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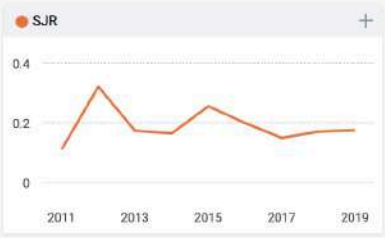
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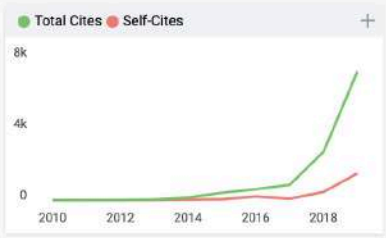
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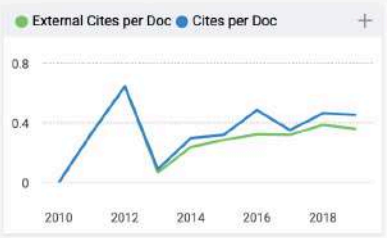
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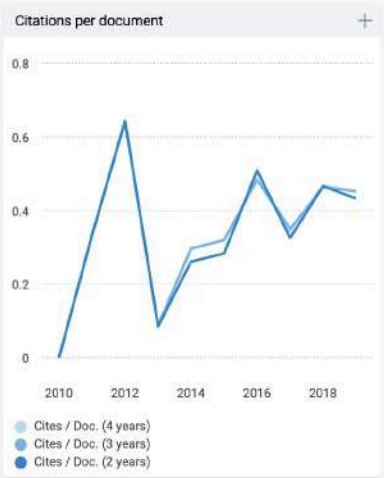
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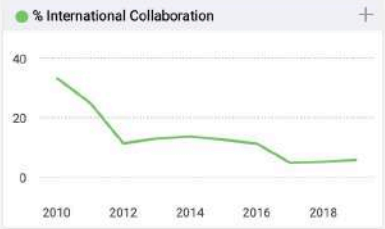
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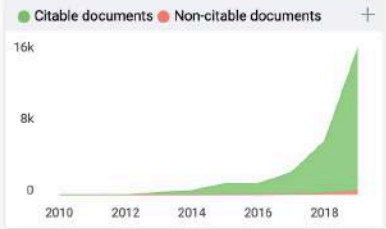
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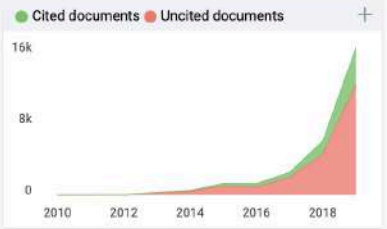
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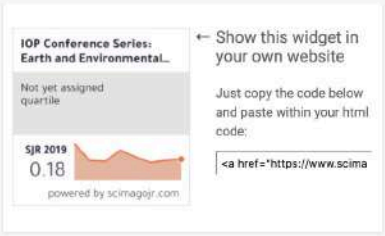
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Issue 2

Pollutant load capacity of Situ Parigi, Banten Province

Pollutant load capacity of Situ Parigi, Banten Province

A Zharifa, M F Fachrul and D I Hendrawan*

Department of Environmental Engineering, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta, Indonesia

*dianahendrawan@trisakti.ac.id

Abstract. Situ Parigi is located in Parigi Lama Village, Pondok Aren District, South Tangerang City. Based on the water quality measurements of Situ Parigi, BOD parameter has the highest concentration. This indicates that the type of waste that enters this water body is dominated by organic waste produced from domestic activities surrounding. The purpose of this study is to determine the pollutant load capacity of BOD in Situ Parigi. Pollutant load capacity is calculated using formulas in Minister of Environment Regulation No. 28 of 2009 concerning Capacity of Lake Water Pollution and/or Reservoir Load. Situ Parigi has an area of 4 Ha, an average depth of 0.98 m, a debit of 0.023 m3/sec and a hydraulic residence time of 18.25 days. Based on the calculations results, the pollutant load capacity of Situ Parigi is 3,169.81 kg/year but must accommodate a load of 20,553.15 kg/year. These results show that the pollution that occurs in Situ Parigi has exceeded its capacity. Control strategies such as dredging work and the construction of communal wastewater treatment plants could be carried out in an effort to reduce the occurring pollution levels.

1. Introduction

Situ Parigi is a small lake located in South Tangerang City. According to previous measurements show that the concentration of BOD far exceeds its quality standard. Presumably, this is due to the influence of organic waste from surrounding activities, particularly domestic activities. The high concentration of BOD may have an impact on the pollutant load capacity of Situ Parigi. According to the Minister of Environment Regulation No. 28 of 2009 concerning Capacity of Lake Water Pollution and/or Reservoir Load, the pollutant load capacity for lake water and/or reservoir means the ability of lake or reservoir water to receive pollutant without the lake or reservoir water are polluted.

Water pollution that occurs is caused by the presence of a substance or other elements that enter the water, thus causing a decrease in water quality [1]. The pollution level which occurs in the waters could affect its pollutant load capacity. This is indicated by increasing level of pollution in the waters, reducing the pollutant load capacity or far exceeding the pollutant load capacity [2].

The various human activities coupled with increasing population and lack of sanitation development have accelerated environmental degradation through direct disposal of waste into the waters. This increasing the pollutant load in the waters thus reaching dangerous limits [3]. Therefore, the purpose of this study is to calculate the pollutant load capacity in Situ Parigi, Province of Banten.

2. Methods of study

This study was conducted in Situ Parigi, Pondok Aren District, South Tangerang City in May up to July 2018. Water sampling was carried out 3 (three) times on May 11th 2018, June 4th 2018, and July 4th 2018. A map of the study location show in figure 1 and sampling coordinates show in table 1.

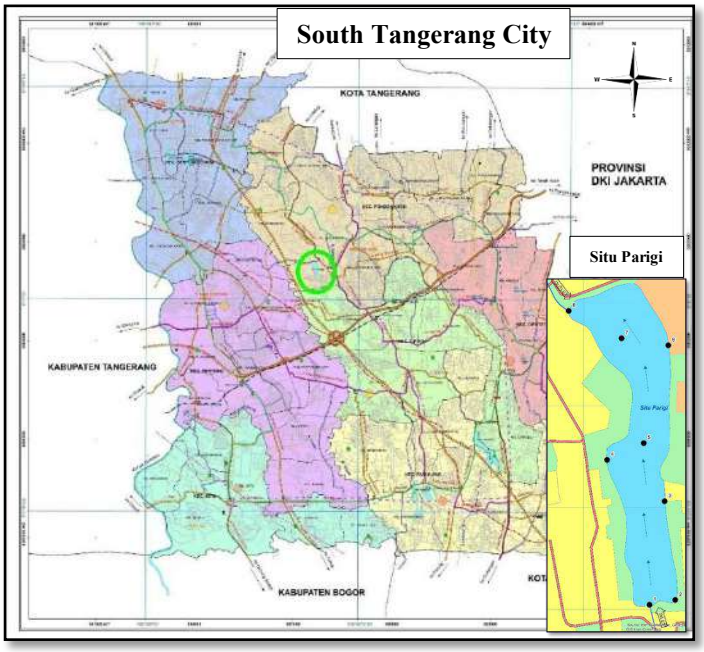

Figure 1. Study location.

Table 1. Sampling coordinate points.

No.	Coordinate Points
1	6°17'9,81"S 106°41'47,65"E
2	6°17'9,51"S 106°41'49,64"E
3	6°17'4,75"S 106°41'48,83"E
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5	6°17'1,95"S 106°41'48,06"E
6	6°16'57,85"S 106°41'49,28"E
7	6°16'56,97"S 106°41'47,14"E
8	6°16'55,59"S 106°41'44,11"E

According to Chapra, the volume of the waters can be calculated based on the depth, using the formula below [4]:

$$V_{i,i+1} = \sum_{j=0}^{i} \left[\frac{A_{(Hi)} + A_{(Hi+1)}}{2}\right] (H_{(i+1)} - H_i) \quad (1)$$

Annotation:
V = Volume (m^3); A = Surface Area of Specific Depth (m^2)
I = Depth Layer (m); H = Depth Range between 2 Depth Layers (m)

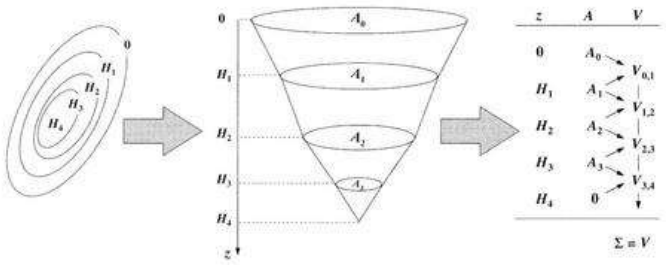

Figure 2. Waters volume calculations principle [4].

To calculate the pollutant load capacity of Situ Parigi, the preliminary data such as area, minimum depth and maximum depth, average depth; inlet and outlet flow, and existing BOD concentration are needed. Pollutant load capacity in Situ Parigi is calculated using formulas comply with the Minister of Environment Regulation No. 28 of 2009 concerning Capacity of Lake Water Pollution and/or Reservoir Load [5]. The steps in calculating pollutant load capacity are as follows:

- Acquiring the area, minimum depth, maximum depth, volume, inlet flow and outlet flow of Situ Parigi.
- Calculating the water replacement rate using the formula below:

$$\rho = \frac{Qo}{V} \tag{2}$$

Annotation:
ρ = Water Replacement Rate (/year)
Qo = Total Water Discharge (million m^3/year)
V = Water Volume (million m^3)

- Calculating the residence time
- Calculating the BOD waste load allocation using the formula below:

$$[BOD]_{STD} = [BOD]_i + [BOD]_{DAS} + [BOD]_d \tag{3}$$

$$[BOD]_d = [BOD]_{STD} - [BOD]_i - [BOD]_{DAS} \tag{4}$$

Annotation:
$[BOD]_{STD}$ = Maximum BOD Parameter Value Requirement comply with Water Quality Standard or Water Class (mg/m^3)
$[BOD]_i$ = Value of BOD Parameter Obtained from Monitoring (mg/m^3)
$[BOD]_{DAS}$ = Total BOD Load Allocation from Watershed or Catchment Area (mg/m^3)
$[BOD]_d$ = Activity Waste BOD Load Allocation in the Waters (mg/m^3)

- Calculating the total of BOD residing within the sediments using the formula below:

$$R = \frac{1}{(1 + 0{,}747\ \rho^{0{,}507})} \tag{5}$$

Annotation:
R = The Total of BOD Residing within the Sediments
ρ = Water Replacement Rate (/year)

- Calculating the BOD capacity per unit area using the formula below:

$$L = \Delta\ [BOD]_d\ \check{Z}\ \rho\ /\ (1- R) \tag{6}$$

Annotation:
L = BOD Waste Capacity per Unit Area (mg BOD/m^2.year)
$[BOD]_d$ = Activity Waste BOD Load Allocation in the Waters (mg/m^3)

$\check{Z}$ = Average Depth (m)
ρ = Water Replacement Rate (/year)
R = The Total of BOD Residing within the Sediments

Calculating the total of BOD waste capacity in the waters using the formula below:

$$La = L \times A /100 = \Delta [BOD]_d A \check{Z} \rho /100 (1- R) \quad (7)$$

Annotation:
La = The Total of BOD Waste Capacity in the Waters (kg BOD/year)
L = BOD Waste Capacity per Unit Area (mg BOD/m^2.year)
A = Total Area (m^2)
$[BOD]_d$ = Activity Waste BOD Load Allocation in the Waters (mg/m^3)
$\check{Z}$ = Average Depth (m)
ρ = Water Replacement Rate (/year)
R = The Total of BOD Residing within the Sediments

3. Result and discussion

Situ Parigi has an area of 4 hectares or 40,000 m^2 and an outlet flow of 0.023 m^3/sec. The parameter used in calculating the pollutant load capacity is BOD, due to measuring the water quality of Situ Parigi, value of BOD concentration exceeds the standard quality. The measurement results of BOD concentration is 19.452 mg/L or 19,452 mg/m^3. The permissible BOD concentration according to the quality standards of Government Regulation No. 82 of 2001 for class 2 is 3 mg/L or 3,000 mg/m^3 [6]. Rusly et al. indicated that the water quality is impacted by the activities around, especially the household activities [7].

The dominant pollutant source originates from domestic activities/settlements around Situ Parigi. Activities around Situ Parigi include residential houses, mini markets, restaurants, shops, workshops, laundries, schools, mosque, swimming pool, digital printing, salon, printing shop and a taxi pool. The many activities around Situ Parigi, as well as the piles of garbage in the inlet canal and around the edges, could affect its state of water quality.

The minimum depth measured in Situ Parigi is 0.38 m, while the maximum depth measured is 1.58 m. Situ Parigi has a volume of 34,613.23 m^3. Based on calculations, the rate of water replacement in Situ Parigi is found to be 20.96 per year and the hydraulic residence time is 18.25 days. The results of pollutant load capacity calculations show in **Table 2.**

Table 2. Pollutant load capacity calculations results.

Morphometry	Unit	Value
Area	m^2	40,000
Minimum Depth	m	0.38
Maximum Depth	m	1.58
Average Depth	m	0.98
Volume	m^3	34,613.23
Inlet Flow	m^3/sec	0.28
Outlet Flow	m^3/sec	0.023
Total Water Outflow	m^3/year	725,328
Water Replacement Rate	per year	20.96
Residence Time	year	0.05
	day	18.25
Existing BOD	mg/m^3	19,452
BOD Quality Standard	mg/m^3	3,000
Watershed BOD	mg/m^3	-16,452
R	-	0.22
Pollutant Load Capacity per Area (Quality Standard)	g/m^2 year	79.25
Pollutant Load Capacity per Area (Existing)	g/m^2 year	513.83
Total Pollutant Load Capacity (Quality Standard)	kg/year	3,169.81
Total Pollutant Load Capacity (Existing)	kg/year	20,553.15
Excess Load	-	6.5 times

The capacity of BOD load from the whole area of Situ Parigi is 79.25 g/m^2 year, but existing conditions accommodate a load of 513.83 g/m^2 year. Meanwhile, the BOD load capacity in the waters is 3,169.81 kg/year, however existing conditions accommodate a load of 20,553.15 kg/year. These results show pollution in Situ Parigi which has exceeded its pollutant load capacity. This is also show by the excess of BOD load which reaches 6.5 times higher. Improvement the pollutant load capacity in Situ Parigi can conducted by increasing the volume through sediment dredging work to make deeper, construction a wastewater treatment plant, so the wastewater is not disposed of directly to the water body.

4. Conclusion

Situ Parigi has accommodated BOD loads exceeding its capacity. BOD load capacity of Situ Parigi is 3,169.81 kg/year, but existing conditions show that Situ Parigi accommodates a load of 20,553.15 kg/year. The excess BOD load of Situ Parigi 6.5 times higher. In order to increase the pollutant load capacity of Situ Parigi, it is necessary to carry out sediment dredging work and the construction of a wastewater treatment plant.

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Pollutant load capacity of Situ Parigi, Banten Province

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A Zharifa, M F Fachrul and D I Hendrawan*

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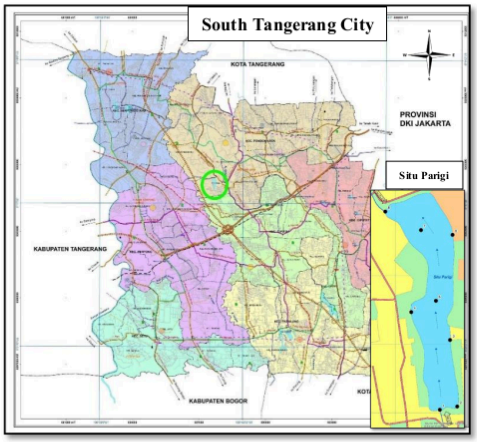

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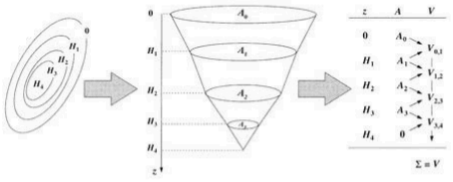

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Annotation:
R = The Total of BOD Residing within the Sediments
ρ = Water Replacement Rate (/year)

- Calculating the BOD capacity per unit area using the formula below:

$$L = \Delta\ [BOD]_d\ \check{Z}\ \rho\ /\ (1-\ R) \quad (6)$$

Annotation:
L = BOD Waste Capacity per Unit Area (mg BOD/m^2.year)
$[BOD]_d$ = Activity Waste BOD Load Allocation in the Waters (mg/m^3)

$\check{Z}$ = Average Depth (m)
ρ = Water Replacement Rate (/year)
R = The Total of BOD Residing within the Sediments

Calculating the total of BOD waste capacity in the waters using the formula below:

$$La = L \times A /100 = \Delta [BOD]_d A \check{Z} \rho /100 (1- R) \quad (7)$$

Annotation:
La = The Total of BOD Waste Capacity in the Waters (kg BOD/year)
L = BOD Waste Capacity per Unit Area (mg BOD/m^2.year)
A = Total Area (m^2)
$[BOD]_d$ = Activity Waste BOD Load Allocation in the Waters (mg/m^3)
$\check{Z}$ = Average Depth (m)
ρ = Water Replacement Rate (/year)
R = The Total of BOD Residing within the Sediments

3. Result and discussion

Situ Parigi has an area of 4 hectares or 40,000 m^2 and an outlet flow of 0.023 m^3/sec. The parameter used in calculating the pollutant load capacity is BOD, due to measuring the water quality of Situ Parigi, value of BOD concentration exceeds the standard quality. The measurement results of BOD concentration is 19.452 mg/L or 19,452 mg/m^3. The permissible BOD concentration according to the quality standards of Government Regulation No. 82 of 2001 for class 2 is 3 mg/L or 3,000 mg/m^3 [6]. Rusly et al. indicated that the water quality is impacted by the activities around, especially the household activities [7].

The dominant pollutant source originates from domestic activities/settlements around Situ Parigi. Activities around Situ Parigi include residential houses, mini markets, restaurants, shops, workshops, laundries, schools, mosque, swimming pool, digital printing, salon, printing shop and a taxi pool. The many activities around Situ Parigi, as well as the piles of garbage in the inlet canal and around the edges, could affect its state of water quality.

The minimum depth measured in Situ Parigi is 0.38 m, while the maximum depth measured is 1.58 m. Situ Parigi has a volume of 34,613.23 m^3. Based on calculations, the rate of water replacement in Situ Parigi is found to be 20.96 per year and the hydraulic residence time is 18.25 days. The results of pollutant load capacity calculations show in **Table 2.**

Table 2. Pollutant load capacity calculations results.

Morphometry	Unit	Value
Area	m^2	40,000
Minimum Depth	m	0.38
Maximum Depth	m	1.58
Average Depth	m	0.98
Volume	m^3	34,613.23
Inlet Flow	m^3/sec	0.28
Outlet Flow	m^3/sec	0.023
Total Water Outflow	m^3/year	725,328
Water Replacement Rate	per year	20.96
Residence Time	year	0.05
	day	18.25
Existing BOD	mg/m^3	19,452
BOD Quality Standard	mg/m^3	3,000
Watershed BOD	mg/m^3	-16,452
R	-	0.22
Pollutant Load Capacity per Area (Quality Standard)	g/m^2 year	79.25
Pollutant Load Capacity per Area (Existing)	g/m^2 year	513.83
Total Pollutant Load Capacity (Quality Standard)	kg/year	3,169.81
Total Pollutant Load Capacity (Existing)	kg/year	20,553.15
Excess Load	-	6.5 times

The capacity of BOD load from the whole area of Situ Parigi is 79.25 g/m^2 year, but existing conditions accommodate a load of 513.83 g/m^2 year. Meanwhile, the BOD load capacity in the waters is 3,169.81 kg/year, however existing conditions accommodate a load of 20,553.15 kg/year. These results show pollution in Situ Parigi which has exceeded its pollutant load capacity. This is also show by the excess of BOD load which reaches 6.5 times higher. Improvement the pollutant load capacity in Situ Parigi can conducted by increasing the volume through sediment dredging work to make deeper, construction a wastewater treatment plant, so the wastewater is not disposed of directly to the water body.

4. Conclusion

Situ Parigi has accommodated BOD loads exceeding its capacity. BOD load capacity of Situ Parigi is 3,169.81 kg/year, but existing conditions show that Situ Parigi accommodates a load of 20,553.15 kg/year. The excess BOD load of Situ Parigi 6.5 times higher. In order to increase the pollutant load capacity of Situ Parigi, it is necessary to carry out sediment dredging work and the construction of a wastewater treatment plant.

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