Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology
Available at http://ejournal.undip.ac.id/index.php/saintek
Vol. 16 No. 3 : 225-234, October 2020

POLLUTION INDEX AND SEDIMENTATION RATE BASED ON LAND USE AT BANJIR KANAL BARAT AND SILANDAK RIVERS, SEMARANG

Pollution Index and Sedimentation Rate based on Land Use at Banjir Kanal Barat and Silandak Rivers, Semarang

Churun Ain, Haeruddin, Siti Rudiyanti, Amryta Dominig, Arina Adriani, dan Dilia Puspita Asih
Study Program of Aquatic Resources Management Departement of Aquatic Resources
Faculty of Fisheries and Marine Science, Universitas Diponegoro
Jl. Prof. Soedarto, SH, Tembalang, Semarang, Jawa Tengah – 50275, Telp/Fax. +6224 7474698
Email: churun.ain80@gmail.com

Received 23 September 2020, Accepted : 29 October 2020

ABSTRACT

Land use around the river, can affect the condition water quality of waters. The purpose of this study are to determine the pollution index and the rate of river sedimentation, and land use around the Banjir Kanal Barat and Silandak River. The method for sampling was purposive sampling. Sampling was carried out in the Banjir Kanal Barat and Silandak River, each of which had 5 points and 2 repetitions (P1 and P2). The variables analyzed were TSS, BOD, COD, total coliform where analyzed with Indonesian Standard National (SNI); DO, pH, temperature, discharge of water analyzed with Water Quality Checker (WQC), Buchanan method used to analyzed sedimentation rate, and sediment fraction. The results of the study, showed that IP in the Banjir Kanal Barat River obtained an IP value of 4.13 (lightly polluted), while the Silandak River obtained an IP value of 4.69 (lightly polluted). The highest sedimentation rate in the Banjir Kanal Barat River with a value of 35.64 tons / day, while the Silandak River has the highest value of 55.81 tons / day. Sediment fraction in Banjir Kanal Barat River is dominated by clay, and Silandak River it is dominated by clay. Land cover in Banjir Kanal Barat river are 3% industry, 85% settlement, 0% water and 12% vegetation, and Silandak River are 7% industry, 69% settlement, 5% water and 7% vegetation.

Keywords: Pollution Index; Sedimentation Rate; Sediment Fractions; Land Use

INTRODUCTION

Banjir Kanal Barat and Silandak are rivers that flow into central Semarang Bay, they both have the same function as a drainage system. Banjir Kanal Barat river has a function as a drainage system for Central Semarang and Silandak river for West Semarang. This is stated in Semarang Mayor Regulation number 18 of 2014 about the work plan for the development of the city of Semarang in 2015 that the potential hydrological conditions of water in the city of Semarang originate from the rivers that flow in the city of Semarang.

According to regulation of minister of environment (KepMen LH no. 115 of 2003) about guidelines for determining the status of water quality, that the pollution index is used to determine the level of pollution relative to permissible water quality parameters. This index has a different concept from the water quality index. Pollution index is determined for a designation, then can be developed for several uses for the entire body of water or part of the river. Management of water quality on this pollution index can assess the quality of water bodies for a desgination and take action to improving quality if there is a decrease in quality due to the presence of pollutant. The Pollution Index includes a meaningful and independent group of quality parameters.

Sedimentation is the deposition of rock material transported by hydropower or wind, when erosion occurs, water-carrying rocks flows into rivers, lakes and eventually reaches the sea. When the carrying force decreases, the rocks are deposited in the watercourse (Hambali and Yayuk, 2016). The sediment deposition process can be estimated through the size of the sediment grains. Grain size distribution can explain of spatial changes, sedimentation, sedimentary environmental characteristics, grain size distribution, sorting, and identification of suspension sediment resources (Nugroho and Abdul, 2014). Grain size distribution is influenced by several factors such as the type of transportation agent, waves tides, local winds, episodic storms which have their own spatial and temporal characteristics (Liu *et al*, 2000). The measurement of sediment rate is closely related to the variable of river discharge, TSS, and sediment fraction..

Along the river floor canals and silandak there are various kinds of land cover such as industry, settlement, and vegetation. As a result, there are many community activities whose waste disposal can affect river conditions. According to Suthar *et al.* (2009), rapid population growth, land development along river flow, urbanization and industrialization making rivers under pressure causing water pollution and environmental damage. Whether the river is

polluted or not can be determined by measuring the pollution index. There are many instrument to measure of river pollution such as uses storet, WQI (water quality Index), IP (poluution index), and CCME which has its own advantages to assess of human activities impact and seasonal variation on river (Altansuukh, A dan Davva, G, 2011; Anhwange,.et al., 2012). Besides, the existence of land cover activity around the river can affect the amount of sedimentation in the river. Based on the description, it is necessary to measure the status of water quality to determine the index of water pollution and sedimentation rate in Banjir Kanal Barat and Silandak river. The purpose of this study was to determine the pollution index and a river sedimentation rate and land cover around the Banjir Kanal Barat and Silandak river.

RESEARCH METHODS

Material

The materials used in this research are water and sediment samples from Banjir Kanal Barat and Silandak rivers. The variables measured were temperature, nitrate, phosphate, TSS, BOD, COD, DO, pH, total coliform, river discharge, sedimentation rate, and sediment fraction. Processing land cover mapping around the river using a geographic information system

Research Method

The method used in this research is the descriptive quantitative method, while the sampling method is purposive sampling, 5 points are taken from upstream to downstream Banjir Kanal Barat and Silandak rivers. Determination of the sampling point selected based on the characteristic of land cover. Sampling was carried out twice on October 15th and 17th October 2018. First repetition on October 29th and the second repetition on November 1st, 2018. The following is the sampling location on the Banjir Kanal Barat and Silandak river presenters in tables 1 and 2 as shown in figures 1 and 2.

Table 1. Map of sampling locations on the Banjir Kanal Barat river

Point	Coordinate	Description
1	S : 07º01’22.9” E : 110º22’41.0”	Point 1 is at Kalipancur, Sukorejo, Gunungpati Semarang City, where this point is upstream of the Banjir Kanal Barat River. There are residential areas and agricultural fields close to the research point.
2	S : 06º59’43.27” E : 110º24’07.90”	Point 2 is on Jalan Kaligarang, West Semarang. This location is close to PDAM. The distance between points 1 and 2 is 4 Km. This point has a lot of trash in the water and domestic waste disposal. The condition of the waters is quite cloudy due to sediment.
3	S : 06º58’36.37” E : 110º24’05.30”	Point 3 is on Jalan Madukoro Raya, the distance between point 2 and point 3 is 3 Km, many residential and industrial settlements
4	S : 06º58’10.25” E : 110º24’02.43”	Point 4 is on Jalan Madukoro Raya, the distance between points 3 and 4 is 0,79 Km. This point has is close to the estuary used as the boat dock
5	S : 06º57’42.19” E : 110º23’58.92”	Point 5 is on Jalan Madukoro Raya, this point is close to the estauary of Marina Beach. The distance between points 4 and 5 is 0,87 Km. There are domestic and industrial activties and sewerage

Table 2. Map of sampling location on the Silandak river

Poin	Coordinate	Description
1	S : 06º59’37.37” E : 110º22’9.40”	Point 1 is under the Krapyak-Jatingaleh toll bridge, Kembangarum Village, West Semarang, near of upstream Silandak River. There are settlements and development activities
2	S : 06º59’22.23” E : 110º22’10.45”	Point 2 is on Jalan Sriwibowo, Kembangarum Village, West Semarang, the distance between points 1 and 2 is 0,47 Km. There are settlements and has a lot of domestic waste
3	S : 06º58’50.50” E : 110º22’34.02”	Point 3 is on Jalan Muradi Raya, Kalibanteng Kulon, West Semarang, the distance between points 2 and 3 is 1,42 Km. There are residential area and industry. The wastewater is discharged into the water so that it flows to point 3, 4, and 5
4	S : 06º57’42.50” E : 110º21’33.92”	Point 4 is near to Maron Beach, the distance between point 3 and 4 is 0,44 Km near from estuary and has a lot of mangrove on the side
5	S : 06º57’17.7” E : 110º21’34.85”	Point 5 is on Jalan Tirang Beach, Ahmad Yani Airport, point 5 is the downstream of the river from a Maron Beach estuary. The distance between point 4 and 5 is 1,21 Km

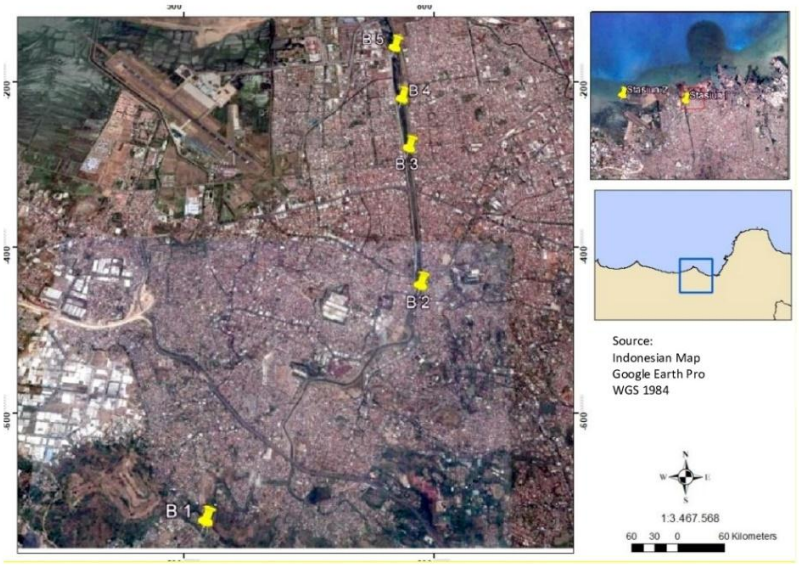

Figure 1. Map of sampling location on the Banjir Kanal River

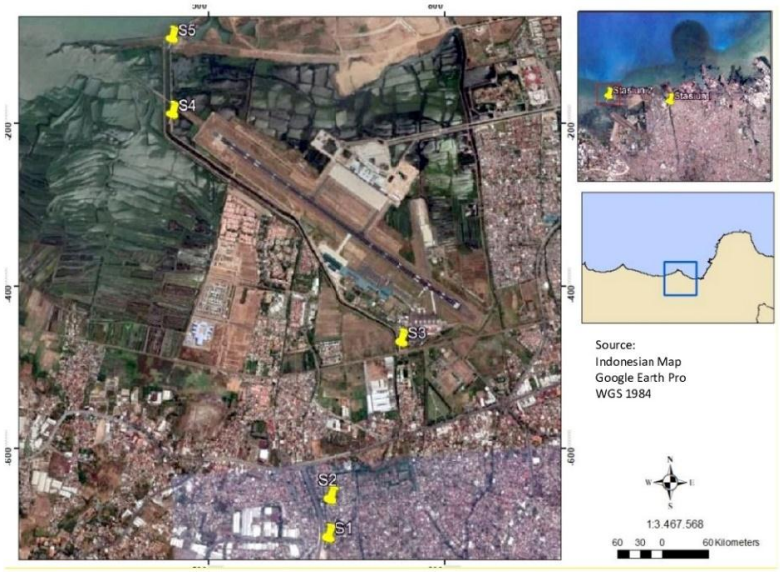

Figure 2. Map of location on the Silandak river

Sample Analysis Method

Water quality parameters are measured in situ and ex situ. The parameters measured in situ were temperature, river discharge, pH, and DO. While the parameters measured ex situ or laboratory are BOD, COD, total coliform, TSS, sedimentation rate, and sediment fraction.

The water sample obtained is then analyzed in the laboratory. The method was used for BOD analysis based on SNI 01-2332.1-2006, TSS analysis is based on SNI 06 6989.3-2004. Total Coliform analysis is based on SNI 2332.3.2015. Measurement and analysis of several parameters such as temperature, river discharge, pH, DO, use water quality checker.

Data Analysis

Pollution Index

The results of measurement of water quality variables were obtained and compared with quality standard class II based on Governmental Regulation (PP) No. 82 of 2001 and then analysing by Pollution Index method. The pollution index is expressed by the value of Ci and Li. Ci is the concentration of water quality parameters dana Li is the concentration of water quality parameters based on water quality standards. Method to determine IP value based on regulation of minister of environment (Kepmen LH) No. 115 of 2003 :

$$PI_j = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}} \quad \text{..... (1)}$$

Note :
PIj = Pollution Index for (J) function of Ci/Lij
Ci = Concentration of the measured parameter
Lij = Concentration parameter of the water quality standar
$\left(\frac{Ci}{Lij}\right)^2 M$ = Value of Ci/Lij Maximum
$\left(\frac{Ci}{Lij}\right)^2 R$ = Value of Ci/Lij Rata-rata

After getting Pij value, water quality can be evaluated by determining the water quality status agains the Pij value in the following categories :

$0 \leq PI_j \leq 1,0$: Meet quality standard
$1,0 < PI_j \leq 5,0$: Lightly polluted
$5,0 < PI_j \leq 10$: Moderately polluted
$PI_j > 10$: Heavily polluted

Sediment Rate Analysis

Sedimentation rate can be determined using calculations according to the SCS National Enginering handbook DPMA, 1986

$$Qs = 0,0864 \times Cs \times Q \quad \text{..... (2)}$$

Note : Qs = Sediment Discharge (ton/day); Cs = Floating load rate or sedient concentration (TSS mg/l); Q = water discharge (m^3/s)

Sedimentation Rate

Sedimen grain fraction analysis using Buchanan method (1971):

$$\text{Sand Fractioon} = \frac{\text{Total weight (gr)}}{\text{Total sample weight}} \times 100\% \quad \text{..... (3)}$$

$$\text{Silt Fraction} = \frac{\text{Total weight of the sludge fraction (gr)}}{\text{Total sample weight}} \times 100\% \quad (4)$$

$$\text{Clay fraction} = 100\% - \%\ \text{Sand fraction} - \%\ \text{Sludge fraction} \quad (5)$$

Land Cover

The value of the sediment fraction and sedimentation rate that has been analyzed then plotted according to the longiutde and latitude coordinate for making land cover maps. Steps that need to be done :

1. Add Data

Add data serves to add administrative map data and downloaded land use maps in .shp format and there is Add XY data which used to add data on the concentration of nitrate and phosphate-based on the longitude and altitude coordinate

2. Classification

Classification using a supervised technique which used to classify land use characteristic based on the training sample made

3. Symbology

Symbology functions to mark the sampling point and display the inputted data

4. Layouting

Layouting is the process of compiling map information, such as title, scale, cardinal directions, insets, and sources. The results of the distribution pattern of nitrate and phosphate, then add map information and export to JPG format.

The steps in calculating the percentage of land cover of Banjir Kanal Barat and Silandak river :

1. Measure the distance between Banjir Kanal Barat and Silandak River
2. Limit the area of land-use area of both
3. Identify the area of land use such as industry, settlement, vegetation, and water of both
4. Calculate the percentage value of each land use characteristic in the two rivers

RESULTS AND DISCUSSION

Result

Pollution Index

The results of measurement of water quality parameters and pollution index refer to KepMen LH No. 115 of 2003 regarding guidelines for determining the status of water quality. Pollution Index from station A (Banjir Kanal Barat River) and B (Silandak river) on table 3 and 4 (Appendix).

BOD/COD Ratio

The Ratio BOD/COD from station A (Banjir Kanal Barat river) is 0.38 (P1) and 0.43 (P2), Station B (Silandak river) is 0.47 (P1) and 0.20 (P2). The ratio shows the pollutants at stations A and B are biodegradable, range 0.1-1 (Samudro dan Mangkoediharjo, 2010).

Tabel 5. Ratio of BOD/COD

Point	A P1		Ratio	A P2		Ratio	B P1		Ratio	B P2		Rasio
	BOD	COD	BOD/COD	BOD	COD	BOD/COD	BOD	COD	BOD/COD	BOD	COD	BOD/COD
1	5.12	14.26	0.36	6.72	10.17	0.66	9.05	21.55	0.42	7.02	34.17	0.21
2	16.72	61.72	0.27	21.7	57.39	0.38	16.34	36.70	0.45	5.70	44.08	0.13
3	9.12	33.09	0.28	6.34	19.19	0.33	16.69	22.14	0.75	8.39	30.49	0.28
4	9.18	18.73	0.49	11.52	25.53	0.45	9.43	23.5	0.40	10.09	69.13	0.15
5	14.54	29.08	0.50	16.51	63.53	0.26	10.97	34.76	0.32	2.86	37.86	0.08
	$\bar{X}$ Ratio BOD/COD		0.38			0.42			0.47			0.20

Sedimentation Rate And Sedimen Fraction

The results of the measurement of sedimentation rate were obtained at point 1 is upstream of the river which was dominated by moor and garden, with a precentage ratio of vegetation land cover is 12%. Sediment rate P1 and P3 is 0.043 ad 0.61 ton/day. Poin 2 and 3 dominated with residential area 85% with sediment rate P1 is 0.73 and 0.33 ton/day, P2 is 3.39 and 1.78 ton.day. Point 4 and 5 dominated with open fields or vegetation 12% with sedimentation rate P1 is 3.,47 and 35.46 ton/day and P2 2 is 17.79 and 11.15 ton/day. While on the Silandak river point 1 and 2 is residential area 69%, rate value P1 is 0.12 and 0.02 ton/day, while P2 is 0.97 and 0.43 ton/day. Point 3 is vegetation 7 %, rate value is 0.85 and 0.97 ton/day. Point 4 and 5 is the pond and near to sea 5 %, value rate sedimentation P1 is 0.85 and 2.36 ton.day, while P2 is 17.28 and 55.81 ton/day.

The distribution of sediment fractions upstream of Banjir Kanal Barat river on point 1 is open filed with sediment type P1 and P2 is clay-sand. Points 2 and 3 dominated by residential area 85%, sediment type of point 2 is clay-silt and P2 is clay, point 3 each repetition (0.0005-0.002 mm) and clay-silt. Point 4 is residential area 85%, sediment fraction P1 is clay (<0.002 mm) and P2 is clay-dust. Point 5 rounded by vegetation 12 %, sediment type each repetition is clay-silt. Distribution of sediment fraction Silandak river on point 1 and 2 is residential area 69%, sediment type point on P1 sand (>2mm) and P2 clay-sand, point 1 on P1, and P2 sand (>2mm) point 3 there is irigation by rice fields 7%, sediment type P1 and P2 is point 4 each repetition clay (<0.002mm). Point 4 and 5 is the pond near to sea 5% sediment type on point 4 each repetition is clay (<0.002 mm) and point 5 P1 is clay-dust, while P2 is clay (<0.002 mm). The following is a map of land cover and sedimentation rate result and fraction sediment of Banjir Kanal River and silandak rivers on repetition 1 and 2 :

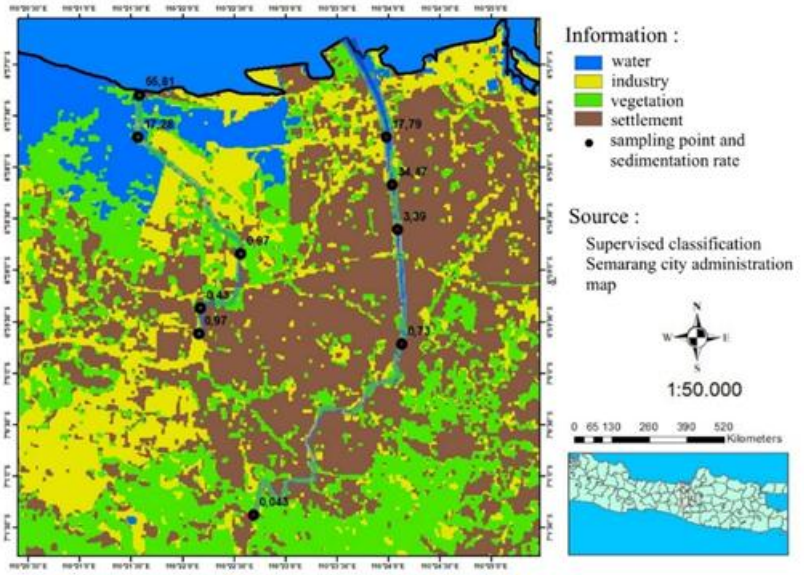

Figure 3. Map of Land Cover And Sedimentation Rate on BKB and SS repetition 1

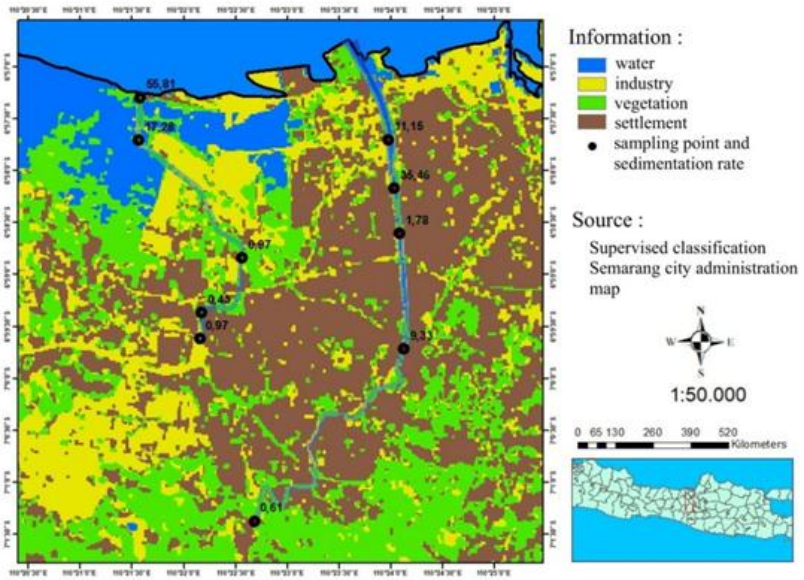

Figure 4. Map of land cover and sedimentation rate on BKB and SS repetition 2

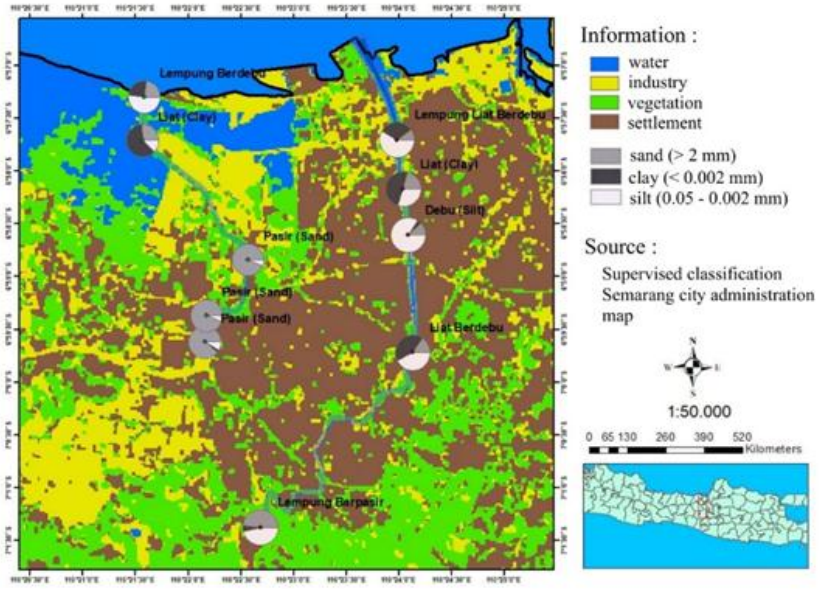

Figure 5. Map of Land Cover and Sediment Fraction BKB and SS Repetition 1

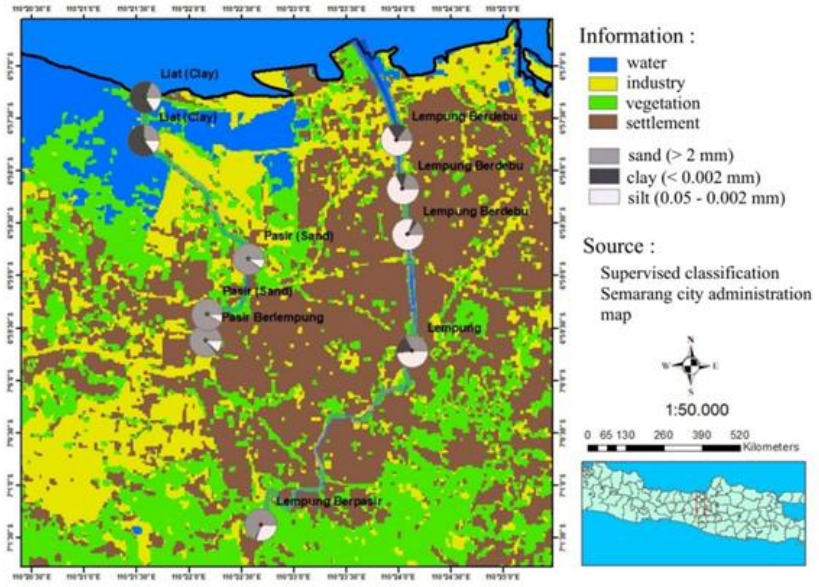

Figure 6. Map of Land Cover and Sediment Fraction BKB and SS Repetition 2

Table 6. The Calculation Results of Sedimentation Rate Banjir Kanal Barat and Silandak River

Point	Sedimentation rate (Qs)BKB		Sedimentation rate (Qs)Silandak	
	P1 (ton/day)	P2 (ton/day)	P1 (ton/day)	P2 (ton/day)
1	0.043	0.61	0.26	0.97
2	0.73	9.33	0.08	0.43
3	3.39	1.78	0.85	0.97
4	34.47	35.46	0.19	17.28
5	17.79	11.15	1.12	55.81

Tabel 7. The Calculation Sediment Fraction Banjir Kanal Barat River

Point	Repetition I				Repetition II			
	A(%)	B(%)	C(%)	Information	A(%)	B(%)	C(%)	Information
1	48.36	5.64	46	Clay-sand	68.6	1.4	30	Clay-sand
2	15.56	42.44	42	Clay-silt	32.24	19.76	48	Clay
3	12.24	3.76	84	Silt	14.6	5.4	80	Clay silt
4	20.84	49.16	30	Clay	21.52	10.48	68	Clay silt
5	9.56	32.44	58	Clay Clay-silt	14.8	19.2	66	Clay silt

Tabel 8. The Calculation Sediment Fraction Silandak River

Poin	Repetition I				Repetition II			
	A(%)	B(%)	C(%)	Information	A(%)	B(%)	C(%)	Infromation
1	88.72	3.28	8	Sand	85.8	2.2	12	Clay-sand
2	93.16	0.84	6	Sand	91.68	0.32	8	Sand
3	93.32	0.68	6	Sand	88.72	1.28	10	Sand
4	25.68	62.32	12	Clay	25.08	60.92	14	Clay
5	23	25	52	Clay-silt	18.72	65.28	16	Clay

Information : A : Sand (> 2mm); B : Clay (< 0.002 mm); C : Slit (0.005 – 0.002 mm)

Land Cover

Percentage of land cover on Banjir Kanal Barat there is the largest percentage a residential area with 85%, while the lowest percentage is water with 0%. Vegetation with 12 % and industry with 3%. The land cover area of Banjir Kanal Barat river is 2211 ha.

Percentage of land cover on Silandak river is the largest percentage is residential area with 69%, while the lowest percentage is vegetation with 7%. Water with 5% and vegetation with 7%. Land cover area of Silandak river is 1623 ha.

Table 9. Comparison of Percentage of Land Cover on Banjir Kanal Barat and Silandak river

River	Land Cover (%)			
	Industrial	Residental	Water	Vegetation
BKB	3	85	0	12
SS	7	69	5	7

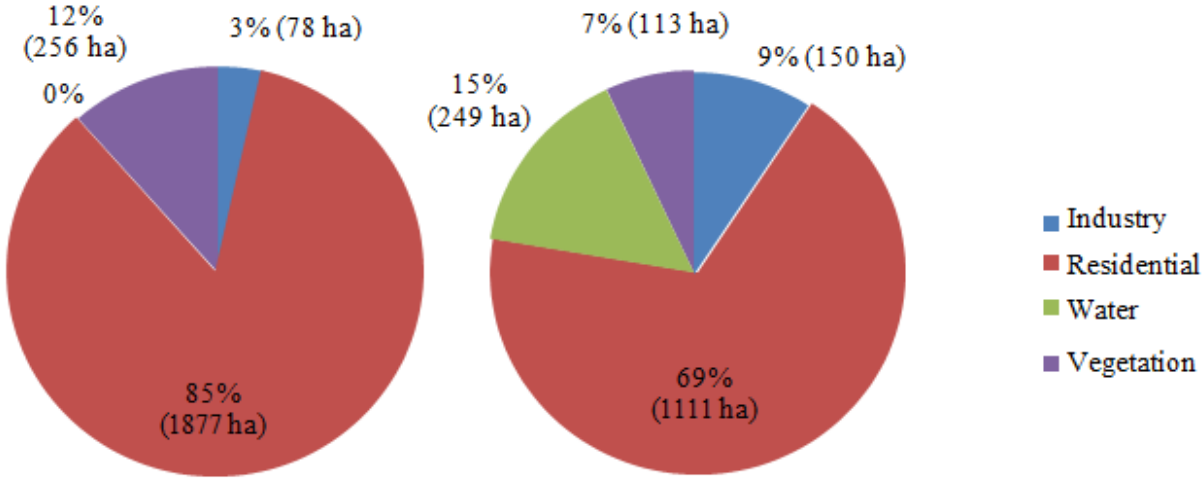

Figure 7. Percentage of land cover Banjir Kanal Barat and Silandak river

Discussion

Pollution Index

Banjir Kanal Barat river water quality status for class II with Pollution Index 4,13. According to KepMen Lh No. 115 of 2003, if the index value is between <1,0 IP<, classified as light pollution. This shows the Banjir Kanal Barat river can still be used for water recreation, fish cultivation, the farm, and water for irrigation. Pollution that occurs in rivers is industrial and domestic. This is evidenced by the land cover around the Banjir Kanal Barat river with 3% (industry) and 85 %(residential area). The high land cover of the settlements has resulted in a large number of domestic waste dumps. Domestic waste has an impact on increasing organic matter. According to Supriyantini *et al.* (2017), organic materials come from waters, through the process of decomposition, weathering of domestic

waste, industry, agriculture, waste of farm or remaining feed that is broken down by bacteria become nutrients. High organic matter content causes high BOD values and low oxygen values.

Silandak river water quality status for class II with Pollution Index 4,69, classified as light pollution. The pollution is caused by the land cover around the Silandak River. Land cover dominated with residential area with percentage 69%. Condition of solid residential land cover and direct waste disposal into the river can increase anthropogenic pollutants. According to Shefiana *et al.,* (2017), if the waste is disposed of directly into the river without treatment it will increase BOD, COD ,DO, free chlorine, and phosphate increases.

The value of the BOD/COD ratio obtained from Banjir Kanal River is 0.38 (P1) and 0.42 (P2), while Silandak River is 0.47 (P1) and 0.20 (P2). The ratio shows the pollutant in stations A and B are biodegradable. The ratio of BOD/COD is an indicator of the level of degradation of waste. According to Mangkoedihardjo (2010) on Tamyiz (2015), the ratio of BOD/COD is nothing more than an indicator for the impact output of organic substances in water, waste, leachate, compost, similar materials in natural and artificial, environments. A ratio of BOD/COD a good ratio is in the biodegradable range is 0.1-1 (Samudro and Mangkodiharjo, 2010). The ratio increase in the ratio indicates a high rate of wastewater biodegradation (Pirsaheba *et al.,* 2015).

Sediment Rate and Sediment Fraction

The highest sedimentation rate on Banjir Kanal Barat river is 35.64 ton/day land use dominated by open fields and residential areas with a percentage of 12% open fields, and 85% for residential area, high sedimentation rate can be affected by waste disposal and erosion and causes silting of waters. According to Assyuhada *et al*, (2016), particles that accumulate at the bottom of the waters will cause silting of the waters, and it will disturb the aquatic ecosystem. Sediment fraction on Banjir Kanal river dominated by clay, this is influenced by the soil entering the river in the form of solids due to erosion caused by rain, at the midpoint in the form of sediment originating from the upstream.

Silandak river has a high value of 55.81 ton/day, this can be affected by the location of sampling and related to the sea with land used percentage 5% while sediment materials also affected. According to Dominiq *et al*, 2019, the transport of sediment from the upstream rivers to the sea causes sediment accumulation. The dominant sediment fraction was clay (<0.002 mm). At the sampling point, there were mangroves. According to (Dominig *et al.,* 2019), mangrove plants can dampen currents so that the sediment grains that settle will be smoother.

CONCLUSION

Based on the result of the research that has been done, it can be concluded that the results of Pollution Index calculations in Banjir Kanal Barat River obtained a Pollution Index of 4.52 in P1 and 4,-1 in P2, and the waters are classified as lightly polluted, while the Silandak River obtained and Pollution Index value of 3.89. At P1 and 5.36 on P2, and they are classified as lighly polluted at P1 and moderately polluted at P2. The highest sedimentation rate in the west flood Canal River with a value of 35.64 ton/ day, while Silandak River has the highest value, namely 55.81 ton/day. The sediment fraction in the Banjir Kanal River is dominated by clay, while the Silandak River is dominated by clay. Land cover in the Banjir Kanal river is 3% industry, 85% residential, 0% water and 12% vegetation, while in Silandak River is 7% industry, 69% residental area, 5% water, and 7% vegetation.

ACKNOWLEDGMENT

The author thanks Allah SWT for bestowing His grace and guidance so that the author can complete this research. Thank you also for the research grant from the Faculty of Fisheries and Marine Sciences 2018. No: 1501-6/UN7.5.10/LT/2018 with the title “Analysis of Pollution Load and Purification Capacity of The River that empties into Semarang Bay” which has helped in the process of writing research result this.

REFERENCES

Altansuukh, A dan Davva, G. 2011. Application of Index Analysis to Evaluate The Water Quality of The River in Mongolia. Journal of Water Resources and Protection 3: 394-414

Anhwange, B.A., E.B. Agbaji, and E.C. Gimba. 2012. Impact Assessment of Human Activities and seasonal Variation on River Benue, Within Makurdi Metropolis. Journal of Sciences and Technology,2. 248-254

Assyuhada, R. D. Putra dan F. Idris. 2016. Laju Volume Akumulasi Sedimen di Perairan Pesisir Kampung Bugis Kecamatan Tanjungpinang Kota Provinsi Kepulauan Riau. Jurnal Umrah. 07:1-12.

Dominig. A., M. R. Muskananfola dan C. A’in. 2019. Laju Sedimentasi Perairan Sungai Silandak, Semarang Barat. Jurnal Maquares. Universitas Diponegoro. 8(3): 126-132.

Hambali. R dan Y. Apriyanti. 2016. Studi Karakteristik Sedimen dan Laju Sedimentasi Sungai Daeng-Kabupaten Bangka Barat. Jurnal Fropil, 4(2):165-174

Keputusan Menteri Lingkungan Hidup Nomor 115 Tahun 2003 Tentang Pedoman Penentuan Status Mutu Air.

Liu, J.T., J.S. Huang, R.T. Hsu dan J.M.Chyan. 2000. *The Coastal Depositonal System of a Small Mountainous River: A Perspective From Grain-size Distributions. Marine Geology*, 165:63-86

Nugroho. S.H dan A. Basit. 2014. Sebaran Sedimen Berdasarkan Analisis Ukuran Butir di Teluk Weda, Maluku Utara. Jurnal Ilmu dan Teknologi Kelautan Tropis, 6(1):229-240

Peraturan Pemerintah Republik Indonesia Nomor 82 tahun 2001 Tentang Pengelolaan Kulaitas Air dan Pengendalian Pencemaran Air.

Peraturan Walikota Semarang Nomor 18 tahun 2014 Tentang Rencana Kerja Pembangunan Daerah (RKPD) Kota Semarang tahun 2015.

Pirsaheba, M., M. Ghayebzadeh, M. Moradi, F. Gharagozlou dan K. Sharafi. *Ratio Variations of Soluble to Total Organic Matters at Different Units of A Full Scale Wastewater Integrated Stabilization Pond*. *Journal of Chemical and Pharmaceutical Research*. 7(5): 1326-1332.

Samudro, G. dan S. Mangkoedihardjo. 2010. *Review on BOD, COD and BOD/COD Ratio: A Triangle Zone For*

Toxic, Biodegradable dan Stable Levels. International Journal of Academic Research. 2(4): 235-239.

Sheftiana, U.S., A. Saminingsih dan W.D. Nugraha. 2017. Penentuan Status Mutu Air Sungai Berdasarkan Metode Indeks Pencemaran Sebagai Pengendalian Kualitas Lingkungan (Studi Kasus : Sungai Gelis, Kabupaten Kudus, Jawa Tengah). Jurnal Teknik Lingkungan. 6(1): 1-10.

Standar Nasional Indonesia Nomor 01-2332.1-2006. Penentuan Coliform dan *Escherichia coli* pada Produk Perikanan.

Standar Nasional Indonesia Nomor 6989.72:2009. Cara Uji Kebutuhan Oksigen Biokimia (*Biochemical Oxygen Demand*/ BOD).

Standar Nasional Indonesia Nomor 6989.73:2009. Cara Uji Kebutuhan Oksigen Kimiawi (*Chemical Oxygen Demand*/ COD).

Supriyantini, E., R.A.T. Nuraini dan A.P. Fadmawati. 2017. Studi Kandungan Bahan Organik Pada Beberapa Muara Sungai di Kawasan Ekosistem Mangrove, di Wilayah Pesisir Pantai Utara Kota Semarang, Jawa Tengah. Buletin Oseanografi Marina. 6(1): 29–38.

Suthar, S., A. K. Nema., M. Chabukdhara., dan S. K. Gupta. 2009. Assesment of Metals in Water and Sediments of Hindon River, India : Impact of Industrial and Urban Discharges. *Journal of Hazardous Materials*. 171 : 1088-1095.

Tamyiz, M. 2015. Perbandingan Rasio BOD/COD pada Area Tambak di Hulu dan Hilir Terhadap BiodegradabilitasBahan Organik. *Journal of Research and Technology*. 1(1): 9-15.

APPENDIX

Table 3. Water Measurement and Pollution Index Measurement of Banjir Kanal Barat for Repetition 1 and 2

Parameter	Sampling Point															Quality standarts	Calculation									
	A1			A2			A3			A4			A5				A1		A2		A3		A4		A5	
																Class II	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new
	P1	P2	x	P1	P2	x	P1	P2	x	P1	P2	x	P1	P2	x	Deviation										
Temperature	30	28	29	31	30	30.50	31	32	31.50	34	35	34.50	33	34	33.50	3	0.08	0.08	0.23	0.23	0.46	0.46	0.92	0.92	0.77	0.77
TSS	20	20	20	80	80	80	40	20	30	380	380	380	200	100	150	50	0.40	0.40	1.60	2.02	0.60	0.60	7.60	5.40	3	3.39
Nitrate	2.11	2.31	2.21	3.42	3.49	3.46	2.56	2.49	2.53	3.80	2.31	3.055	3.21	3.69	3.45	10	0.22	0.22	0.35	0.35	0.25	0.25	0.31	0.31	0.35	0.35
Phospate	0.64	0.65	0.65	0.99	1.54	1.27	1.57	1.12	1.35	2.17	1.17	1.67	1.30	1.55	1.43	0.20	3.23	3.55	6.33	5.01	6.73	5.14	8.35	5.61	7.13	5.27
BOD	5.12	6.27	5.70	16.72	21.70	19.21	9.12	6.34	7.73	9.18	11.52	10.35	14.54	16.51	15.53	3	1.90	2.39	6.40	5.03	2.58	3.06	3.45	3.69	5.18	4.57
COD	14.26	10.17	12.22	61.72	57.39	59.56	33.09	19.19	26.14	18.73	25.53	22.13	29.08	63.53	46.31	25	0.49	0.49	2.38	2.88	1.05	1.11	0.89	0.89	1.85	2.34
DO	8	7	7.50	1.40	1.20	1.30	6.80	1.16	3.98	3.20	5.36	4.28	4.39	7.4	5.90	4	0.01	0.01	0.45	0.45	0.25	0.25	0.23	0.23	0.09	0.09
pH	8	7	7.50	8	8	8	8	7	7.50	8	7	7.50	8	7	7.50	6-9	0.15	0.15	0.33	0.33	0.15	0.15	0.15	0.15	0.15	0.15
Total Coliform	3500	280	1890	13000	240	6620	780	620	700	1700	340	1020	450	16000	8225	5000	0.38	0.38	1.32	1.60	0.14	0.14	0.20	0.20	1.65	2.09
								(Ci/Li)M													5.61					
								(Ci/Li)R													1,63					
								IP BKB													4,13					

Table 4. Water Measurement and Pollution Index Silandak River Repetition 1 dand 2

Parameter	Point sampling															Baku mutu	Calculation									
	B1			B2			B3			B4			B5				B1		B2		B3		B4		B5	
																Class II	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li new	Ci/Li	Ci/Li baru
	P1	P2	x	P1	P2	x	P1	P2	x	P1	P2	x	P1	P2	x											
Temperature	32	32	32	31	31	31	31	31	31	31	31	31	31	30	30.5	Deviastion3	0.62	0.62	0.38	0.38	0.38	0.38	0.38	0.38	0.23	0.23
TSS	40	140	90	20	100	60	120	140	130	200	400	300	360	380	370	50	1.80	2.28	1.20	1.40	2.60	3.07	6	4.89	7.40	5.35
Nitrate	0.59	1.69	1.14	2.07	3.28	2.67	2.28	1.31	1.79	2.21	2.35	2.28	2.35	2.42	2.38	10	0.11	0.11	0.27	0.27	0.18	0.18	0.23	0.23	0.24	0.24
Phospate	1.16	1.10	1.13	1.05	3.82	2.43	1.24	1.34	1.29	0.69	0.49	0.59	0.54	0.52	0.53	0,2	5.65	4.76	12.18	6.43	6.45	5.05	2.95	3.35	2.65	3.12
BOD	9.05	7.02	8.03	16.34	5.70	11.02	16.69	8.39	12.54	9.43	10.09	9.76	10.97	2.86	6.91	3	2.68	3.14	3.67	3.82	4.18	4.11	3.25	3.56	2.31	2.82
COD	21.55	34.17	27.86	36.70	44.08	40.39	22.14	30.49	26.31	23.50	69.13	46.31	34.76	37.86	36.31	25	1.11	1.23	1.62	2.05	1.05	1.11	1.85	2.34	1.45	1.81
DO	1.60	1.20	1.40	5.64	6.80	6.22	10.20	11.10	10.65	5.24	10.80	8.02	7.50	15.10	11.30	4	0.45	0.45	0.09	0.09	0.23	0.23	0.04	0.04	0.28	0.28
pH	7	7	7	7	8	7.50	8	8	8	8	8	8	8	8	8	6-9	0.33	0.33	0.15	0.15	0.33	0.33	0.33	0.33	0.33	0.33
Total Coliform	1600	4000	2800	5400	2100	3750	460	110	285	140	33	86.50	460	23	241.5	5000	0.56	0.56	0.75	0.75	0.06	0.06	0.02	0.02	0.05	0.05
								(Ci/Li)M													6.43					
								(Ci/Li)R													1.62					
								IP Silandak													4.69					

Note : IP = Pollution Index; Ci = Concentration of the measured variable; Li = The Concentration of water quality variables in the quality standar (Ci/Li)R = Value of Ci/Li average; (Ci/Li)M = Value Ci/Li Maximum.