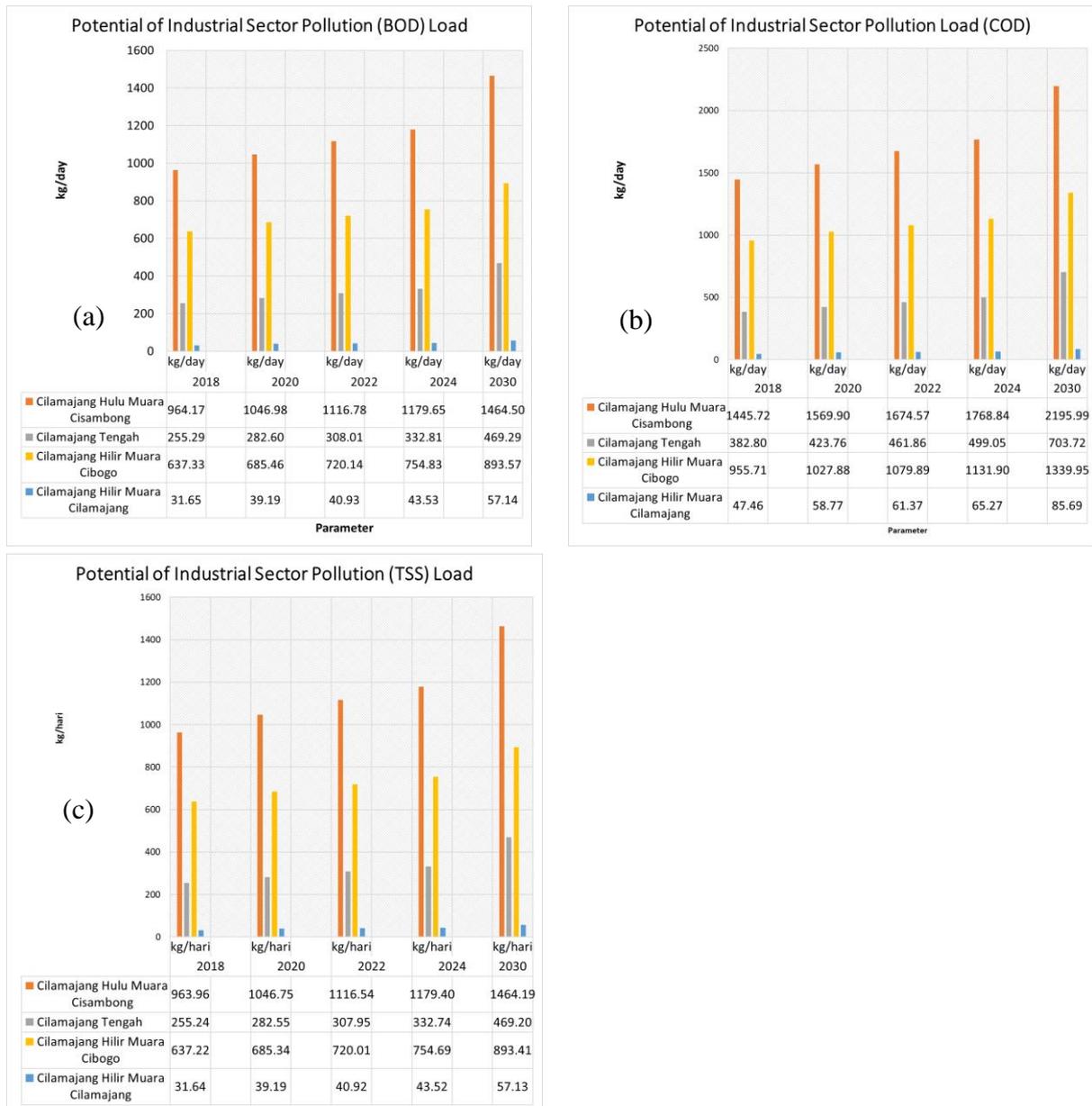
Potential water pollution load is calculated is the potential for domestic, industrial and agricultural pollution loads. The potential for domestic pollution loads is based on population data and individual pollution load emissions. Population data is taken from BPS data, then overlaid with a map of the Tasikmalaya City RTRW. The results of the calculation of the potential pollution load are presented in Figure 3 - Figure 5.



**Figure 3.** Potential Serial Agricultural Sector Pollution Load in 2018 - 2030 (a) BOD and (b) TSS



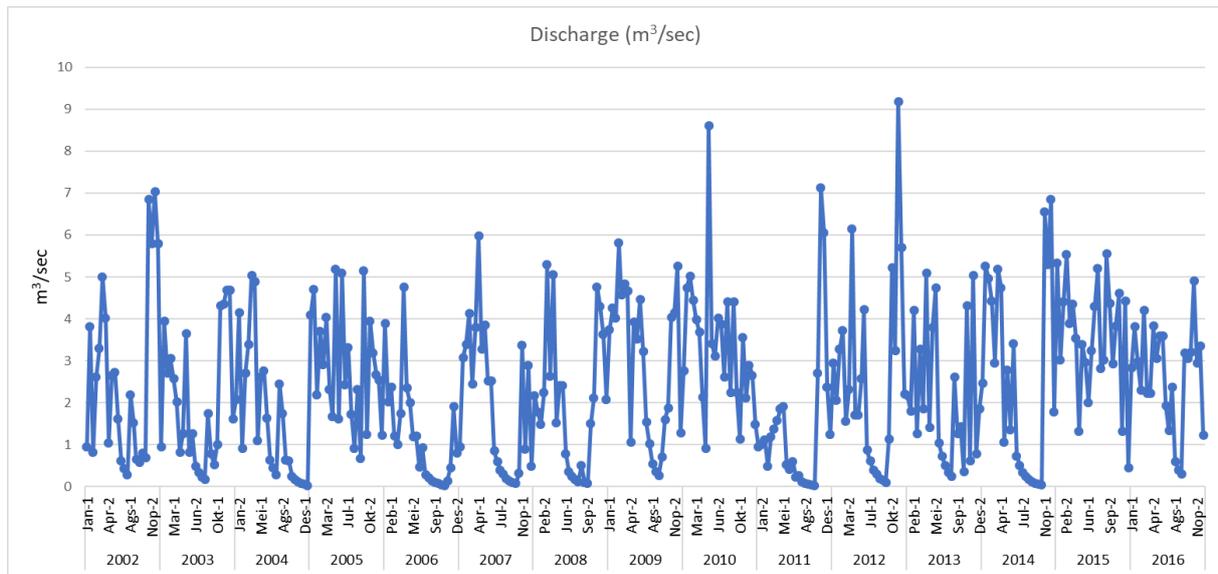
**Figure 4.** Pollution Costs Serial Domestic Sector Year 2018 - 2030 (a) BOD (b) COD and (c) TSS



**Figure 5.** Load of Serial Industry Sector Pollution in 2018 - 2030 (a) BOD, (b) COD and (c) TSS

### 4.2 Discharge Analysis

The Cilamajang watershed has an area of around 29.53 km<sup>2</sup> with the main river reaching 8 km. Dependent discharge analysis using FJ Mock method based on daily rainfall, land cover, soil distribution conditions etc. based on the analysis, the minimum discharge was 474,946 liters / second. The results of this analysis are presented in Figure 6.



Source : Analisis

**Figure 6.** Simulated stream flow Cilamajang

Simulation data shows that the minimum debit of the Cilamajang river occurred in 2016, the amount of discharge is 474.95 liters/second. This debit data will be used to calculate the capacity of river capacity based on potential pollution loads.

**Tabel 1.** Planned Flood Simulation

No	Annual Before sorted	Minimum Discharge (m <sup>3</sup> /sec)	Probability	Debit After sorting (L/det)	Information
1	2002	0.703	6.3%	918.781	
2	2003	0.468	12.5%	859.781	
3	2004	0.504	18.8%	711.921	
4	2005	0.518	25.0%	703.296	
5	2006	0.475	31.3%	685.731	
6	2007	0.599	37.5%	598.856	Qa - 50 %
7	2008	0.529	43.8%	580.598	
8	2009	0.581	50.0%	555.069	
9	2010	0.860	56.3%	528.607	
10	2011	0.712	62.5%	517.854	Qa - 80 %
11	2012	0.919	68.8%	509.072	
12	2013	0.509	75.0%	503.998	
13	2015	0.686	81.3%	491.225	
14	2016	0.555	87.5%	474.946	Qa -90%
15	2017	0.491	93.8%	467.782	

#### 4.3 Water Pollution Capacity Analysis

Cilamajang River has an area of 29.53 km<sup>2</sup>, the main river length reaches 8 km, the minimum discharge from the FJ Mock method simulation is 474.95 liters/second, the current potential pollution load is 5633.21 kg/day for BOD, COD is 3909.16 kg/day and TSS 2692.01 kg/day. This condition

results in a BOD concentration of 131.72 mg/liter, the COD concentration is 91.41 mg/liter and the TSS concentration is 62.95 mg/liter. The conditions of BOD and COD are above the threshold of quality grade IV water quality, while TSS is still in class II [6], [11], [12]. The high potential for pollution load is due to the high activity of home industries in the Cilamajang watershed without wastewater treatment. On the other hand, the domestic sector also provides a very dominant pollution load for the COD and BOD parameters. This condition occurs because most people live on the banks of the river, meanwhile, there is no domestic waste treatment in the area.

## 5 Conclusions

Simulations of the Cilamajang River produce a reliable discharge of 474.95 liters/second, the pollution load in 2018 has exceeded the water quality standard, the BOD parameter is 131.72 mg/liter, the COD parameter is 91.41 mg/liter and the TSS parameter is 91.41 mg/liter. The minimum discharge and class II water quality standards according to PP 82 of 2001 show that the capacity of the Cilamajang River BOD pollution load is 0.78 tons/day, COD is 8.64 tons/day and TSS is 216 tons/day.

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