The Assessment of Biological and Pollution Index of Estuaries Around Port of Tanjung Emas Semarang

by Agus Tjahjono, O Wahyuni And S Purwantini

IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

The Assessment of Biological and Pollution Index of Estuaries Around Port of Tanjung Emas Semarang

To cite this article: A Tjahjono *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **116** 012087

The Assessment of Biological and Pollution Index of Estuaries Around Port of Tanjung Emas Semarang

A Tjahjono[1*], O Wahyuni[2] and S Purwantini[3]

[1]Engineering Department, Semarang Merchant Marine Polytechnic, Singosari 2 a Semarang, Central Java, Indonesia
[2&3]Port & Shipping Department, Semarang Merchant Marine Polytechnic, Singosari 2 a Semarang, Central Java, Indonesia
*+62 0813 2610 5514, a_agus_tjahjono70@yahoo.co.id

Abstract. Estuary is a place of accumulation of the population's actitivites produced by domestic, industry or agriculture. This research was conducted to three of estuary of the rivers around the waters of Port of Tanjung Emas Semarang (PTES). They were estuaries of Baru river, Banjir Kanal Timur (BKT) and Siangker in west monsoon from October to December 2015. The purpose of this research was to analyze pollution index, the abundance of microorganisms either phytoplankton or zooplankton, the content of heavy metal in sediment and sea water, biological index that included diversity (H), uniformity (e), dominance (D), Saprobik Index (SI), and the Total of Saprobik Index (TSI) in the waters either HTL (High Tide Level) or LTL (Low Tide Level). The concentration of heavy metal in both sea water and sediments were analyzed by using Atomic Absorption Spectrophotometer (AAS). The result obtained from 12 parameters which were tested showed that the three waters can be categorized at heavily polluted condition at each value from 12.52 to 24.98. The concentration of heavy metal at sea water during HTW and LTW ranging from Cd is around 0.033 and 0.048 mg/kg, Cu 0.047 and 0.07 mg/kg, Pb 0.48 and 0.71 mg/kg, and Zn 0.043 and 0.057 mg/kg. The saprobity value index based on the existence of phytoplankton or zooplankton was ranging of Oligosaprobik at low pollution or has not been polluted yet.

Keywords : Port of Tanjung Emas Semarang (PTES), pollution index, heavy metal, biological index, west monsoon.

1. Introduction

Coastal areas and river estuaries are susceptible area of pollution from upstream. Pollution in the river estuary area is caused by frequent activity by both domestic and shipping industries in the region [1].

Kali Baru river estuaries located in the Port of Tanjung Emas Semarang (PTES), beside the domestic pollution from upstream, port activities such as shipyards, power plants, ship activities in the region have affected the estuary. Banjir Kanal Timur estuary is an area that is also close to PTES waters and a fishing area where the water quality is influenced by fishing activities and discharges from domestic households in the area. Siangker Estuary is a river estuary located in the west side of PTES close to the airport that will affected to the river estuary.

The purpose of this research is to analyze the value of Kali Baru river estuary pollution, BKT (Banjir Kanal Timur) and Siangker in terms of diversity (H '), uniformity (e), dominance (D), Saprobik Index (SI) and Total Saprobik Index (TSI) in both phytoplankton and zooplankton at HTL (High Tide Level) and LTL (Low Tide Level). Analysing the heavy metal concentrations Cu, Cd, Pb and Zn in both seawater and sediment. The last calculation of the pollution index on the territorial waters

2. Material and Methods

The research was conducted at the coastal estuaries around the Port of Tanjung Emas Port Semarang (PTES) in 3 areas with 3 research station, 1st station (estuary Kali Baru), 2nd station (estuary Banjir Kanal Timur) and 3rd station (estuary Siangker). Research conducted from October to December 2015.

Phytoplankton identification includes phytoplankton endemic in port waters, environmental parameters other than depth, current velocity, direction of current at each station also physical parameters (brightness, BOD_5, DO, temperature), chemical parameters (pH, salinity), while phytoplankton was analyzed using individual abundance (N), index of species diversity (H'), fairness index (E), dominance index (D), Saprobic Index (SI) and Total Saprobic Index (TSI) [2,3,7].

Abundance of individuals (N)

$$N = \frac{1}{A} x \frac{B}{C} x \frac{D}{E} x F \quad (1)$$

Where
N = abundance (individual/liter),
A = volume of filtered water (liter),
B = volume of water in sample (125 ml),
C = volume of preparation at identification (1 ml),.
D = breadth of glass cover (mm^2),
E = field view area (mm^2),
F = average number of observed individuals

The diversity index and equitability index by Shannon-Wier (1949),

$$H' = - \Sigma \text{ (pi ln pi)} \quad (2)$$

Where
H '= index of species diversity,
Ni = species abundance at rank -1,
N = total abundance

The evenness index (e)

$$E = \frac{H^1}{H^1 maks} \quad (3)$$

Where
e = (Index of evenness or stability),
H_{max} = log 2 S = 3.3219 log10S,
S = the number of taxa in a community.

To know the dominance of certain types in the waters can be used Simpson dominance index,

$$D = \Sigma \, S_{i=1} \left| \frac{n_i}{N} \right|^2 \quad (4)$$

where
D = Simpson dominance index ,

N_i = individual type of rank -i,
N = total number of individuals,
S = number of genera.
Index of dominance between 0-1; D = 0, means that no species dominate other species or community structures in a stable state;
D = 1, there is a species that dominates other species or unstable community structures, because of the ecological pressures.
Saprobik Index (SI) Persoone & de Pauw is used to determine the level of contamination of organic matter in water [2][7].

$$SI = \frac{C+3D+B-3}{A+B+C+D}. \quad (5)$$

where,
SI = saprobic coefficient (-3 to 3),
A = Ciliata organism group
C = Chloroccales and Diatomae organism group
D = Peridinae, Chrysophyceae and Conjugaeceae organism group
A, B, C and D = the amount of different organism of each group
Index Saphrobic Trophic is

$$TSI = \frac{1(nC)+3(nD)+(nB)-3(nA)}{1(nA)+3(nB)+1(nC)+1(nD)} \text{ x } \frac{nA+nB+nC+nD+nE}{nA+nB+nC+nD} \quad (6)$$

where
N = number of individual organisms in each group of saprobity,
NA = the number of individual composers of the polysaprobik group,
NB = the number of individual composers of the α-Mesosaprobic group,
NC = the number of individual composers of the β-Mesosaprobic group,
ND = the number of individual composers of the Oligosaprobik group,
NE = the number of individual composers other than A, B, C and D
Index Pollution method is use to determine the level of relative pollution toward the parameter of water quality needed with formula (Nemerow and Sumitomo, 1970)

$$IP_j = \sqrt{\frac{\left(C_i/L_{ij}\right)_M^2 + \left(C_i/L_{ij}\right)_R^2}{2}} \quad (7)$$

In which:
IP_j = index of pollution for j
C_i = parameter of consentration of water quality i
L_{ij} = parameter of quality which submitted in quality j water
M = maximum
R = average

There are 4 IP (Index Pollution) class with score $0 \leq IP \leq 1.0$ fullfilled quality standard, $1.0 \leq IP \leq 5.0$ slightly polluted, $5.0 \leq IP \leq 10$ moderately polluted and $IP \geq 10$ status of the water heavily polluted. The observed parameter consist of 12 parameters, there are turbidity, pH, sulfida, phenol, DO, BOD_5, PO_4 (phosphat), nitrat , metal Cd, Cu, Pb and Zn.

3. Results and Discussion

The mean average concentration of heavy metal under sea water at three estuaries when LTL is bigger than when its HTL, but for Cu concentration when LTL smaller than when its HTL. Heavy metal concentration, both when its LTL or HTL each are Cd around 0.033 and 0.048 mg/kg, Cu around 0.046 and 0.070, Pb around 0.48 and 0.71 mg/kg and Zn around 0.043 and 0.057 mg/kg (Figure 1).

IOP Conf. Series: Earth and Environmental Science 116 (2018) 012087 doi:10.1088/1755-1315/116/1/012087

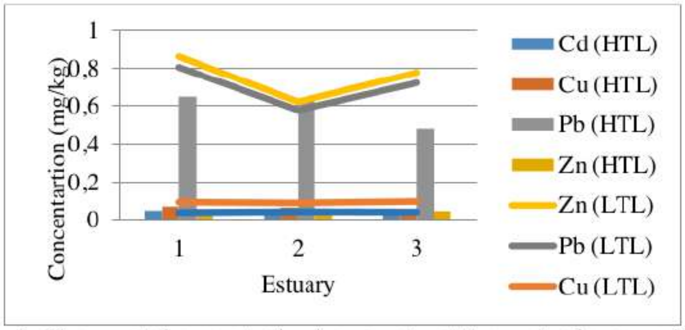

Figure 1. Heavy metal concentration in sea water at three estuaries around PTES

Zn consentration at three estuaries each Zn around 23.253 and 53.957 mg/kg, Pb around 7.583 and 18.0 mg/kg, Cu around 6.947 and 22.03 mg/kg meanwhile Cd around 0.247 and 0.351 mg/kg. Consentration Zn is on highest rank then followed by Cu, Pb and last, Cd. All of metal element consentration are on highest rank at Kali Baru estuary (Figure 2).

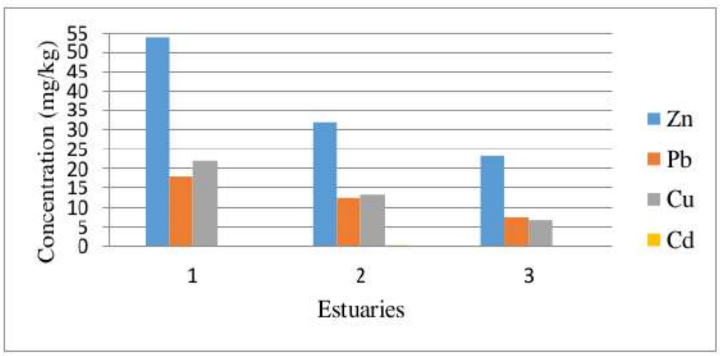

Figure 2. Heavy metal consentration in sediment at three estuaries around PTES

H' index (diversity) at three estuaries when its HTL around 0.65 and 1,65 meanwhile when LTL around 0.975 and 1.88 which shows when its LTL, the estuary of Kali Baru is heavily polluted, BKT moderate and Siangker heavily polluted. When the condition HTL and each is heavily polluted, moderate and moderate. The uniformity index (e) at LTL ranges from 0.37 and 0.66 while in HTL 0.425 and 0.71. The higher the uniformity index value indicates that all species are more abundant while the lower shows the smaller [5]. The dominance index (D) at LTL ranges from 0.32 and 0.7 whereas when the tide ranges from 0.21 and 0.565. Based on the index, the three river estuaries showed a heavily polluted condition when LTL, while when HTL of Kali Baru river, BKT and Siangker each showed heavily, moderate and heavily polluted (Figure 3).

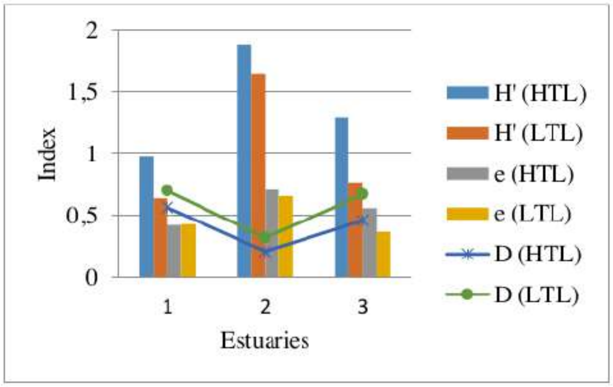

Figure 3. Index value H', e and D phytoplankton at October 2015 at three estuaries around PTES

Saprobity Index (SI) value is when it's HTL or LTL close to similar of the three estuary. Meanwhile TSI value at three estuary get several difference in which when it's HTL the value will be bigger compared when it's LTL (Table 1.). At three estuaries, the value of saprobity counted as oligosaprobic waters, in which slightly polluted or haven't polluted [3].

Table 1. SI and TSI phytoplankton at three estuary at October 2015 around PTES

Stations/Tides		Baru	BKT	Siangker
SI	LTL	1.925	1.33	1.8
SI	HTL	1.925	1.28	1.8
TSI	LTL	3.255	4.08	3.22
TSI	HTL	3.545	6.12	3.98

There are four classes of phytoplankton found in October 2015 named *Bacillariophyceae, Dinophyceae, Chrysophyceae* and *Cyanophyceae* where the abundance at HTL is greater than at LTL. The abundance of *Skeletonema* when HTL or LTL dominate between the other genus (Table 2)

Table 2. The abundance of phytoplankton in HTL or LTL on three estuaries on October 2015

No.	Genus	LTL			HTL		
		Estuaries					
		Baru	BKT	Siangker	Baru	BKT	Siangker
A.	Bacillariophyceae						
1	*Skeletonema sp.*	13822	122	20255	32197	34	13248
2	*Sydnedra sp.*	127.5	8	255	2357	20	637
3	*Rhizosolenia sp.*	95.5	8	637	732.5	4	1083
4	*Asteroinella sp.*	605	-	-	1306	1	-
5	*Chaetoceros sp.*	286.5	4	573	1242	1	955

6	*Thalassionema* sp.	159	14	-	10350	6	
7	*Thalassiothrix* sp.	478	30	2357	1337.5	52	1720
8	*Navicula* sp.	32	-	-	32	-	-
9	*Cyclotella* sp.	63.5	3	-	700.5	1	-
10	*Stephanopyxis* sp.	63.5	-	-	63.5	-	-
11	*Guinardia* sp.	-	27	-	0	18	191
12	*Coscinoduscus* sp.	-	-	382	318.5	3	955
13	*Pleurosygma* sp	-	-	-	-	3	-
14	*Bacteriastrum* sp.	32	-	-	-	-	-
15	*Pleurosygma* sp.	-	6	127	-	-	-
16	*Hemiaulus* sp.	-	-	-	-	-	-
17	*Eucampia* sp.	-	4	-	-	-	-
18	*Biddulphia* sp.	-	4	-	-	2	-
19	*Nitzschia* sp.	6.5	-	-	-	-	-
20	*Asterionella gracialis*	-	-	-	-	-	-
21	*Amphora* sp.	-	-	-	-	-	-
22	*Thallasiosira* sp.	-	-	-	-	-	-
23	*Gyrosigma* sp.	-	-	-			
B.	*Dinophyceae*						
24	*Ceratium sp.*	-	-	382	-	-	446
25	*Protoperidinium sp.*	-	-	-	-	-	-
26	*Noctiluca* sp.	-	-	-	-	1	382
27	*Ornithocercus* sp	-	-	-			
C.	*Chrysophyceae*						
28	*Peridinium sp.*	-	-	-	-	-	191
29	*Pyrocystis sp.*	-	-	-	-	-	-
30	*Dictyocha sp.*	-	-	-	-	-	-
D.	*Cyanophycea*						
31	*Anabaenopsis sp.*	95.5	1	-	63.5	2	-
Total		15866.5	231	24968	50700	148	19808

The zooplankton biodiversity index in October at HTL ranged from 1.92 and 2.26 while at LTL ranged from 1.13 and 2.22 indicating that Kali Baru estuary and BKT were slightly polluted while the Siangker estuary was slightly polluted. The uniformity index (e) shows that the species condition is abundant except for the LTL condition at the Kali Baru estuary. The dominant index on the three river estuaries indicates the absence of a species dominance in these waters (Figure 4).

IOP Conf. Series: Earth and Environmental Science **116** (2018) 012087 doi:10.1088/1755-1315/116/1/012087

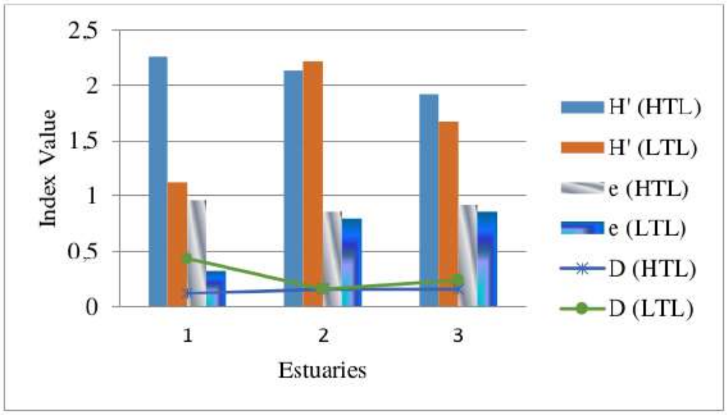

Figure 4. The index values of H ', e and D
zooplankton in October 2015 in three estuaries around PTES

The *Acartian* genus dominates on three estuaries compared to *Microstella sp*. and *Trocophora sp*. Where the abundance of zooplankton is more at the Kali Baru estuary than in other waters. Crustacean class is more dominant than other classes, where in that class found 21 species of genus while in class Ciliata only found 13 genus while class Cirripida least found (Table 3).

Table 3. The abundance of zooplankton at HTL and LTL
on three estuaries in October 2015 around PTES waters

No.	Genus	HTL			LTL		
		Station					
		Baru	BKT	Siangker	Baru	BKT	Siangker
	Crustacea						
1	*Nauplius*	2.12	-	-	-	-	-
2	*Corycaeus*	0.64	-	-	-	-	-
3	*Acartia*	3.48	7.64	13	28.5	6	6
4	*Calanus*	0.64	2.55	25	12.5	2	19
5	*Oithona*	0.85	6.37	38	19	5	51
6	*Euterpina sp.*	-	-	6	16	-	-
7	*Eurytemora sp.*	-	5.1	25	22.5	4	19
8	*Undinopsis sp.*	-	-	-	-	-	-
9	*Oncaea sp.*	-	1.27	-	-	-	-
10	*Eucalanus sp.*	-	-	-	-	-	-
11	*Microsetella sp.*	-	-		-	1	-
12	*Parvocalanus sp.*	-	-	13	-	-	-
13	*Evadne sp.*	-	-	-	-	-	-
14	*Euphausia sp.*	-	-	-	-	-	-
15	*Tigriopus*	-	1.27	-	-	4	-
16	*Paracyclopina sp.*	-	-	-	-	-	-

17	*Canthocalanus sp*	-	-	-	-	-	-
18	*Acrocalanus sp.*	-	-	-	-	-	-
19	*Podon sp.*	-	-	-	-	-	-
20	*Sergia sp.*	-	1.27	-	-	1	-
21	*Sapphirina sp.*	-	-	-	-	-	-
Ciliata							
22	*Eutintinnus*	6.115	-	-	-	-	-
23	*Salpingella*	1.27	-	-	-	-	-
24	*Codonellopsis*	5.48	-	-	-	1	-
25	*Epicycloclysis*	3.32	-	-	-	-	-
26	*Achanstostomella*	5.32	1.27	-	-	8	-
27	*Leprotintinnus sp.*	-	2.55	6	3	2	19
28	*Scolecithrix sp.*	-	-	-	-	-	-
29	*Tintinnopsis sp.*	11	17.84	25	32	30	-
30	*Parafavella sp.*	-	-	-	-	3	6
31	*Favella sp.*	-	5.1	-	-	7	
32	*Xystonellopsis sp*	6.5	-	-	-	-	-
33	*Rhabdonella*	-	-	-	-	-	-
34	*Dictyoscysta sp*	-	-	-	-	-	-
35	*Trocophora sp.*	-	-	-	-	1	-
	Scyphomedusae						
36	*Trichocerca sp.*	-	-	-			
37	*Branchionus sp.*	-	5.1	-	-	13	
	Tentaculata						
38	*Notholca sp.*	-	-	-			
39	*Salpinengacantha*	5.48	-	-	-	-	-
40	*Rhodonella sp.*	5	-	-	-	-	-
41	*Trocophora sp.*	-	-	-	-	-	-
42	*Balanus*	-	-	-	3	3	6
43	*N Eurytermora*	-	-	-	-	-	-
44	*N Euphasia*	-	-	-	-	-	-
45	*N Oithona*	-	-	-	-	-	-
46	*N Acartia*	-	-	-	-	-	-
47	*Branchiiolaria sp.*	8	-	-	-	-	-
	Cirripeda						
48	*Balanus*	-	-	-	-	-	-
Total		65.215	57.33	151	136.5	91	126

Diversity value in Kali Baru estuary at HTL or LTL show that biota community is not stable or heavily polluted while at another water area is`slightly polluted to moderate. These things seen at the value of homogeneity at Kali Baru estuary which is equally relative of homogeneity while for another estuary teritory low species homogeneity is occured. Ecological pressure is occured at Kali Baru estuary rather than other water in BKT and Siangker because domination value that close to one. This thing is because of the pressure form domestic waste and shipyard around the estuary (Figure 5).

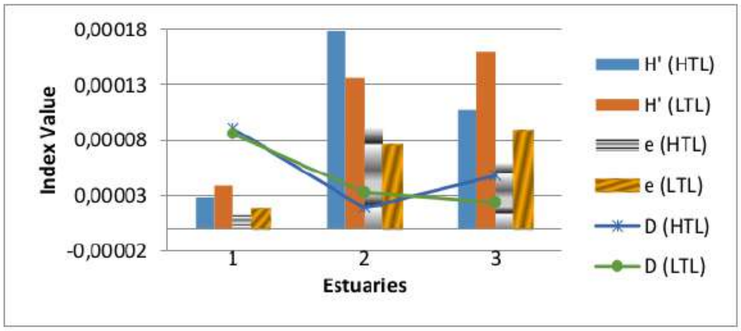

Figure 5. Indeks value H', e dan D
phytoplankton in November 2015 in three estuaries around PTES

Saprobity water condition is in oligosaprobik condition or slightly polluted or haven't polluted at all except at HTL at BKT is in condition β-mesosaprobik which is polluted condition at low to medium level (Table 4).

Table 4. SI dan TSI phytoplankton in three estuaries
in November 2015 in around PTES

Station/Tide		Baru	BKT	Siangker
SI	HTL	1.59	0.6	1.5
SI	LTL	1.665	1.5	1.67
TSI	HTL	3.01	1.38	2.48
TSI	LTL	2.955	2.57	2.95

In November there is amount of class that fewer than in the earlier month at west season, there are only three classes which are *Baciilariophyceae*, *Dinophyceae*, *Chrysophyceae* dan *Cyanophycea*. Skeletonema genus is still dominating followed by *Synedra sp.* and the last is *Thallassiothrix sp.* and *Pyrocystis sp.* (Table 5).

Table 5. The abundance phytoplankton at HTL and LTL
at three estuaries in November 2015

No.	Genus	LTL			HTL		
		Station					
		Baru	BKT	Siangker	Baru	BKT	Siangker
A.	Bacillariophyceae						
1	*Skeletonema sp.*	16798.3	3375.8	3694.27	11648.62	1528.66	7133.76
2	*Sydnedra sp.*	4.775	-	-	11648.62	1528.66	7133.76
6	*Thalassiothrix sp.*	31.845	-	-	31.845	-	-

7	*Coscinoduscus sp.*	3.185	-	1464.97	79.62	-	-
8	*Pleurosygma sp*	-	445.86	1082.8	38.215	382.17	-
9	*Biddulphia sp.*	-	-	-	-	445.86	-
B.	*Dinophyceae*						
10	*Ceratium sp.*	767.515	318.47	828.03	98.725	828.03	1401.27
11	*Noctiluca sp.*	-	-	505.55	0	382.17	191.08
C.	*Chrysophyceae*						
12	*Peridinium sp.*	159.235	382.17	-	95.54	-	191.08
13	*Pyrocystis sp.*	-	-	-	31.845	-	-
D.	*Cyanophycea*						
14	*Anabaenopsis sp.*	170.38	-	-	41.4	-	-
15	*Oscallatoria sp.*	63.695	-	-	-	-	-
Total		18674.09	6305.74	9677.53	24106.15	8025.49	17770.7

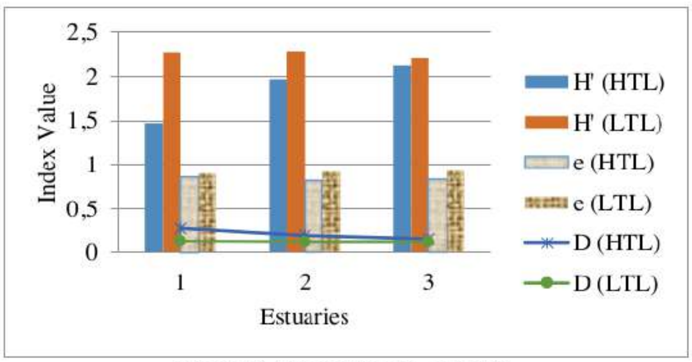

Figure 6. Index value H', e and D zooplankton in November 2015 in three estuaries around PTES

Table 6. Zooplankton abundance when HTL and LTL in all three estuaries in November 2015

No.	Genus	HTL			LTL		
		Station					
		Baru	BKT	Siangker	Baru	BKT	Siangker
A.	Crustacea						
1.	*Acartia*	25.4775	15.92	35.03	19.11	15.92	9.55
2.	*Calanus*	3.1845	6.37	22.29	7.96	9.55	19.11
3.	*Oithona*	19.1085	41.4	73.23	25.48	12.74	22.29
4.	*Euterpina sp.*	0	3.18	0	1.59	3.18	0
5.	*Eurytemora sp.*	19.1085	9.55	22.29	12.735	12.74	9.55
6.	*Eucalanus sp.*	0	0	3.18	0	9.55	9.55
7.	*Macrostella sp.*	0	0	3.18	0	3.18	0
8.	*Parvocalanus sp.*	6.3695	15.92	38.22	3.185	3.18	12.74

9.	*Tigriopus*	0	3.18	0	3.185	0	0
10.	*Undinopsis sp.*	0	0	0	1.59	0	0
11.	*Ctenocalanus sp.*	0	0	0	0	6.37	6.37
12.	*Metridia sp.*	0	0	0	1.59	0	0
13.	*Brachionus sp.*	0	3.18	6.37	0	0	0
14.	*Cytemnestra sp*	0	0	0	3.185	0	0
15.	*Globigerina sp.*	0	0	0	0	0	3.18
B.	*Ciliata*						
16.	*Codonellopsis*	0	0	0	3.185	0	0
17.	*Achanstostomella*	0	0	0	3.185	0	0
18.	*Leprotintinnus sp.*	6.3695	3.18	15.92	31.845	0	0
19.	*Tintinnopsis sp.*	12.7395	0	0	14.33	0	0
20.	*Parafavella sp.*	0	3.18	9.55	0	6.37	22.29
21.	*Favella sp.*	0	6.37	6.37	6.365	0	0
C.	*Tentaculata*						
22.	*Notholca sp.*	0	0	0	0	22.29	0
D.	*Rotatoria*						
23.	*Balanus*	0	0	0	6.37	3.18	9.55
E.	*Mollusca*						
24.	*Trocophora sp.*	0	0	0	3.185	0	0
F.	*Cirripeda*						
25.	*Balanus*	3.1845	0	6.37	0	0	0
Total		95.542	111.43	242	148.075	108.25	124.18

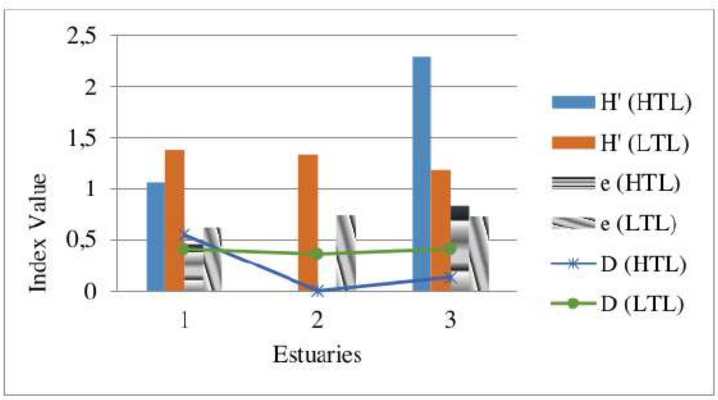

Figure 7. Index value H', e and D
phytoplankton in December 2015 in three estuaries around PTES

Table 7. SI and TSI phytoplankton in three estuary in December 2015 around PTES

Station/Tide		Baru	BKT	Siangker
SI	HTL	1	0	1
SI	LTL	1	1.67	1
TSI	HTL	2.745	0	1.13
TSI	LTL	2.62	2.7	2.32

Table 8. Phytoplankton abundance when HTL and LTL in all three estuaries in December 2015

No.	Genus	HTL			LTL		
		Station					
		Baru	BKT	Siangker	Baru	BKT	Siangker
A.	Bacillariophyceae						
1	*Skeletonema sp.*	16410.83	-	2886.4	5391.72	3949.04	9235.67
2	*Rhizosolenia sp.*	63.695	-	828.03	63.695	764.33	1592.36
3	*Asteroinella sp.*	3.185	-	4012.74	-	-	-
4	*Chaetoceros sp.*	713.38	-	382.17	264.33	-	-
5	*Thalassionema sp.*	-	-	573.25	-	-	-
6	*Thalassiothrix sp.*	35.03	-	-	127.39	-	-
7	*Cyclotella sp.*	334.395	-	318.47	1436.305	-	1783.44
8	*Stephanopyxis sp.*	-	-	-	-	254.78	-
9	*Guinardia sp.*	-	-	1146.5	130.575	-	-
10	*Coscinoduscus sp.*	73.25	-	127.39	130.575	-	-
11	*Pleurosygma sp*	82.805	-	764.33	63.695	318.47	-
12	*Hemialus sp.*	-	-	191.08	-	-	-
13	*Biddulphia sp.*	168.79	-	1910.83	512.74	-	445.86
14	*Helosira sp.*	-	-	191.08	-	-	-
B.	*Dinophyceae*						
15	*Ceratium sp.*	254.775	-	700.64	226.115	1401.27	2292.99
C.	*Chrysophyceae*						
16	*Peridinium sp.*	63.695	-	191.08	63.695	-	-
D.	*Chyanophycea*						
17	*Anabaenopsis sp.*	63.695	-	127.39	-	-	-
18	*Oscillatoria sp.*	191.08	-	1719.75	194.27	-	-
Total		18458.605	0	16071.13	8605.105	6687.89	15350.32

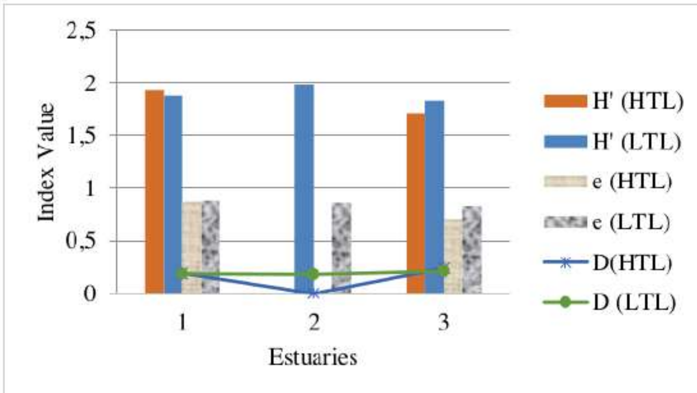

Figure 8. index value H', e and D
zooplankton in December 2015 in the three estuaries around of PTES

Table 9. Zooplankton abundance HTL or LTL
on the three river estuary in December 2015

No.	Genus	HTL			LTL		
		Station					
		Baru	BKT	Siangker	Baru	BKT	Siangker
A.	***Crustacea***						
1	*Acartia*	11.4655	0	42.04	8.9175	10.191	3.82
2	*Calanus*	5.096	0	11.46	0.637	1.274	1.27
3	*Oithona*	14.0125	0	91.72	14.014	6.369	1.27
4	*Euterpina sp.*	3.185	0	0	6.37	0	1.27
5	*Eurytemora sp.*	4.459	0	3.82	3.1845	2.548	0
6	*Oncaea sp.*	0	0	6.37	0	0	0
7	*Parvocalanus sp.*	5.0955	0	0	4.459	0	0
8	*Tigriopus*	1.274	0	0	3.185	1.274	0
9	*Acrocalanus sp.*	3.185	0	0	0	0	0
10	*Sergia sp.*	0.637	0	0	0	0	0
11	*Lucicutia sp.*	1.274	0	2.55	3.185	0	0
12	*Eutintinus*	0	0	2.55	0	0	0
13	*Canthocalanus sp*	0	0	0	0.637	0	0
B.	***Ciliata***						
14	*Leprotintinnus sp.*	10.192	0	15.29	21.021	2.548	8.92
15	*Tintinnopsis sp.*	14.0135	0	57.32	16.2405	2.548	7.64
16	*Parafavella sp.*	0	0	0	0	1.274	0
17	*Favella sp.*	0	0	1.27	4.775	0	1.27
C.	***Mollusca***						

18	*Trocophora sp.*	0	0	5.1	0	0	0
D.	***Sarcodina***						
19	*Globigerina sp.*	0	0	0	0	0	1.27
E.	***Maxillopoda***						
20	*Balanus*	3.822	0	0	0	1.274	1.27
F.	***Monogononta***						
21	*Brachionus sp.*	0	0	0	0	1.274	0
Total		77.711	0	239.49	86.6255	30.574	28

Table 10. Physical-chemical waters parameters

Parameter	Unit	Baru		BKT		Siangker		Quality [6]
		HTL	LTL	HTL	LTL	HTL	LTL	
Temperatur	^{0}C	27.82	30.18	18.43	32.9	30.3	32.33	
Depth	meter	6.257	6.33	1.26	1.25	1.62	1.12	
Brightness	meter	1.08	1.27		0.71	0.63	0.51	
TDS	mg/l	303.7	508.5	426	507	447.67	505.67	
Salinity	‰	33.35	33.2	22.3	26.2	27.67	28.43	
pH		7.887	7.812	5.327	7.587	7.94	7.737	7 - 8.5
DO	mg/l	5.573	4.157	3.33	6.91	5.75	5.4	< 5
Nitrate	mg/l	0.19	0.14	0.0365	1.233	0.53	0.237	0.008
Phosphat	mg/l	0.955	0.455	0.84	1.13	0.483	0.72	0.015
Turbidity	NTU	33.125	36.87	27.25	26.845	16.59	56.85	< 5
Sulfide	mg/l	0.065	0.088	0.075	0.07	0.063	0.06	0.01
Phenols	mg/l	0.018	0.022	0.033	0.022	0.034	0.024	0.002
BOD_5	mg/l	3.265	1.617	2.175	1.98	1.557	1.05	20

llution contamination index on the three river estuaries shows highly polluted conditions T and Siangker estuaries are higher at HTLwhile at LTL at the estuary of the BKT river hest value (Table 11).

Table 11. IP values on the three estuaries around PTES waters from October to December 2015

No.	Parameters	HTL			LTL				IP HTL			IP LTL		
		C_{imax}	C_{imax}	C_{imax}	C_{imax}	C_{imax}	C_{imax}	L_{ij}	Baru	BKT	Siangker	Baru	BKT	Siangker
1	Turbidity	62.5	32.1	19.5	113	39.8	98.5	5						
2	pH	7.96	8.07	7.95	7.93	7.9	7.88	8						
3	Sulfide	0.07	0.08	0.08	0.23	0.11	0.08	0.01						
4	Phenol	0.027	0.04	0.037	0.03	0.032	0.04	0.002	12.544	14.998	19.495	12.4	24.908	12.521
5	DO	5.7	5.2	5.4	5.2	8.94	5.9	5						
6	Cd	0.05	0.049	0.045	0.04	0.058	0.052	0.01						
7	Cu	0.072	0.067	0.061	0.06	0.066	0.077	0.05						

8	Pb	0.69	0.67	0.61	1.01	0.58	0.71	0.05
9	Zn	0.05	0.07	0.07	0.11	0.05	0.07	0.1
10	Nitrate	0.23	0.73	1.49	0.31	1.32	0.31	0.008
11	BOD_5	3.3	3.38	2.98	3.35	3.19	1.71	20
12	PO_4	1.23	1	0.87	0.84	1.52	0.89	0.015

4. Conclusion

Pollution index from all three estuaries shows the most heavily polluted condition which are in BKT and Siangker the value is higher when the HTL, and when the LTL BKT estuary has the highest value. The result obtained from 12 parameters which were tested showed that the three waters can be categorized in heavily polluted condition at each value from 12.52 to 24.98. the concentration of heavy metal at sea water during HTL and LTL ranged from Cd is around 0.033 and 0.048 mg/kg, Pb 0.48 and 0.71 mg/kg, and Zn 0.043 and 0.057 mg/kg. the saprobity value index based on the existence of phytoplankton or zooplankton was ranged of Oligosaprobik at slightly polluted or haven't been polluted.

Acknowledgement

Thank you for all the vicinity research team from Fisheries and Oceanology Faculty, Diponegoro University that being held in October until December 2015. Also thank you to Vian that never tired to do identification and calculation of plankton in laboratory and also to all staff in Health Laboratory of Semarang Region

References

[1] Ojekunle O Z, Ojekunle O V, Adeyemi A A, Taiwo A G, Sangowusi O R, Taiwo A M and Adekitan A A 2016 Evaluation of surface water quality indices and ecological risk assessment for heavy metals in scrap yard neighbourhood *Springer Plus* **5**: 560, p. 1-16.

[2] Effendi H 2003 *Water quality study for resource management and aquatic environments* (Penerbit Kanisius : Yogyakarta) [In Indonesian].

[3] Anggoro S 1983 *Water subsidence problems for increased fish production in ponds* Faculty of Animal Husbandry, Diponegoro University of Semarang.

[4] Nemerow N L and Sumitomo H 1970 Benefits of water quality enhancement report no. 16110 DAJ, prepared for the U.S. Environmental Protection Agency.

[5] Fachrul M F 2007 *Methods of bioecological sampling* (Bumi Aksara: Jakarta) [In Indonesian].

[6] Republik Indonesia 2014 *The degree of the Minister of the Environment number 51/2004 about sea water quality standards* [In Indonesian].

[7] Wibisono M S 2005 *Introduction to marine science* (Gramedia Widiasarana Indonesia/Grasindo: Jakarta) [In Indonesian]

[8] Anggoro S 1988 T*ropical-saprobic analysis (Trosap) to assess the feasibility of marine aquaculture location, in: sea water cultivation workshop of Central Java* Coastal Development Laboratory. Prof. Dr. Gatot Rahardjo Joenoes. University of Diponegoro, Semarang, pp. 66-90 [In Indonesian].

[9] Sachlan M 1982 *Planktonology correspondence course centre* Directorate General of Fisheries, Ministry of Agriculture Jakarta, 141 p.

The Assessment of Biological and Pollution Index of Estuaries Around Port of Tanjung Emas Semarang

ORIGINALITY REPORT

23%	16%	16%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Diponegoro Student Paper	9%
2	www.bioflux.com.ro Internet Source	3%
3	es.scribd.com Internet Source	3%
4	D M Nuriasih, S Anggoro, Haeruddin. "Saprobic analysis to Marina coastal, Semarang city", IOP Conference Series: Earth and Environmental Science, 2018 Publication	2%
5	Submitted to Universitas Airlangga Student Paper	1%
6	Agus Tjahjono, Aziz Nur Bambang, Sutrisno Anggoro. "Plankton And Heavy Metal Correlation From Commercial Vessels In Port Of Tanjung Emas Semarang", E3S Web of Conferences, 2018 Publication	1%

7	E. D. Anyanwu, S. N. Umeham. "Identification of waterbody status in Nigeria using predictive index assessment tools: a case study of Eme River, Umuahia, Nigeria", International Journal of Energy and Water Resources, 2020 Publication	1%
8	opinvisindi.is Internet Source	1%
9	aip.scitation.org Internet Source	<1%
10	Submitted to University of Nottingham Student Paper	<1%
11	"Principles of Tidal Sedimentology", Springer Science and Business Media LLC, 2012 Publication	<1%
12	Agus Tjahjono, Vega Fonsula Andromeda, Boedojo Wiwoho, Saifudin Afandi. "An Analysis of the Effect of Plunger Barrel Performance of High Pressure Pumps and Fuel Against the Main Engine Injector Performance", KnE Social Sciences, 2019 Publication	<1%
13	A W Hastuti, Y Pancawati, I N Surana. "The abundance and spatial distribution of plankton communities in Perancak Estuary, Bali", IOP Conference Series: Earth and Environmental	<1%

Science, 2018
Publication

14	Submitted to Federal University of Technology Student Paper	<1%
15	Nurul Chazanah, Barti Muntalif, Priana Sudjono. "Macrozoobentos Distribution as a Bioindicator of Water Quality in the Upstream of the Citarum River", Journal of Ecological Engineering, 2020 Publication	<1%
16	Submitted to Universiti Kebangsaan Malaysia Student Paper	<1%
17	ejournal-s1.undip.ac.id Internet Source	<1%
18	Submitted to Universitas Dian Nuswantoro Student Paper	<1%
19	Angelova, V.. "Bio-accumulation and distribution of heavy metals in fibre crops (flax, cotton and hemp)", Industrial Crops & Products, 200405 Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		