Analysis of Heavy Metal Content (Pb) on Waters and Fish at The Floating Cages BPPP Ambon

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Abstract. Coastal waters play important roles due to highly in natural resources and developing of environmental services. However, there are highly intensity of natural resources utilization, environment and settlement. Consequently, environment and natural resources would be degraded such as in the Ambon Bay. One of the potency at the Ambon Bay is mariculture area namely the floating cages (KJA) which belongs to Fisheries education and training (BPPP) Ambon. The research aimed to analyze physical-chemical of waters (temperature, pH, salinity and current speed), to analyze heavy metal concentration (Pb) on water and fish from floating cages (KJA) and to analyze waters pollution status at KJA BPPP Ambon. The average salinity of each floating cage ranged from 30.09 - 30.34°C, pH ranged from 8.03 – 8.44, salinity ranged from 31.36 – 33.34 PSU, and current speed at spring tide ranged from 0.5 – 55.8 Cm/sec while neap tide ranged from 0.1 – 9.8 Cm/sec. Heavy metal concentration (Pb) on waters was below the standard for waters quality and the average concentration was 0.002 mg/l. Whilst, the heavy metal concentration (Pb) on fishes was below standard for floating cages (floating cages 2-6) which was 0.05 and 0.17mg/l. Otherwise, floating cage 1 had been above maximum standard for fish food and its processing following SNI 7387:2009 (0.3mg/l) which was 0.31 mg/l. The status of waters pollution at KJA BPPP Ambon belonged to C class and could be categorized as moderate based on standard for waters quality issued by State Ministerial Decree for the Environment No. 51 Year 2004.

1 Introduction

Coastal waters play important roles due to highly in natural resources and developing of environmental services. However, there are highly intensity of natural resources utilization, environment and settlement. In line with highly intensity of natural resources, development and communities necessities, caused waste in coastal area and sea becomes varied with highly volume. This highly waste volume will have an impact on quality of waters environment [1]. The Inner Ambon Bay and its surrounding are coastal waters and have highly intensity of natural resources utilization, and environmental services, so it causes changed in natural resources and environment. One of the potency of the Inner Ambon Bay is mariculture area where there is floating cages (KJA) which belongs to Balai Pendidikan dan Pelatihan Perikanan (BPPP) Ambon. In addition, the Inner Ambon Bay has been used for transportation such as ferry boat, speed boat and ship repair.

The successful of fish mariculture in floating cages is determined by waters quality. The highly intensity of spatial utilization in the Inner Ambon Bay is possible to change its waters quality especially for the entry of pollutant materials into the ecosystems. The pollutant materials could be toxic. One of the pollutants which harmful for the mariculture biota are heavy metal [2]. According to Palar [3,4] one of the toxic and dangerous heavy metal as pollutant and tend to affect the waters organisms is Pb metal.

The previous study indicated that heavy metal (Pb) in the waters of Ambon Bay ranged from 0.004 mg/l-0.008 mg/l [5]. Otherwise, the heavy metal content (Pb) in the body of rabbit fish (*Siganus canaliculatus)* and caranx (*(caranx sexfasciatus)* ranged from 0,007-0254 ppm [6]. Based on the some facts as explain above, it could be assumed that the concentration of heavy metal (Pb) has been increasing due to highly intensity of space in the Inner Ambon Bay. This would be threatened the sustainability of floating cages mariculture. Therefore, the research aimed were to analyze physical-chemical of waters (temperature, pH, salinity and current speed), to analyze heavy metal concentration (Pb) on water and fish from floating cages (KJA) and to analyze waters pollution status at KJA BPPP Ambon.

2 Methods

2.1 Study sites

The research was conducted from April to June 2014 and consisted into two stages: fieldwork and laboratory analysis. The fieldwork was done in floating cages (KJA) BPPP Ambon, located in Tanjung Martha Fons. The sampling station of six floating cages was situated at

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128°13'30" E - 128°13'36" E and 03°37'47,12" - 03°37'50,12" S (Figure 1).

The analysis of waters quality including physical-chemical such as waters current, temperature, pH and salinity were done as in situ by using CTD and current meters in 6 floating cages at 0.5-10m depth. Whereas, the analysis of heavy metal content (Pb) both in waters and fish were conducted in the testing laboratory of Oceanography Research Centre LIPI Ancol – Jakarta. The equipment and materials for testing heavy metal (Pb) in the laboratory follow SNI 2354.5:2011 to determine heavy metal content (Pb) of fisheries product.

2.2 Methods of sampling water and fish

Water sample were collected in 6 floating cages (KJA) with the size of 3x3x3m^3 at 1 meter depth by using *Van Dorn bottle sampler*. Then, the water was placed into polyethylene bottle and preserved by adding HNO3 to pH < 2. Finally, the water samples were put into the cool box. In addition fish sample were collected at each floating cages (6 units) especially *Caranx* approximately at age 6 months with average weight 250 grams and length 21 cm. Fish were put into plastic PE then it's are frozen. The analysis of heavy metal content (Pb) both in waters and fish were conducted in the testing laboratory of Oceanography Research Centre LIPI Ancol – Jakarta.

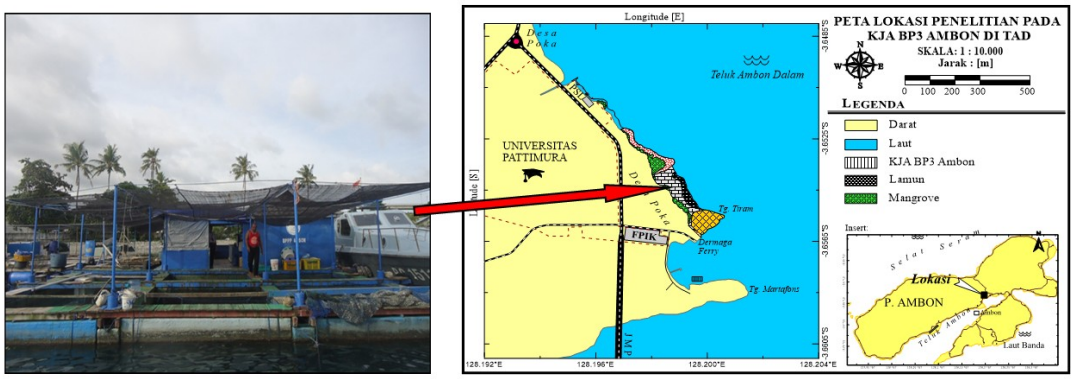

Fig.1. Study site

2.3 Data analysis

The results of the analysis correspond to standard for seawater quality issued by State Ministerial Decree for the Environment No. 51/200 [7,8]. The results of heavy metal (Pb) analysis both in water and fish were also corresponded to standard for heavy metal especially for water and biota (fish) and could be categorized as polluted or unpolluted.

To determine the water status, used scoring system US-EPA (Environmental Protection Agency), is classified into four classes namely:

1. A: very good , score = 0 = fulfilled the standard
2. B : good, score = -1 to -10 = lightly polluted
3. C : moderate, score = -11 s/d -30 = moderate polluted
4. D : bad,score ≥ -31= heavily polluted

The procedure to determine status of water quality by using STORET Method as follows: Data (physical, chemical and biology) obtained should be calculated the minimum, maximum and average values then compare to the standard for seawater quality with some criteria:

- If water quality data fulfilled measurement of the standard with ≤ standard quality, score 0,
- If water quality data unfulfilled measurement of the standard with ≥ standard quality, scoring as follows Table 1.

Table 1. Determination of value system for water quality status

Parameters	Value	Parameters		
		Physic	Chem	Bio
< 10	Maximum	-1	-2	-3
	Minimum	-1	-2	-3
	Average	-3	-6	-9
≥ 10	Maximum	-2	-4	-6
	Minimum	-2	-4	-6
	Average	-6	-12	-18

(Appendix State Ministerial Decree for the Environment No. 115 / 2003) [9].

3 Results and Discussion

3.1 Physical-Chemical Waters Quality and Its Correlation with Pb

3.1.1 Temperature

Temperature distribution during the research at each floating cages ranged from 27.47 – 30.51°C with the average 29.52°C. The average temperature of each floating cage was represented in figure 2. The results indicated that the temperature at water surface (0.5 m depth) of each floating cage was higher (30.09 - 30.34°C) than that of the bottom (10 m depth) 28.55 –

28.70°C. According to Nontji water surface is warm layer due to getting sun radiation in the day [10,11],.

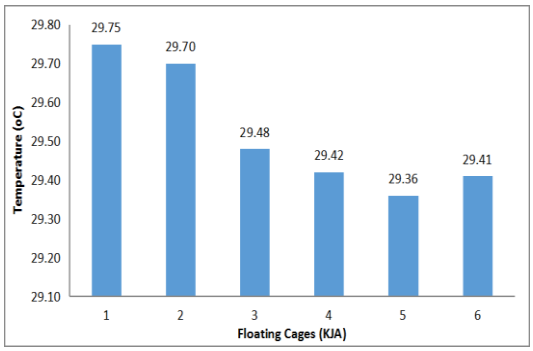

Fig. 2. Temperature at floating cages KJA BPPP Ambon

On the other hand, the increasing of water depth in the water column, decreasing temperature due to less of sun radiation. The water depth has influenced temperature of water body [12, 13]. Based on the standard for seawater quality (State Ministerial Decree for the Environment No. 51 / 2004), recommended temperature ranged from 28-30°C and temperature in Indonesian waters ranged from 28-31°C.

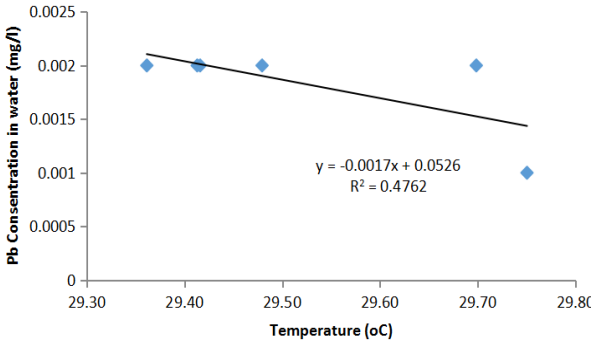

Fig. 3. The correlation of Pb concentration and water temperature

Therefore, the temperature at 10m depth in the KJA BPPP Ambon was normal and could be tolerated by waters organism. Temperature distribution at each floating cage with different depth showed that the temperature was suitable for mariculture and the temperature could decrease negative effect of metal on the marine organism (mariculture fish). The presentation of Pb in the water colum could be pushed by the reaction of physical-chemical parametres. The simple correlation was represented in Figure 3, which showed a weakness correlation of 47.62 % of water temperature and Pb concentration.

3.1.2 pH

pH is a parameter which explains dissolved hydrogen content in water. It could influence element content and chemical compound found in the waters. Palar stated that toxicity of heavy metal are also influenced by pH changed which toxicity of heavy metal will increase, if pH decrease. The research conducted by Ambon city government and Unpatti showed that pH at water surface in the Inner Ambon Bay ranged from 8.3-8.6 whereas in the depth 30-40m ranged from 7.3-8.6. This depth the pH varied compared to other depth. Selanno stated that pH at each monsoon ranged from 7.99-8.28 [14]. The results indicated that pH ranged from 8.03-8.44 with the average 8.17. The average pH at each floating cages could be seen in Figure 4.

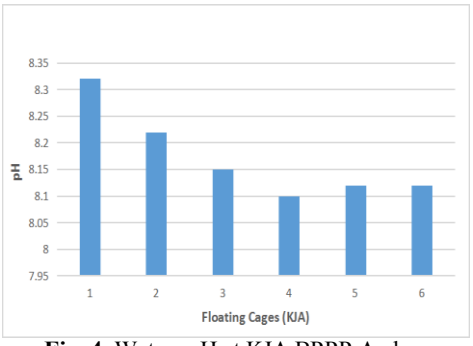

Fig. 4. Waters pH at KJA BPPP Ambon

pH of the waters could influence accumulation of heavy metal in fish because the lower water pH and sediment, the higher heavy metal dissolved (ion). So, it was easily to penetrate in the fish through gill, food or diffusion [15]. According to the standard for seawater quality issued by State Ministerial Decree for the Environment No. 51/2004, for marine organism pH 7 – 8,5. Therefore, the water pH at KJA BPPP Ambon was in recommended, could be tolerated by organisms. The dissolved of heavy metals in the water could be controlled by water pH. The increased of water pH would be decreased the dissolved of metal in the water.

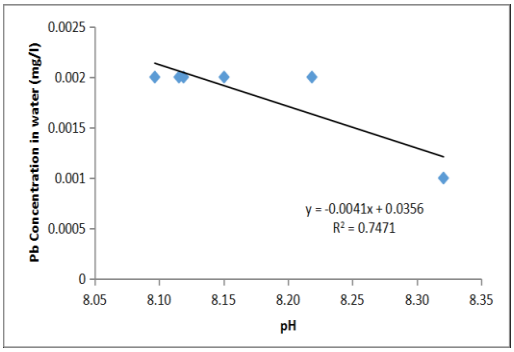

Fig.5. The Correlation of Pb concentration and water pH

Therefore, the increased of water pH will be changed the stability of carbonate shape to hydrocide that formed a bond with some particles in the water column and might be sediment as a mud (Effendi, 2003). Figure 5, showed a significant correlation of 74.71% of Pb concentration in the water and water pH.

3.1.3 Salinity

There are some factors which influenced waters salinity such as evaporation, water circulation, rainfall and river flows. The changes of the salinity could be varied both temporal and spatial due to changes of the sea condition, evaporation, and distance from the sun. The research conducted by Ambon city government and Unpatti

(2002) showed that salinity the Inner Ambon Bay was 27.00 – 32.00 PSU. Selanno also found salinity at each monsoon ranged from 29.45 – 35.27 PSU. The results indicated that salinity at KJA BPPP Ambon ranged from 31.36 – 33.34 PSU with the average 32.87 PSU. The average salinity at each floating cages could be seen in Figure 6 and their correlation could be seen in Figure 7. There was a significant correlation of 55.56% of Pb concentration and water salinity.

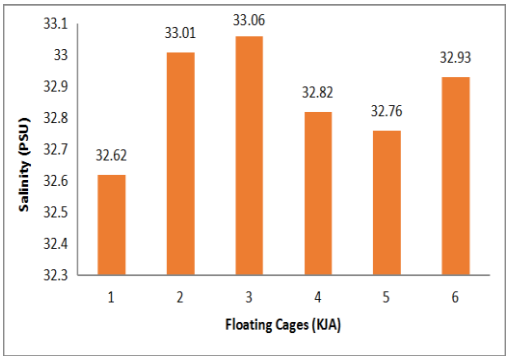

Fig. 6. Waters salinity at KJA BPPP Ambon

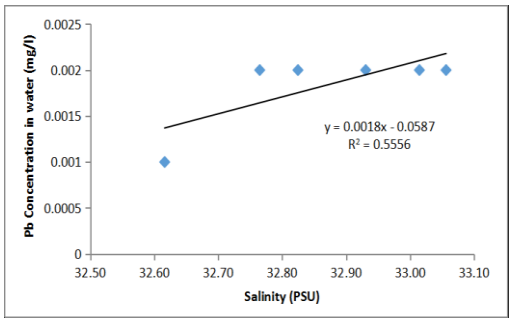

Fig. 7. The correlation of Pb concentration and water Salinity

3.1.4 Current

Waters current will influence the existence of heavy metals in the waters. Hoshika stated that the occurrence of heavy metals in the waters was influenced by current pattern [11]. Current could distribute dissolved heavy metal in the sea. The Inner Ambon Bay is semi-enclosed waters and tends to have limited physical characteristics, such as slow current speed, being protected from wave with limited water circulation and followed tidal pattern [13]. The tide in the Ambon Bay is mixed semidiurnal so it would also affect waters condition. The current when high tide was 0.5 – 55.8 Cm/sec whilst during low tide was 0.1 – 9.8 Cm/sec. The tidal current plays important role in nutrient and plankton transport. In addition, it is also diluted and controlled waste which going through to the sea [12].

3.1.5 Heavy metal concentration (Pb) in water at KJA BPPP Ambon

The analysis of heavy metal concentration (Pb) in water which collected from each floating cages could be seen in Figure 8.

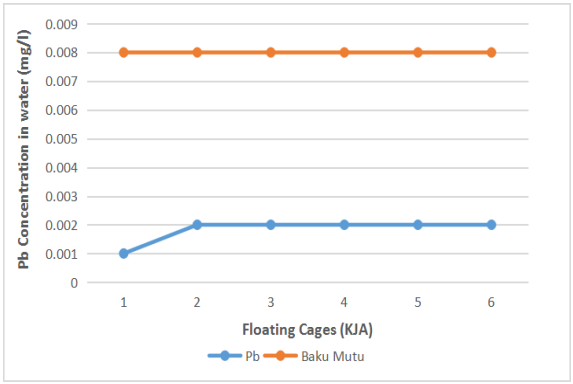

Figure 8. Pb concentration in water at KJA BPPP Ambon

It could be seen from Figure 8, that heavy metal concentration (Pb) at KJA BPPP Ambon station (floating cages 2, 3, 4, 5, 6) has similar concentration of Pb which was 0,002 mg/l except for floating cage 1 0.001 mg/l. So, it meant that the heavy metal concentration (Pb) in waters at KJA BPPP Ambon was less than the determined standard namely 0.008 mg/l. Nevertheless, the concentration of Pb could increase due to time and increasing of human activities both in land and sea.

3.1.6 Heavy metal concentration (Pb) in fish at KJA BPPP Ambon

Fish is bioindicator of environmental pollution including chemical pollution. This is showed that fish reacts on pollution in the waters in certain concentrations such as activity changes, abnormal growth to death [15]. The figure 9 indicated that the heavy metal concentration (Pb) in fish of floating cages 2, 3 and 4 was 0.05 mg/kg is less than the standard of Pb concentration for food and fish product. On the other hand, the heavy metal concentrations (Pb) in fish at floating cages 5 and 6 was 0.17 mg/kg reaching the maximum standard whereas at floating cage 1 was 0.31 mg/kg, higher than the standard of heavy metal pollution for food and fish products based on SNI 7387 : 2009, that is 0.3 mg/kg.

Heavy metal concentration in fish at KJA BPPP Ambon was possible occurred due to accumulation of heavy metal (Pb) in fish bodies earlier. It also probably the accumulation began when fish reached juvenile stage from previous places transported to the KJA BPPP Ambon.

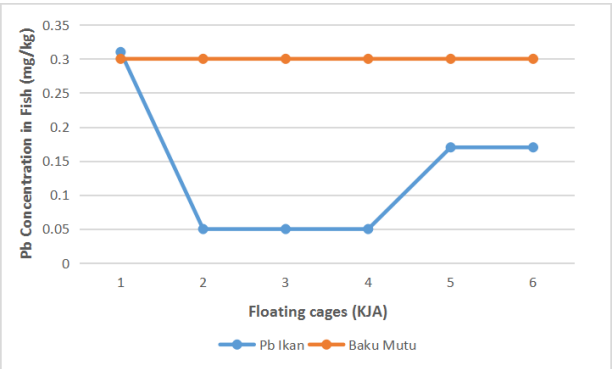

Fig. 9. Pb concentration in fish at KJA BPPP Ambon

Besides that there were also some reasons namely the location of KJA in coastal area where highly community activity, next to jetty, transportation area for ferry and other ships. The accumulation of heavy metal (Pb) occurred in fish due to continually of bioaccumulation process and biomagnifications through food chain of aquatic animals [15]. However, some of the floating cages had lower heavy metal concentration than the standard and also higher than the standard based on, SNI 7387 : 2009 for food and fish products, the residue of this heavy metal must take into account. The impact of this residue is dangerous for human life.

3.1.7 Water Pollution Status at KJA BPPP Ambon

The STORET method is used to determine the status of pollution. The analysis indicated that the total score was -13. So, it could be categorized that water quality at KJA BPPP Ambon belonged to class C moderate or moderate polluted (Table 2).

Table 2. Water Pollution Status at KJA BPPP Ambon According to STORET Value System

No.	Parameter	Unit	Standard Quality	Floating cages			Total Score
				Max	Min	Average	
	Physical						
1	Water temperature	℃	28 – 30	30.51	27.47	29.52	-2
2	Current	M	>5	19.8	0.1	7.8	-1
	Chemical						
1	pH		7 - 8.5	8.44	8.03	8.17	0
2	Salinity	PSU	18 – 32	33.34	31.3	32.84	-8
	Heavy metal						
1	Lead (Pb) water	mg/l	0.008	0.002	0.001	0.002	0
2	Lead (Pb) fish	mg/l	0.3	0.31	0.005	0.083	-2
	Total						**-13**

The status of moderate water polluted explained that waters surround KJA BPPP Ambon would be dangerous and lead to intolerant condition for growth of marine organisms especially for KJA activities. This status would be a warning for stakeholder KJA management namely BPPP Ambon especially for fish consumption for today and future. Therefore, the community surround the Ambon Bay should be careful in doing activities and utilizing marine resources. It was needed to BPPP Ambon to continually monitor water quality.

4 Conclusions and Recommendations

4.1 Conclusions

1. The waters quality of physical and chemical are still in determined standard.
2. Heavy metal concentration (Pb) in water is less than determined standard.
3. Heavy metal concentration (Pb) in the fish is less and higher than determined standard for food and fish products as SNI 7387 : 2009.
4. The status of water pollution at KJA BPPP Ambon using STORET method belonged to C class, moderate polluted.

4.2 Recommendations

Based on the results, it is needed to analysis heavy metal at waters, sediment and marine organisms at different monsoon so the heavy metal pollution (Pb) in KJA BPPP Ambon and its surrounding will be complete. It could be used to determine the source of pollutant. BPPP Ambon should continually monitor water quality in order to know the status of water pollution at the KJA.

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