Proceedings of The 2nd Annual International Conference Syiah Kuala University 2012
& The 8th IMT-GT Uninet Biosciences Conference
Banda Aceh, 22-24 November 2012

Water quality of Krueng Balee in Lafarge Cement Indonesia Factory in Lhoknga Aceh Besar according to benthos biodiversity

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Abstract. The study of the quality of water of Krueng (River) Bale in Factory Environment Lafarge Cement Indonesia (LCI) in Lhoknga Aceh Besar according to benthos biodiversity was aimed to determine the species of benthos and water quality of Krueng Bale according to benthos diversity. The study area was divided into four locations that were the upstream of the tunnel (Location 1), bridge area at the south (Location 2), branch of the river area (Location 3), and the downstream of the two creeks. The study was done from April to June 2012. The method was survey and destructive sampling. The species of benthos was analysed descriptivelly and the diversity was analysed by diversity index formula (H). The results showed that there were 20 species of benthos found in the area and the index of diversity was between 1.996 and 2.652. In brief, River Bale is still suitable as the habitat of aquatic organisms.
Keywords: LCI, benthos, diversity

Introduction

There are various organisms consisting of plankton, nekton, and nekton found in the river. Plankton is an drifted organism and its movement relied on the water flow whereas nekton is free-moving underwater organisms (Barus, 2004). Unlike both types organisms, benthos is adherent , freely moving or drown in the riverbed (Barus, 2001). The river receives the effluent water, specially from LCI plant and from the mountain ranges. The effluent water is liquid waste from dari cement miling activities and electricity generator (Darusman, 2006). The effluent from the ranges are running water and sedimentation produced from erosion and the blasting of the limestone (Darusman. 2006 and Anonimus, 2009).

Benthos is aquatic biota living attached to other things , crawling, and suppressing themselves on riverbed. Porifera, Coelenterata, Annelids, Molluscs, Arthropods, and Echinoderms are belong to this group. Generally, Porifera and Coelenterata's organisms living attach to riverbed, Arthropods' and Echinoderms' crawl on the riverbed and Molluscs attach to, crawl on and also hide in the riverbed.

According to Sarong *et al* (2012) there are 20 species living on the riverbed of River Bale belonging to some classes such as Gastropods, Crustacea, and Bivalvia. Benthos in Krueng Bale are dominated by class Bivalvia that crawling on riverbed (Sarong, 2012). The existence of Bivalvia in Krueng Bale LCI Lhoknga can be used as water quality indicator of the river. This due to they move difinitelly and have relativelly large size of the body. Moreover, their existence is influenced by the alteration of environmental condition (Barus, 2001). The study was aimed to determine the species of benthos indicating of the water quality of River Bale and the quality of water of River Bale due to the availability of the benthos. The results of the study can be used by other researchers and parties who need the information about the quality of water of River Bale regarding to benthos existence.

Materials and Methods

The study was determined in river Krueng Bale around PT. LCI Lhoknga Aceh Besar. The study area was divided into three locations; the southern area of the river (Location 1), brackish water area at the south (Location 2), and the downstream (Location 3). The study was done from April to June 2012. The equipments used were a two stage sieve, hand refractometer, pH meter, thermometer and quadrant. Each station has three sampling plots with the size 1 m x 1 m each. The benthos were collected in the plots by destructive and non-destructive method. Non destructive method was used to collect the benthos above the riverbed whereas the destructive one used for benthos inside the riverbed. The number of species of benthos was analysed descriptivelly. The quality of water was analysed relied on the diversity index of benthos according to Shannon-Wiener formula (Fakhrul, 2007): $H = \sum pi \ln pi$

Where, H = Index of Diversity, pi = ni/N, ni = number of individual each species and N = Total number of Individual. The categories used to decide the quality of water according to Fachrul (2007) is shown in Table 1.

Table 1. The quality of water based on Shannon-Wiener Diversity Index

No	Diversity Index (H)	Diversity Category	Quality of water
1	>2,0	High	Uncontaminated
2	1,5-2,0	Moderate (Medium)	Minor Contaminated
3	1,0-1,5	Moderate (Medium)	Moderate Contaminated
4	< 1,0	Low	Heavy Contaminated

Results and Discussion

Number of the species of benthos

There were 20 species of benthos found in the area of River Bale. The species belong to Mollusca (13 species) and Arthropoda (7 species). The 13 species of Mollusca consists of 4 species of Bivalvia and 9 species of Gastropoda. Bivalvia were dominantly found on the riverbed. Arthropoda were dominated by Crustacea. The phylum were dominated by prawn consisting of 4 species living inside the riverbed. It was found that crab, the member of Decapoda, live on the zone of littoral. Mollusca, animal with soft body, can be used as the indicator of contamination. Wardhana (2005) states that the members of Mollusca are the indicator of water contamination. Meanwhile, Arthropoda only can survive in the uncontaminated fresh, brackish, and sea water. Species of benthos found in the location is shown in Table 2.

Tabel 2. Species of Benthos in River Bale LCI Lhoknga, Aceh Besar

No	Species	Number of individuals found in each station		
		1	2	3
1	Bivalvia sp1	0	16	5
2	*Cliton squrrosus*	0	0	1
3	*Littorina undulata*	6	12	0
4	*Littorina scabra*	5	25	0
5	*Littoraria articulata*	0	10	0
6	*Fannus ater* (Ind/m^2)	3	12	0
7	Craccostrea sp. (Ind/kel)	2	5	0
8	Macrobranchium sp.	1	5	0
9	*Caridina* sp. (Ind/m^2)	4	13	0
10	Crustacea sp1	2	4	1
11	*Macrobranchium equident*	2	3	0
12	*Euphagurus* sp.	1	2	0
13	Bivalvia sp1.	0	6	1
14	Bivalvia sp2	0	9	1
15	Gastropoda sp1.	1	6	0
16	Gastropoda sp2.	2	2	0
17	Gastropoda sp3.	0	3	3
18	Gastropoda sp4.	0	2	2
19	*Uca* sp.	1	2	2
20	*Ocypoda* sp	0	2	3
	Total	30	139	19

The Diversity of Benthos and Water Quality of River Bale

The index of diversity of benthos in the area of the river was around 1,878 to 2,486. It was found that the lowest index was found in Station 3 whereas the highest one was in Station 2. The lowest diversity index was assumed due to the effluent water from the washery of driving engine of the plant. The temperature of the machine was 500^{o}C. The cooling was done using sea water. After cooling, the water was transfered to the channel terminated to the southern area of River Bale. Mukhtasor (2007) states that environemtal components , such as temperature and pH, cause the enviromental changes. The interference of physiological processes of animals and their death are caused by higher or lower environmental temperature than their optimum physiological temperature. The variety of species of benthos and water quality of River Bale is shown in Table 3. The analysis showed that the index of diversity of benthos in Station 1 and 2 was high indicating the environmental condition of those stations were not spoiled by pollutants. The water of the upriver, the site of the river near Kubu Badeuk Mountain Ranges , was clean.

This is assumed that because the site had a variety of plants and no waste channel, from the plant and other buildings around the plant, found in the area. According Sarong (2012) there were 39 species of flora and 60 species of fauna in the area of LCI Plant Lhoknga.

Table 3. The Diversity of Benthos and Water Quality of River Bale LCI Lhoknga, Aceh Besar

Station	Index of Diversity (H)	Explanation
1	2.253	Uncontaminated
2	2.486	Uncontaminated
3	1.878	Minor Contamination

Fachrul (2007) states that H>2,0 indicates high diversity, 1,5>H<2,0 moderate diversity, 1,0> H < 1,5 moderate diversity, and H < 1,0 indicates low diversity. Based on the categories, the diversity of aquatic animals in the area of River Bale LCI Lhoknga was medium to high. Moderate diversity of animals indicated that there was minor contamination has occured in Station 3. However ,the condition was still proper for aquatic organisms to live. In general, the quality of water of River Bale regarding to benthos existence was moderate contaminated. However, the water quality of Station I was not contaminated. This due to the area was not interfered with the activity of the plant. Moreover, the riverside was still composed by many plants. The southern area of the river, the channel of the effluent water was absent.

The Condition of Environmental Components of The Area of The River

The collected data for the water components of River Bale showed that the water and air temperature were about 27-29 ^{o}C and 29-31 ^{o}C respectivelly. The pH of water and salinity were around 7,0-8,5 and 0-5% respectivelly. The texture of sediment at the upriver was muddy and sandy at the downstream. The average of the depth at the upriver was 0,5 to 1,2 meter and 0,4 to 0,5 meter at the downstream and the rivermount (Sarong, 2012). The measurement of environmental components of River Bale is shown in Table 4.

Table 4. The Condition of Environmental Components of River Bale LCI Lhoknga, Aceh Besar

No	The measured components	Station			The Range
		I	II	III	
1	Water Temperature (^{o}C)	27-28	27-29	28-29	27-29
2	Air Temperature (^{o}C)	28-30	29-31	29-31	29-31
3	pH	7,0	7,2	7,5-8,5	
4	Salinity (%)	0,0-0,0	0,0-3	3,0-5,0	
5	Texture of Sediment (dominant)	muddy	sandy	Sandy	
6	Depth (m)	1,2	0,4	0,50	

Relied on the data of environmental components, the river was still proper as the habitat of the organisms. The brackhis water was suitable for almost aquatic organism. Bengen (2004) states that brackhis water has 0,5-30% salinity comprising of nutrient-rich mud. The mud is from the plants living along the river bank and in the river. The aquatic animals living in the brackhis water consist of sea, brackhis, and fresh water animals. Effendi (2000) states that there is a slight decrease in the diversity of plankton and benthos at pH 6,0-6,5 and is significant reduced at pH 5,5-6,0. Therefore, the pH of River Bale which was up to 7,0 indicating that the river was a suitable habitat for the aquatic organisms.

Conclusions

There were 20 species of benthos found in the location showing the quality of water of River Bale. River Bale was a suitable habitat for the aquatic organims.

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