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Original Paper

EVALUATION OF IDLE ERODED COASTAL WATER FOR MARICULTURE BASED ON THROPIC SAPROBIC INDEX ANALYSIS (Case Study: Coast of Sayung Distric Demak, Central Java Indonesia)

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ABSTRACT

Coastal erosion in Sayung Distric, Demak Regency submerged 300 hectares of brackish water ponds. However, after the local government management by soft and hard barriers construction resulting the formation of semi-closed coastal water area with the depth of 1 – 7 m in depth. The condition of the this eroded coastal water is physically degraded, idle and abandont. The aims of this research were to evaluate ecological condition of the eroded coastal water at Sayung for coastal aquaculture based on its Trophic Saprobic Index values. The research was carried out from September 2009- August 2010. The results show that the eroded coastal water at Morosari, Sayung District Demak Central Java is lightly to moderately polluted, however, ecol[ogically it is still suitable for coastal aquaculture activity, especially for cultured organisms which are at the lowest level of the food chain/the plankton feeder .

Key Words : Coastal erosion ; mariculture ; thropic saprobic analysis

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INTRODUCTION

Coastal regions are transitional areas between terrestrial and marine ecosystems are affected by changes in land and sea (Undang Undang No. 27 Tahun 2007). This region is very rich in natural resources and environmental services called coastal resources. Natural resources consist of biological, non-biological and artificial resources. Elements of biological resources consist of fish, mangroves, coral reefs, sea-grass and other marine biota, non-biological elements consist of mineral resources and other abiotic coastal land, surface water, the water column and seabed, while the artificial resources consists of building artificial beaches and physical infrastructures; environmental services are the natural values like the scenery, the wave energy and other (Dahuri et al, 2004). Utilization of coastal resources is considered important in supporting regional economic development and national levels to increase employment, incomes and foreign exchange,

Currently the erosion in the North coast of Central Java Province is very severe. Data from the Environmental Impact Management Agency of Central Java province showed that erosion area was recorded in Central Java more than 5500 hectares, which was spread in 10 regencies / cities. Coastal erosion in Sayung Distric, Demak Regency submerged 300 hectares of brackish water ponds (BAPPEDA Demak, 2007; Kantor Pengendali Dampak Lingkungan (2008). The management or handling of the eroded area by local government by mangrove planting (soft barrier) and beach wall construction (hard barrier) resulting the formation of semi-closed coastal water area with the depth of 1 – 7 m in depth that is still affected by the tide, and it is idle and abandon. Those area are considered to have a high productivity which can support the coastal organisms live since it was an inundated brackish water ponds. Moreover, the organic

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matter and nutrients influx in the water body both from the sea and from the terrestrial sources can support the phytoplankton production. The condition of the eroded coastal water is degraded physically, however, ecologically, this area was believed can be utilized for coastal aquaculture. Therefore, research on the ecological evaluation of this site for coastal aquaculture based on the Tropic Saprobic Index (TSI) and Saprobic Index (SI) need to be done.

The Tropic Saprobic Index (TSI) and Saprobic Index (SI) of the plankton are commonly used to find out the ecosystem fertility based on its primary productivity as well as the ecosystem degradation. The evaluation of water quality based on self-purification zone of phytoplankton (saprobic indicators) is widely used in European and Asian countries (Walley *et al*., 2001; Barinova *et al*., 2004). According to Dokulil, (2003), The saprobic system is applicable only to organic pollution undergoing bacterial decomposition and is unsuitable for the assessment of toxin or other pollution. This index is applicable for natural small water bodies and artificial reservoirs. It is also applicable to all fresh water and marine environment which contain organic matter pollutants. In other words, this system can be used in a wide range of aquatic environment. The evaluation of water quality based on self-purification zone of phytoplankton (saprobic indicators) is widely used in European and Asian countries (Walley et al., 2001; Barinova et al., 2004). The lists of indicator species of alga, zooplankton, and benthic, were added by other researchers (Dokulil, 2003).Therefore, identification of phytoplankton species provides useful information on tropic state in water ecosystems. Rakocevis-Nedovic and Hollert (2005) found that with decreasing H′ value, the tropic status shifted from oligotrophic to eutrophic condition. According to the study of Salusso and Morana (2002), there are 3 classes of pollution status based on H′. In their scale, water bodies with H′ more than 3 has no contaminant, H′ values ranged 1-3 contain moderate contaminants and H′ <1 indicates high pollution level.

Classification of trophic state is feasible by the results obtained in saprobic system In some studies, species richness and evenness were used to compare of different trophic status (Kitsiou and Karydis, 2000). Wilham and Dorris (1968) and Wilham (1970) also proposed a water quality classification based on H′.

The saprobic index level according to Pantle and Buck(1955) and modified by Anggoro (1983 and 1988)

- Polysaprobic is the saprobic level of the water body that is heavily polluted and its fertility cannot be ulilized for aquaculture
- α-Mesosaprobik is the saprobic level of the water body that is moderately to heavily polluted and its fertility cannot be ulilized for aquaculture
- ß-Mesosaprobik is the saprobic level of the water body that is lightly to moderately polluted and its fertility can be ulilized for aquaculture
- Olygosaprobic the saprobic level of the water body that is less to un polluted and its fertility can be ulilized for aquaculture

Planktons are organisms that are used to identify the saprobic level of a such water body (Liebman, 1962). This is because certain saprobic organisms/planktons can live in a certain condition (polluted and less polluted and un polluted) water.

The aim of this research is to evaluate ecological value of the eroded coastal water at Sayung for coastal aquaculture based on its Saprobic Index and Trophic Saprobic Index values. The research was carried out from September 2009- August 2010.

MATERIALS AND METHODS

The samples were taken from idle eroded coastal water coastal waters in Bedono village, Morosari Kecamatan Sayung, Demak (Latitude: 06^0 55’ 46.3” S Longitude:110^0 29’ 05.3” E – **Fig. 1**)) between 08.00 – 12.00 am for 12 months from Septembert 2009 – August 2010.

For phytoplankton population filtering 10 L of water through a phytoplankton net and the filtered water was kept in 100 ml pastic botle preserved with 4% formalin. Benthos sample were taken from bottom sediment collected using Eickment Grab, sieved fixed and kept in a plastic botle preserved using 4% formalin and rosebengol. The major physico-chemical factors data collected were current velocity, depth, water temperature, pH, salinity, dissolved oxygen, nitrate, phosphate and calcium. (APHA, 1976; 1985).

Filtered plankton, benthos samples were identified using the keys provided by Davis (1995), Sahlan (1982), Yamaji (1976). Benthos samples were identified using the keys provided by Carpenter (1988), Day (1967(a), 1967(b), Gibbs (1977), Naylor (1972). Data analysis From the basic biological data various pollution indices like saprobic index, following Anggoro (1983 and 1988). Palmer's algal pollution species index (Palmer, 1969), biological index and Shannon-Weaver index (Shannon & Wearver, 1949) were calculated to qualify the water quality of the water bodies.

RESULTS AND DISCUSSION

The results of the abundance and variety of plankton found in the eroded coastal water during the research is shown in Table1, the abundance range between 70.300-255.222 individu/L. The evenness index (e) at the range of 0.83-0.98, which closed to 1, indicated that the the plankton were evenly distributed. It means that there was no domination of the plankton in the study area. The diversity index (H') of plankton at the range between 2.51-3.09 which means that the ecosystem was at stable condition with light pollution level. The range of Trophic Saprobic Index (TSI) were 0.78-1.35 and Saprobic Index (SI) was 0.86-1.47 (**Table 3**) which showed that the ecosystem was in a stable condition with very light to light pollution levels. Pantle & Buck (1955), Wilham and Dorris (1968), Wilham (1970); Lee *et al.,* (1978) and Knobs (1978) in Anggoro (1988), Anggoro (1983 and 1988); (Kitsiou & Karydis, 2000). mentioned that those range value of the saprobic index and the trophic saprobic index are catagorized as the Oligosaprobic/ß-Mesosa probik water, means that the eroded coastal water is lightly polluted but still suitable for coastal aquaculture. Furthermore, the plankton classified as β – mesosaprobik Organisms Group (13 species) and Oligosaprobik Organisms Group (12 species) present in larger number than Polysaprobik Organisms Group (6 species) an dα– mesosaprobik Organisms Group (4 species) (**Table 1**). These mean that the fertility of the water body can be ulilized for aquaculture (Pantle and Buck(1955) and modified by Anggoro (1983 and 1988). As mentioned by Cranford *et al.,* (2011) that shellfish as an opportunistic filter feeder, mostly feed on plankton. That organisms are at the lowest level of food chain or the plankton feeder, therefore, they are suitable to be cultured in a such area. Moreover, the results of water quality parameters range during the study (**Tabel 4**) shown that the water quality parameters are suitable for certain cultured organisms (Maena, 2003).

Abundance and variety of benthos in eroded coastal water sediment obtained during the study is shown in **Table 2.** The abundance were at the range between 36-118 indv/175 cm^3 the diversity index (H') range between 2.23-2.77 and the evenness index (e) range between 0.89-0.98 (**Table 3**). According Wilhm and Dorris (1966), diversity index (H') of benthos between 1-3 (**Table 3**) indicates a good water quality condition. Krebs (1994) suggested that the distribution of benthos mainly determined by individual character and as the nature of the interaction between the organisms and the surounding environment. Furthermore, it was mentioned that the evenness index (e) at the range of 0.89-0.98 which closed to 1 (**Table 3**), indicates the evenly distribution of the benthos organisms, means that there was no domination of the organisms. The abundance of the benthos were consisted of 24 genera from 5 phylum (Polychaeta, Gastrophode, Crustacea, Bivalve, Sipunculidae) (**Table 2**) .

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Table 1. The Abundance (Individu/L) and variety Of Plankton In The Eroded Coastal Water During Investigation From August 2009 – July 2010

No	Organisms	Abundance (individu/L)											
		Aug'09	Sept	Oct	Nov	Dec	Jan'10	Feb	March	April	May	June	July
A.	***Polysaprobik Organisms Group***												
1	*Oscillatoria putrid*	4.585	-	-	4.075	3.057	3.057	3.057	7.132	4.075	4.075	4.585	5.094
2	*Clamydomonas reinhardtii*	-	1.019	1.019	2.038	2.038	2.038	-	3.057	-	-	-	-
3	*Anabaena flosaque*	3.057	2.547	2.547	3.566	3.057	-	3.566	7.132	3.057	3.566	-	12.736
4	*Lyngbya lagerheimii*	2.547	-	-	-	-	-	-	-	2.547	4.075	4.075	4.075
5	*Spirulina jenneri*	-	-	-	-	-	-	2.547	-	-	-	-	-
6	*Condonella giganteum*	18.849	-	-	-	-	5.094	4.075	13.245	8.151	8.151	18.849	21.396
B.	***α – mesosaprobik Organisms Group***												
7	*Nitzchia palea*	8.151	3.566	4.585	6.113	5.604	5.604	4.585	6.113	3.057	6.623	7.132	7.132
8	*Scenedesmus subspicatus*	4.585	4.075	3.566	3.057	3.566	3.057	3.566	3.641	3.057	4.585	5.604	6.623
9	*Eudorina wallichii*	-	1.528	3.057	-	-	-	-	-	-	-	-	-
10	*Coelastrum sphaericum*	-	-	-	-	-	-	6.113	-	-	-	-	-
C.	***β – mesosaprobik Organisms Group***												
11	*Pandorina charkoweinsis*	-	3.566	4.075	4.585	4.585	3.566	1.528	11.207	-	3.057	1.528	4.075
12	*Peridinum conicum*	4.075	-	-	6.113	6.623	4.585	4.075	9.679	-	4.075	4.585	6.113
13	*Ceratium focus*	3.566	1.019	4.075	2.547	1.019	2.038	3.057	7.132	2.547	3.566	5.604	4.585
14	*Pediastrum boryanum*	6.113	3.566	3.057	3.566	3.057	3.566	-	6.113	-	4.075	4.585	6.113
15	*Asteroinella formose*	4.585	1.528	2.038	3.057	2.547	-	-	-	2.038	3.566	-	-
16	*Spirogyra crassa*	-	-	-	2.038	1.528	1.528	-	7.132	2.038	-	4.075	4.075
17	*Synendra acus*	-	5.094	5.094	-	-	-	-	-	4.075	-	-	-
18	*Melosira varians*	4.075	-	-	-	-	-	-	-	-	-	3.566	4.585
19	*Gyrosigma atomaria*	-	6.623	6.113	4.075	5.094	5.094	-	-	-	-	-	-
20	*Climacodium fravenfeldianum*	14.773	5.094	5.094	5.604	4.075	4.075	-	-	4.585	6.623	21.905	19.358
21	*Asterolampra indicus*	-	6.113	6.113	-	-	-	-	-	-	-	-	-
22	*Eucampia zoodiscus*	-	6.113	6.113	-	3.057	5.604	-	11.207	-	-	-	-

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Acrredited : 83/Dikti/Kep/2009

No	Organisms	Abundance (individu/L)											
		Aug'09	Sept	Oct	Nov	Dec	Jan'10	Feb	March	April	May	June	July
23	*Ondotella carneum*	-	-	-	-	-	-	5.094	-	-	-	-	-
	D. *Oligosaprobik Organisms Group*												
24	*Tabellaria flocculosa*	-	-	-	2.547	-	-	-	-	-	-	-	-
25	*Navicula oelliculosa*	14.264	-	-	7.641	7.132	6.623	6.113	12.736	4.075	21.905	30.056	27.509
26	*Ulothrix zonata*	15.283	5.094	7.641	8.151	7.641	6.113	6.113	13.754	4.585	10.188	23.434	75.395
27	*Surirella spiralis*	3.566	4.585	5.094	5.604	4.075	-	-	11.717	3.566	4.585	6.113	6.113
28	*Enthophysalia sp*	-	4.585	4.585	4.075	4.585	-	-	-	3.057	5.094	-	-
29	*Pinnularia nobilis*	-	6.113	7.132	5.604	4.075	4.075	-	-	2.547	5.604	-	-
30	*Cyclotella bodanice*	3.057	4.585	7.132	7.132	7.132	-	4.075		3.566	4.075	3.566	4.075
31	*Hildenbrandia crouanii*	-	2.038	1.528	7.641	5.604	-	-	-	-	3.566	1.528	2.038
32	*Mycrasterias truncata*	-	-	-	4.585	4.075	4.585	3.566	10.698	3.057	4.075	-	-
33	*Cladophora glomerata*	3.057	-	1.528	-	3.057	3.566	3.057	8.151	2.547	6.623	4.585	4.585
34	*Rhodomonas baltica*	4.075	-	-	-	-	-	-	-	-	-	3.057	4.585
35	*Vaucheria cornata*	-	-	-	1.019	-	-	-	-	-	-	-	-
E.	***Others Organisms Group***												
36	*Marphysa caudata*	-	-	-	4.585	-	-	-	-	-	-	-	-
37	*Pyrosoma operculata*	16.302	-	-	-	-	3.566	6.113	11.717	4.075	9.170	20.886	24.962

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Table 2. The Abundance and variety Of Benthos In The Eroded Coastal Water During Investigation From August 2009 – July 2010

No	ORGANISMS	Abundance (individu/L)											
		Aug'09	Sept	Oct	Novr	Dec	Jan'10	Feb	March	April	May	June	July
1.	**Polychaeta**												
1	*Neries* sp.	684	684	1.026	1.026	798	1.140	1.482	570	684	1.026	1.026	684
2	*Capitella* sp.	342	342	912	798	684	1.026	1.254	684	342	912	912	342
3	*Glycera* sp.	-	-	912	798	570	-	-	-	-	912	912	-
4	*Ophelia* sp.	-	-	798	798	-	-	456	-	228	798	798	-
5	*Magelona* sp.	-	-	570	-	-	-	-	342	-	570	570	-
6	*Eunice* sp.	-	-	-	798	-	-	-	-	-	-	-	-
7	*Maldanella* sp.	456	456	570	228	-	-	-	456	342	570	570	456
8	*Syllis* sp.	-	-	-	228	456	-	-	342	-	-	-	-
9	*Lumbrineries* sp.	228	228	456	-	-	-	-	-	-	456	456	228
10	*Nepthys* sp.	-	-	-	-	342	342	114	228	228	-	-	-
2.	**Gastrophode**												
11	*Cerithium* sp.	912	912	2.052	912	1.254	1.026	1.368	456	684	2.052	2.052	912
12	*Fusinus* sp.	-	-	-	-	-	228	-	228	342	-	-	-
13	*Nassarius* sp.	-	-	684	-	456	-	228	342	228	684	684	-
3.	**Bivalvea**												
14	*Tellina* sp.	456	456	912	798	684	1.140	1.254	456	684	912	912	456
15	*Nucula* sp.	-	-	684	570	-	-	228	-	-	684	684	-
16	*Macoma* sp.	228	228	798	684	456	-	-	342	342	798	798	228
17	*Donax* sp.	-	-	-	-	-	342	-	-	-	-	798	114
18	*Anadara* sp.	-	-	-	-	-	342	-	-	-	-	-	-
19	*Solen* sp.	114	114	798	570	1.254	684	228	-	-	798	-	-
4.	**Crustacea**												
20	*Ocypoda* sp.	228	228	570	798	570	228	-	-	-	570	570	228
21	*Byblis* sp.	228	228	456	684	684	798	456	570	684	456	456	228
22	*Gnathia* sp.	228	228	456	456	-	342	456	570	456	456	456	228
23	*Ciranola* sp.	-	-	-	456	912	-	570	456	342	-	-	-
5.	**Sipunculidae**												
24	*Sipanculus* sp.	-	-	-	570	-	912	-	-	-	-	-	-

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Table 3. The Analysis of the Diversity (H') and Uniformity (e) of Plankton and Benthos and the Trophic Saprobic Index (TSI) and the Saprobic Index (SI) In The Eroded Coastal Water During the Investigation

Months	Benthos		Plankton		TSI	SI	Notes
	H'	e	H'	e			
Aug'09	2,23	0,93	2,71	0,92	0,78	0,86	Stable ecosystem condition Light pollution level
Sept	2,23	0,93	2,88	0,96	1,20	1,51	Stable ecosystem condition Very light pollution level
Oct	2,23	0,93	2,94	0,97	1,29	1,60	Stable ecosystem condition Very light pollution level
Nov	2,68	0,97	3,09	0,97	1,35	1,74	Very good ecosystem condition Very light pollution level
Dec	2,77	0,98	3,04	0,97	1,26	1,65	Very good ecosystem condition Very light pollution level
Jan'10	2,41	0,97	2,88	0,98	0,89	1,18	Stable ecosystem condition Light pollution level
Feb	2,42	0,94	2,78	0,98	0,63	0,97	Stable ecosystem condition Light pollution level
March	2,22	0,89	2,82	0,98	0,65	1,02	Stable ecosystem condition Light pollution level
April	2,59	0,98	2,94	0,98	1,00	0,78	Stable ecosystem condition Light pollution level
May	2,48	0,97	2,93	0,95	1,10	1,53	Stable ecosystem condition Light pollution level
June	2,68	0,97	2,62	0,88	1,11	1,38	Stable ecosystem condition Light pollution level
July	2,68	0,97	2,51	0,83	0,90	1,47	Stable ecosystem condition Light pollution level

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Table 4. Physical and Chemical Water Quality Parameters In The Eroded Coastal Water During the Investigation

Parameter	Bulan											
	Aug ’09	Sept	Oct	Nov	Dec	Jan’ 10	Feb	March	April	May	June	July
Depth (m)	5,44	5,59	5,54	5,57	5,43	5,57	5,57	5,58	5,58	5,60	5,52	5,60
Transparancy (m)	3,24	3,24	3,24	2,47	3,99	0,47	0,52	3,06	3,05	2,86	3,04	3,92
Current (cm/sec)	9	9	9	25	27	25	25	26	10	19	13	24
Temperature (°C)	29,0	30,4	29,0	30,9	31,5	30,9	30,1	30,9	30,1	30,2	29,8	30,0
Salinity (‰)	34,8	34,4	33,6	28,1	28,4	28,1	28,4	34,5	32,9	31,9	32,5	28,6
DO (mg/L)	6,3	6,3	6,3	6,4	5,6	5,5	6,2	6,2	6,4	6,2	5,7	6,0
Amonia (ppm)	0,127	0,104	0,114	0,103	0,108	0,100	0,100	0,070	0,110	0,095	0,113	0,113
pH	7,1	7,4	7,1	7,6	7,6	7,6	7,8	7,6	7,4	7,5	7,4	7,5
Phoaphate (ppm)	0,367	1,950	0,367	0,369	0,359	0,347	0,438	0,246	1,827	0,450	0,373	0,377
	4,077	1,534	3,448	1,908	2,899	1,637	2,667	3,398	2,210	4,077	3,839	0,334

Notes
1. Sampling was done monthly from 09.30-16.30
2. The water quality parameters data were the average of 5 points sampling with 3 replications at the depth of 1-3 m

CONCLUSION

Based on the Trophic Saprobic Index anaysis, it can be concluded that the eroded coastal water at Morosari, Sayung District Demak Central Java was in a stable ecosystem condition with very light to less polluted and it is still suitable for coastal aquaculture activity, especially for the plankton feeder organisms which are at the lowest level of the food chain such as bivalve molluscs.

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