

Determining Ecological Status of Two Coastal Waters in Western Java using Macrozoobenthic Community: A Comparison between North Part and South Part

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Abstract. The main problem of coastal waters in Indonesia is generally caused by anthropogenic activities that promoting the accumulation of organic matters in sediments. It was well-known that organic matters in sediment might influence the macrozoobenthic communities. AMBI and M-AMBI are two recent developed indices which could be used to evaluate the health of soft bottom macrozoobenthic community and their ecological quality status. This present study was aimed to compare and evaluate the ecological status of macrozoobenthic communities in Tangerang coast (northern part of Java) and Palabuhanratu Bay (southern part of Java) based on AMBI and M-AMBI indices. This study was conducted in April-May 2013 in Tangerang coastal area, and in May 2016 in Palabuhanratu Bay. There are 18 sampling sites in the Tangerang coast, and 30 sampling sites in Palabuhanratu Bay. The results showed that the disturbance level of macrozoobenthos community in Palabuhanratu Bay based on AMBI analysis ranged from undisturbed to slightly disturbed, while in Tangerang coastal waters ranged from undisturbed to moderate disturbed. Ecological quality status based on the M-AMBI ranged from poor to high for both locations. The AMBI and M-AMBI indices showed that benthic environment in Palabuhanratu Bay was ecologically better than that in Tangerang coastal waters.

1. Introduction

The main problems of coastal waters in Indonesia are generally caused by anthropogenic activities. Some anthropogenic activities (*e.g.* industrial wastewater and domestic sewage, shellfish aquaculture, oil and gas industry and marine transportation, etc.) are believed to promote the accumulation of organic matters in sediments. The organic matters in the sediments are well proved to play an important role in benthic communities affecting the trophic structure and biomass [1]. Many studies showed that benthic organisms were very powerful as bio-indicators of the environmental conditions, since benthos had a measurable response to natural environmental disturbances or human activity [2-5]. Several indices have been developed to evaluate the health of the aquatic environment based on benthic communities, such as the Norwegian Classification Tool [6], AMBI [7], and Bentix [8], etc. AZTI's Marine Biotic Index (AMBI), one of marine biotic indices, has been applied broadly across the globe. The index was successfully used in Spain [7, 9, 10], China [11-12], Southern California [13], Uruguay [14], and Slovenia [15].



Borja *et al.* [7] who developed the index, strongly recommended the application of AZTI Marine Biotic Index (AMBI) to evaluate benthic community response as a result of natural environment changes and anthropogenic pressures. This index can classify the level of disturbance or pollution in a region based on the level of health of the benthic community [16]. Assessment of AMBI index is based on the distribution and abundance of five ecological groups of macro-benthos [17] related to its sensitivity to the environmental pressure. Furthermore, evaluation by Borja *et al.* [9] showed the usefulness of the index for evaluating benthic community health due to different impact resources, for example the impact of organic enrichment, physical changes in habitat, the input of heavy metals, etc., along the coasts of Europe.

Although AMBI has been widely implemented in various coastal areas with different sources of pressures, yet it must be careful to use a single index for all systems due to the complexity of benthic communities and diversity of benthic environment gradients [18]. Therefore, Muxika *et al.* [19] suggested the use of M-AMBI to assess ecological status of benthic communities instead. M-AMBI is Multivariate- AZTI Marine Biotic Index, which is an integration of the Shannon diversity index, richness and AMBI into a multivariate approach.

Benthic ecological status assessment is essential considering the increase of anthropogenic activities over time as a result of the waste load into coastal areas. Coastal waters on the northern and southern part of Java have been affected by anthropogenic activities. Nevertheless, the south and north coastal of Java have different characteristics of bathymetry and oceanography as well as the impact resources. Palabuhanratu Bay, situated in south coast of Java is semi-closed waters with less sources of impact due to anthropogenic or industrial activities. Meanwhile, the northern part, particularly the Tangerang coastal waters is an open coastal area experiencing high anthropogenic pressures [20], from industrial activities, power plants, farms and residential of the mainland. The study was aimed to compare and evaluate the ecological status of macrobenthic communities in Tangerang coastal waters and Palabuhanratu Bay based on AMBI and M-AMBI indices.

2. Methods

2.1. Sampling

Tangerang Coastal is an open coastal waters located in the northern part of Java, precisely in the West Java area. Tangerang coastal waters is considered suffered from high pressure due to the increasing anthropogenic activities over years. The anthropogenic sources comes from industrial areas, residential, power plant, transportation, etc [20]. Palabuhanratu Bay is semi-enclosed waters located in the south of Java. The water body also has been affected by anthropogenic pressures due to tourism and residential activities. There is also a power plant constructed recently in the bay as a source of, at least, thermal pollution. The bay area is the largest bay on the south coast of Java and the wave condition is rough since it is directly facing Indian Ocean. This study was conducted in April-May 2013 in Tangerang coastal area, and in May 2016 in Palabuhanratu Bay. There are 18 sampling sites in the Tangerang coast, and 30 sampling sites in Palabuhanratu Bay. Macrozoobenthos was collected by a van Veen Grab (13x26 cm). The macrozoobenthos samples were then screened using 1 mm sieve and preserved in 10% formalin. Fig. 1 showed the map of study sites.

2.2. Data Analysis

Assessment of disturbance level of the macrozoobenthos community structure and determination of the ecological status was performed through a calculation using the AZTI Marine Biotic Index (AMBI) and M-AMBI. This biotic indices classified the type of macrozoobenthos on the sampling sites into five ecological groups (Ecological Group/EG) based on their sensitivity to pollutants [7]. Grall and Glemarec [17] described the five ecological groups of macrozoobenthos. Group I consists of species which is very sensitive to organic enrichment and present under unpolluted conditions (initial state). Group II consists of species which is indifferent to enrichment, always present in low densities with non-significant variations with time (from initial state to slight unbalance). Group III consists of

species which is tolerant to excess organic matter enrichment. These species may occur under normal conditions, but their populations are stimulated by organic enrichment (slight unbalance situations). Group IV consists of species which is second-order opportunistic species (slight to pronounced unbalanced situations). Group V consists of species which is first-order opportunistic species (pronounced unbalanced situations). AMBI index is calculated with the formula below [7] [16].

$$AMBI = \frac{[(0)(\%EGI) + (1.5)(\%EGII) + (3)(\%EGIII) + (4.5)(\%EGIV) + (6)(\%EGV)]}{100}$$

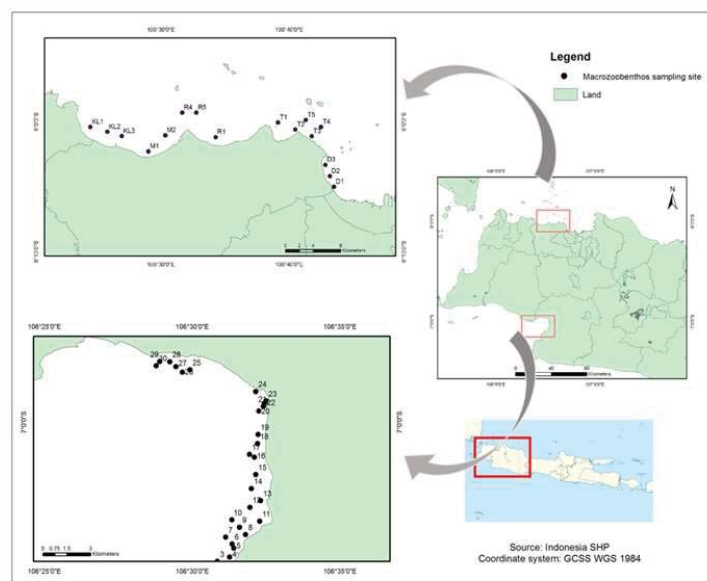


Figure 1. Study area of macrobenthos sampling sites in western Java, i.e. Tangerang Coastal waters (north part) and Palabuhanratu Bay (south part).

AMBI value indicate the level of environmental disruption of benthic habitat. After obtaining the value of AMBI, a multivariate analysis (M-AMBI) was required to measure the ecological status of the benthic environment [19]. M-AMBI calculation involves values of diversity index (Shannon-Wiener index), species richness, and AMBI index. The level of disturbance and ecological quality status were summarized in Table 1.

Table 1. AMBI value and M-AMBI value associate with disturbance classification and ecological status [7, 21, 22].

AMBI	Disturbance classification	M-AMBI	Ecological Quality Status
$0.0 < \text{AMBI} \leq 1.2$	Undisturbed	> 0.77	High
$1.2 < \text{AMBI} \leq 3.3$	Slightly disturbed	$0.53 < \text{AMBI} < 0.77$	Good
$3.3 < \text{AMBI} \leq 5.0$	Meanly disturbed	$0.38 < \text{AMBI} < 0.53$	Moderate
$5.0 < \text{AMBI} \leq 6.0$	Heavily disturbed	$0.20 < \text{AMBI} < 0.38$	Poor
$6.0 < \text{AMBI} \leq 7.0$	Extremely disturbed	< 0.20	Bad

3. Results

Based on the analysis of 30 sampling sites in Palabuhanratu Bay, 65 taxa were obtained included in 6 groups consisting Echinodermata, Polychaeta, Crustaceans, Sipuncula, Nemertina, and Pelecypoda. Polychaeta is the group with the highest number of taxa, i.e. 30 taxa, followed by crustaceans (19 taxa), Pelecypoda (7 taxa), Echinodermata (5 taxa), Sipuncula (3 taxa), and Nemertina (1taxa) (Figure 2). The results of the analysis of macrozoobenthos community of 18 sampling sites in the coast of Tangerang showed that there were 81 taxa included in 15 groups (Polychaeta, Crustaceans, Bivalves, Anopla, Enopla, Clitellata, Gastropods, Eumidasanguinea, Sipunculidea, Ophiuroidea, Actinopterigii, Echiura, Anthozoa, Echinoidea, Ascidiaceae). Similar to Palabuhanratu Bay, Polychaeta also had the highest number of taxa in Tangerang coast, i.e. 24 taxa. Eumidasanguinea, Sipunculidea, Ophiuroidea, Actinopterigii, Echiura, Anthozoa, Ascidiaceae only had one taxa found in each group, thus they were grouped into miscellaneous group (Figure 3).

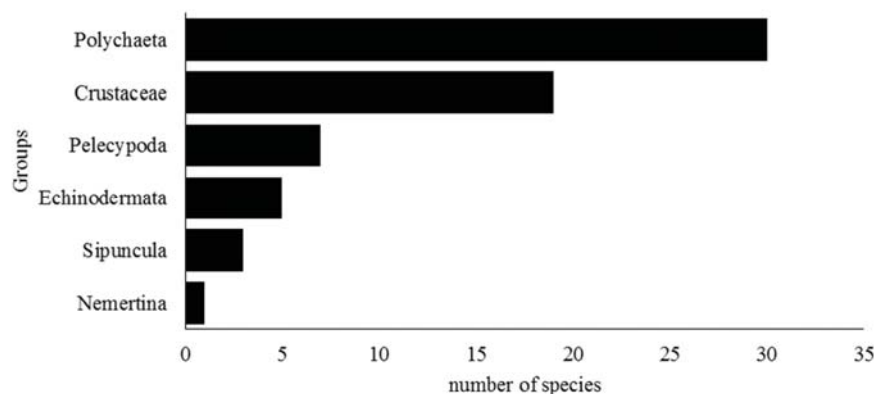


Figure 2. Macrozoobenthos composition from 30 sampling sites in Palabuhanratu Bay.

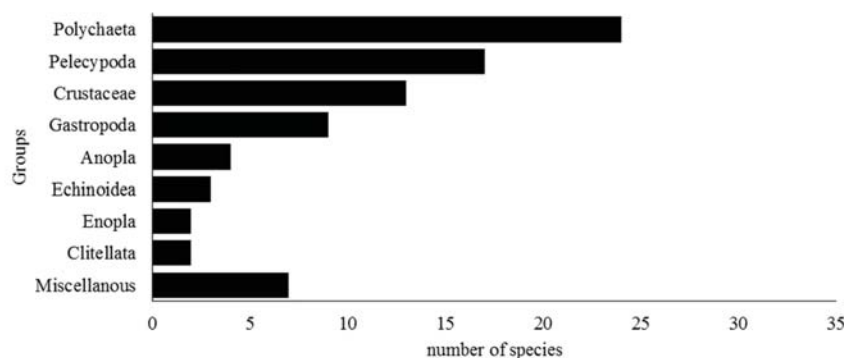


Figure 3. Macrozoobenthos composition from 18 sampling sites in Tangerang coastal waters.

Macrozoobenthos highest density in Palabuhanratu Bay was detected at station 22 (2021 ind/m²), and the highest number of individual was observed in *Cirratulus grandis* belonging to Polychaeta. The lowest benthos density was observed at station 19 (44 ind/m²) consisting of two species only, namely *Cirratulus* sp. and *Pontogeneia intermedia* which belong to Polychaeta and Crustacea, respectively. Total density of macrozoobenthos of each station in Palabuhanratu Bay was summarized in Figure 4. Macrozoobenthos density in Tangerang coast ranged from 0 to 1069 ind/m² (there was no macrozoobenthos samples found in R2 and R3 station). Unlike Palabuhanratu Bay, the highest density of macrozoobenthos in Tangerang coastal waters was observed at D3 station (Figure 5) whis was dominated by *Nuculana vernula* of Pelecypoda group.

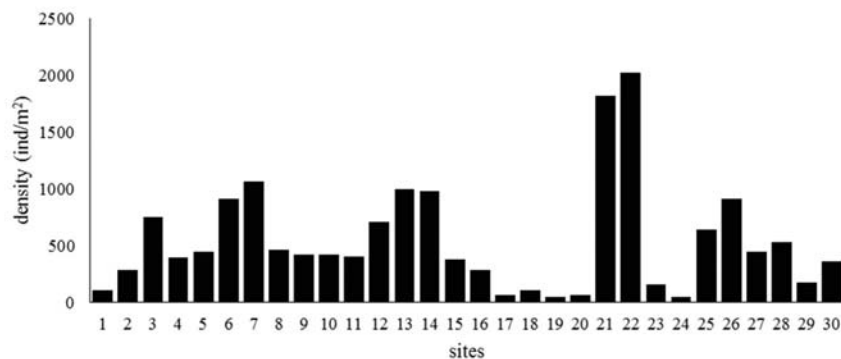


Figure 4 Macrozoobenthos at each sampling station density in Palabuhanratu Bay.

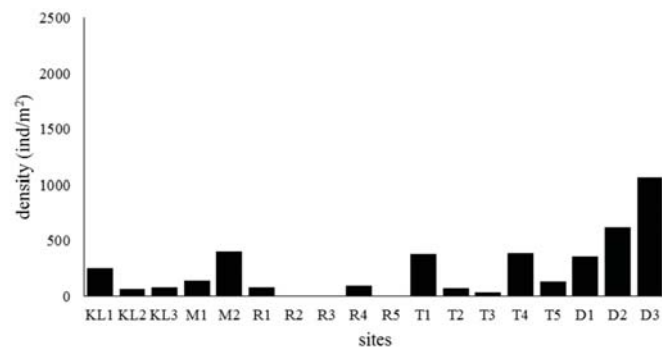


Figure 5. Macrozoobenthos density at each sample station in Tangerang coastal waters. No fauna was found in stations R2 and R3.

From all of the macrozoobenthos community in Palabuhanratu Bay, no species belong to Ecological Group V of AMBI was observed. The mean value of AMBI obtained for each station ranged from 0.5 to 3.5, which implied the level of disturbance of macrozoobenthos communities classified as undisturbed until moderate disturbed (Table 2). Several stations were classified as undisturbed population, i.e. stations 8, 11, 15, 16, and 17; yet station 3 was classified as moderate disturbed. The rest is classified as slightly disturbed. This indicated that the condition of benthic communities in most of the sites in Palabuhanratu Bay was still in relatively good condition because it was in level of undisturbed and slightly disturbed. Macrozoobenthos composition based on the type of ecological group at each station in Palabuhanratu Bay is shown in Figure 6.

Although the condition of macrozoobenthos community in most of stations in Palabuhanratu Bay could be considered as relatively good, the number of taxa (S) was found in great variation (2-19 taxa). There were two stations which have the lowest number of taxa, i.e. station 19 and 24, and the highest number of taxa was observed at station 26. The value of diversity index (H') also varied from 0.95 to 3.90 and Simpson's dominance index (C) ranged from 0.08 to 0.72. These tell us the occurrence of disturbance in macrozoobenthos community at some sampling stations in Palabuhanratu Bay.

Table 2. AMBI and M-AMBI values of 30 sampling stations in Palabuhanratu Bay.

Sites	Ecological Group Presentation (%)						AMBI	Disturbance classification	M-AMBI	Ecological status
	I	II	III	IV	V	not assigned				
1	33.3	33.3	33.3	0.0	0	40	1.5	Slightly disturbed	0.52	Moderate
2	9.1	63.8	9.1	18.1	0	15.3	2.0	Slightly disturbed	0.64	Good
3	3.0	18.1	21.2	57.7	0	2.9	3.5	Moderate disturbed	0.65	Good
4	33.5	19.9	26.6	19.9	0	16.8	2.0	Slightly disturbed	0.73	Good
5	30.7	30.7	7.7	31.0	0	35.1	2.1	Slightly disturbed	0.76	Good
6	19.6	19.6	7.3	53.6	0	0	2.9	Slightly disturbed	0.59	Good
7	39.6	20.8	12.5	27.1	0	0	1.9	Slightly disturbed	0.85	High
8	66.7	28.5	0.0	4.7	0	0	0.6	Undisturbed	0.71	Good
9	23.5	29.4	41.3	5.8	0	10.4	1.9	Slightly disturbed	0.62	Good
10	37.6	6.2	31.1	25.1	0	15.9	2.2	Slightly disturbed	0.68	Good
11	64.2	7.1	28.7	0.0	0	22.3	1.0	Undisturbed	0.67	Good
12	28.0	60.1	7.9	4.0	0	21.9	1.3	Slightly disturbed	0.72	Good
13	11.1	84.5	2.2	2.2	0	0	1.4	Slightly disturbed	0.46	Moderate
14	42.5	20.0	5.0	32.5	0	9	1.9	Slightly disturbed	0.70	Good
15	64.8	35.2	0.0	0.0	0	0	0.5	Undisturbed	0.53	Moderate
16	54.7	27.2	18.1	0.0	0	15.3	1.0	Undisturbed	0.77	Good
17	66.7	33.3	0.0	0.0	0	0	0.5	Undisturbed	0.54	Good
18	40.0	40.0	0.0	20.0	0	0	1.5	Slightly disturbed	0.57	Good
19	0.0	50.0	0.0	50.0	0	0	3.0	Slightly disturbed	0.31	Poor
20	0.0	66.7	33.3	0.0	0	0	2.0	Slightly disturbed	0.44	Moderate
21	23.0	10.8	59.5	6.7	0	9.7	2.2	Slightly disturbed	0.66	Good
22	11.2	34.8	49.5	4.5	0	2.2	2.2	Slightly disturbed	0.66	Good
23	14.3	28.6	42.9	14.3	0	0	2.4	Slightly disturbed	0.56	Good
24	0.0	50.0	0.0	50.0	0	0	3.0	Slightly disturbed	0.31	Poor
25	13.2	47.9	21.6	17.3	0	20.7	2.1	Slightly disturbed	0.82	High
26	7.6	33.4	35.9	23.0	0	4.8	2.6	Slightly disturbed	0.87	High
27	11.0	5.5	55.6	27.8	0	9.9	3.0	Slightly disturbed	0.59	Good
28	41.7	33.4	12.4	12.6	0	0	1.4	Slightly disturbed	0.69	Good
29	28.6	28.6	14.3	28.6	0	12.5	2.1	Slightly disturbed	0.61	Good
30	23.6	32.9	14.5	29.0	0	18.6	2.2	Slightly disturbed	0.68	Good

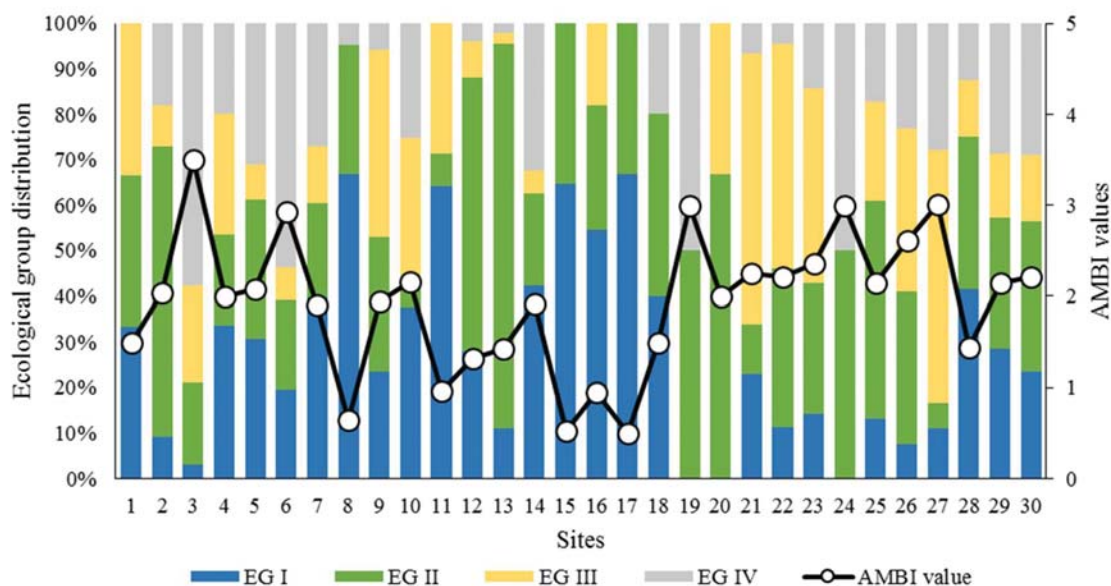


Figure 6. Ecological group composition and AMBI values in 30 sampling sites in Palabuhanratu Bay

Based on the M-AMBI value, the ecological status of macrozoobenthos community in Palabuhanratu ranged from Poor to High. There were 3 stations (10.00%) classified into high ecological quality status, 21 stations (70.00%) classified into good quality ecological status, 4 stations (13.33%) classified into moderate ecological quality status, and 2 stations (6.67%) classified into poor quality ecological status. Ecological status distribution based on the M-AMBI in Palabuhanratu Bay was shown in Figure 7.

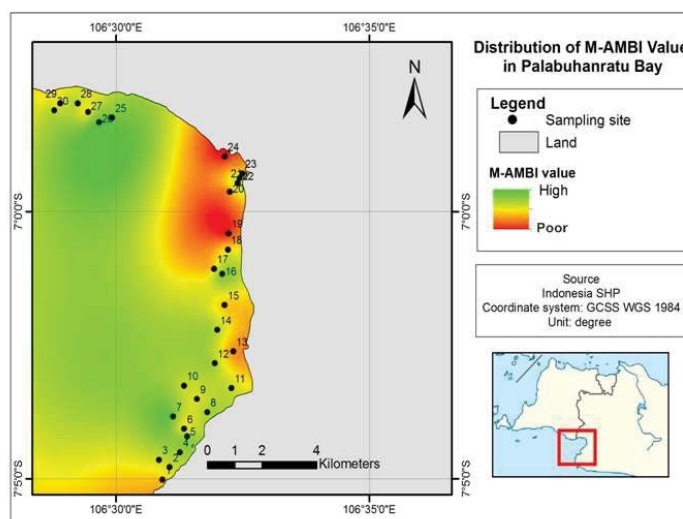


Figure 7. Distribution of ecological status based on macrozoobenthos community with M-AMBI value approach in Palabuhanratu Bay.

AMBI mean value in Tangerang coastal waters ranged from 0.075 to 4.682 (R2 and R3 stations were excluded from the analysis) (Table 3). Macrozoobenthos composition based on the type of ecological group at each station in Tangerang coastal waters is shown in Figure 8. The values indicated that the condition of macrozoobenthos community classified into undisturbed until moderate disturbed. Undisturbed population was examined at T5, D1, D2, D3 station, while the slightly disturbed population observed at T1, T2, T3, T4, KL1, KL2, KL3, M1, M2, and R1 station, however moderate disturbed population observed at R4 and R5 station.

Table 3. AMBI and M-AMBI values of 18 sampling sites in Tangerang coast

Sites	Ecological group presentation (%)						AMBI	Disturbance classification	M-AMBI	Ecological status
	I	II	III	IV	V	not assigned				
KL1	15.4	3.5	73.8	1.9	5.4	0.5	2.68	Slightly disturbed	0.49	Moderate
KL2	1.0	2.1	94.8	1.0	1.0	0	2.98	Slightly disturbed	0.27	Poor
KL3	2.5	0.0	87.4	2.5	7.6	1.7	3.19	Slightly disturbed	0.29	Poor
M1	21.3	1.0	64.9	7.9	5.0	0	2.61	Slightly disturbed	0.58	Good
M2	3.3	1.4	91.6	2.6	1.1	1.7	2.95	Slightly disturbed	0.45	Moderate
R1	45.9	14.4	21.6	2.7	15.3	5.9	1.91	Slightly disturbed	0.71	Good
R2	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
R3	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-
R4	8.6	1.4	24.3	0.7	65.0	0	4.68	Moderate disturbed	0.32	Poor
R5	0.0	40.0	0.0	60.0	0.0	0	3.30	Moderate disturbed	0.25	Poor
T1	30.8	18.8	30.6	14.0	5.8	5.8	2.18	Slightly disturbed	0.82	High
T2	35.6	25.7	15.8	10.9	11.9	1	2.06	Slightly disturbed	0.85	High
T3	8.7	6.5	69.6	15.2	0.0	0	2.87	Slightly disturbed	0.40	Moderate
T4	48.9	23.4	9.7	6.6	11.4	6.5	1.62	Slightly disturbed	0.86	High
T5	75.5	1.6	17.9	4.9	0.0	0.5	0.78	Undisturbed	0.57	Good
D1	96.7	0.4	1.7	1.2	0.0	0	0.11	Undisturbed	0.47	Moderate
D2	97.5	0.0	2.5	0.0	0.0	0	0.08	Undisturbed	0.41	Moderate
D3	91.2	0.6	5.0	1.0	2.2	0	0.34	Undisturbed	0.47	Moderate

Number of taxa found in each station ranged from 0 to 26. The diversity index (H') of macrozoobenthos in Tangerang coastal waters ranged from 0.54 to 3.7 and Simpson's dominance index ranged from 0.11 to 0.86. The low value of the diversity index and high value of the dominance index at some stations indicated there was disturbance to benthic communities in the coast of Tangerang. With 2 stations without fauna (11.11%), the results of the analysis of M-AMBI in Tangerang coastal waters showed that 4 stations (22.22%) were identified as poor in ecological quality, 6 stations (33.33%) as moderate, 3 stations (16.67%) as good and 3 stations (16.67%) as high. Ecological status distribution based on the M-AMBI in Tangerang coastal waters was visualized in Figure 9.

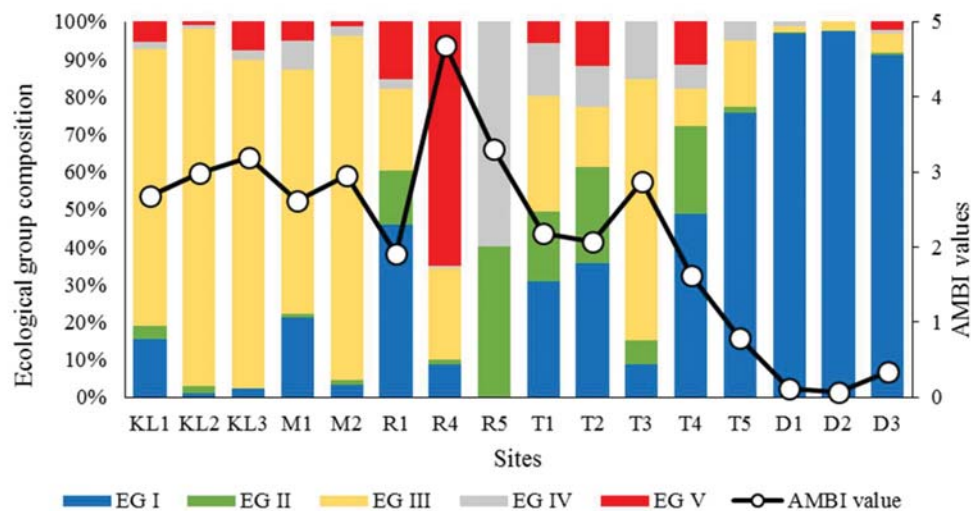


Figure 8. Ecological group composition in 16 sampling sites in Tangerang coast

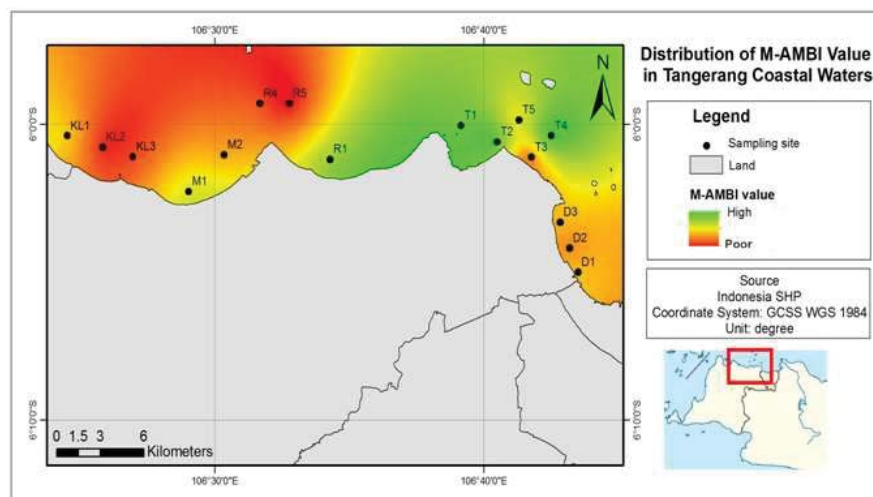


Figure 9. Distribution of ecological quality status based on macrozoobenthos community with M-AMBI value approach in Tangerang coastal waters.

4. Discussion

Analysis of benthic communities in Pelabuhanratu Bay (southern part of Java) and coastal Tangerang (northern part of Java) showed that there were 65 taxa and 81 taxa, respectively. The highest number of taxa in both waters come from the same group, i.e. Polychaeta. The similar results were also discovered by Mavric *et al.* [15] in the Gulf of Trieste, Slovenian which was dominated by Polychaeta (65-84%), and by Zettler *et al.* [23] in the Baltic Sea. This phenomenon is not uncommon condition because polychaetes are usually the most abundant taxon in benthic communities of disturbed soft-bottom sediments, so that is why they are quite often utilized as indicator species of environmental

conditions [24]. Moreover, since the taxon contains both sensitive and tolerant species, the polychaeta have been identified worldwide as group that respond quickly to environment disturbance [2, 25-27]. Polychaetes are an important component of macro-benthic community as they often dominate in term of abundance, biomass, and species or taxa. They play an important role in the stability and functioning of the benthic community and the ecological in general. They are extremely diverse taxa, with wide range of reproductive strategies and feeding guilds [27, 28].

The highest density of macrozoobenthos found at station 22 in Palabuhanratu Bay, and the most dominant species in this station was *Cirratulus grandis* which belong to the Ecological Group III. This group includes species tolerant to excess organic matter enrichment. *C. grandis* is a selective deposit feeder, consuming organic particles found within the sediments, so that *C. grandis* is commonly used as a test organism to study the concentrations and effects of various pollutants found within sediments in marine environments [29, 30]. *C. grandis* also helps to overturn and oxygenate sediment by mixing particles during burrowing and feeding activities [31]. The highest macrozoobenthos density in Tangerang coastal waters was found in station D3 dominated also by Pelecypoda group, *Nuculana vernula*. *N. vernula* is a species belong to family Nuculidae classified into EG I which including species that are very sensitive to organic matter enrichment. The species in this group is considered as an indication of the health environmental ecosystem or unpolluted conditions [7].

The analysis of AMBI showed that benthos community level of disturbance in the Palabuhanratu Bay ecosystem ranged from undisturbed until moderate disturbed, while the result of the M-AMBI analysis stated ecological status in these waters ranged from poor to high. There was a significant difference between the results of the AMBI and M-AMBI on several stations in Palabuhanratu Bay. Stations 19 and 24 were classified as slightly disturbed by AMBI, yet classified as poor of Ecological quality status based on the M-AMBI. This difference could be caused by low species richness (only 2 species) and low diversity index at both stations, therefore the value of M-AMBI become low. There were only two species found in station 19, i.e. *Cirratulus* sp. (EG IV) and *Pontogeneia intermedia* (EG II), while at the station 24, *Prionospio* sp. (EG IV) and *Pholoe* sp. (EG II) were found. According to Zettler *et al.* [23], the AMBI index considers only the abundance and species classification into its ecological group without considering the species richness in the area. Borja *et al.* [32] and Borja & Muxika [33] agreed with this disadvantage and limitation of using it. Therefore Muxika *et al.* [19] suggested the using of Multivariate-AMBI (M-AMBI) which integrates the species richness, diversity index, and the AMBI value. As a note, Borja and Muxika [33] stated if the species found in a location is less than equal to 3 species, then it should be removed from the analysis of AMBI, because the value of AMBI will be less accurate.

The same phenomenon occurred in the Tangerang coast, where the value of AMBI at station KL2 and KL3 belong to the slightly disturbed, but the value of the M-AMBI showed poor ecological quality status. Evaluating from the species richness, there were 6 taxa in both stations. These station also had a low diversity index. This indicated an unbalance in macrozoobenthos communities in both locations. This unbalanced can be caused by the location of the KL2 and KL3 station which located not far from the mouth of two major rivers, i.e. Kronjo and Cidurian Rivers. The two rivers discharged anthropogenic inputs of urban waste to coastal waters areas which might be affecting macrozoobenthos communities in the Tangerang coastal waters. In addition, the water currents of both river which met and bumped to coastal ocean current was indicated causing heavy turbulence which caused natural environmental pressure to the macrozoobenthos communities.

As AMBI was developed for assessing the health status of the macrozoobenthos community in European coastal areas, it is necessary to make adjustments when it is used in other regions, especially in the tropical regions, because the species composition of macrozoobenthos in each location are not the same and many local species is not included in the list. This caution opinion was also revealed by Liu *et al.* [12] who conducted a study in the Changjiang River, China and made some adjustments in classifying some local species to its ecological group by using the assignment of the same genus or expert judgment in accordance with Borja *et al.* [34]. In addition, according to Borja and Muxika [33], generally, not assigned taxa discovered in one location should be less than 15%. However, when the

percentage of not assigned taxa is more than 20%, then the value of AMBI should be interpreted with care. Also, when not assigned taxa found more than 50%, then AMBI should not be used. In this study, there were no station had the percentage of not assigned taxa more than 50%, but there were several stations in Palabuhanratu Bay which had percentage of not assigned taxa more than 20%, i.e. station 1, 5, 11, 12, and 25, hence the AMBI value at these stations should be evaluated with care, especially in case of poor quality status.

Generally, marine environment ecosystem in Palabuhanratu Bay was relatively in better condition than the Tangerang coastal waters by seeing the values of AMBI and M-AMBI indices. In comparison of AMBI value, 96.67% of sampling stations in Palabuhanratu Bay falls into undisturbed and slightly disturbed condition, while in Tangerang coastal waters is only 77.78%. In terms of M-AMBI values, the ecological status with good to high quality in Tangerang coastal waters was only 33.34% sampling station with 11.11% was found without fauna. While in Palabuhanratu Bay, the good to high ecological status was demonstrated by 80% of sampling stations with 0% stations without fauna.

The north coast of Java Island is more densely populated urban areas and has many industrial areas that contribute the large waste into the coastal waters of Tangerang. However, Palabuhanratu Bay was also not free from the anthropogenic activities but it was expected that anthropogenic pressures on the southern coast of Java was lower than that of the north coast of Java. In addition, the position of Palabuhanratu Bay which directly facing the Indian Ocean with huge wave would help the bay to accelerate the flushing of this semi-enclosed waters.

5. Conclusion

The disturbance level of macrozoobenthos community based on AMBI analysis was ranged from undisturbed to moderate disturbed in Palabuhanratu Bay and Tangerang coastal areas. Ecological quality status based on the M-AMBI was ranged from poor to high for both locations. These conditions indicated a disturbance in benthic environment of both location due probably to anthropogenic activities discharging waste to the seas. By comparing the AMBI and M-AMBI indices, it could be concluded that benthic environment in Palabuhanratu Bay (southern part of West Java) was less affected by anthropogenic activities than Tangerang coastal waters (northern part of West Java).

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