Heavy Metal Copper (Cu) Distribution in Water and Its Bioaccumulation in Green Mussel (*Perna viridis*) in Coastal Area of Ujung Pangkah, Gresik District

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Abstract

Environmental pollution in the form of increased concentration of heavy metal Copper (Cu) becomes the main factor that can affect water quality and inhibit green mussel culture (*Perna viridis*) in Ujung Pangkah Coastal Area of Gresik District. The purpose of this research is to analyze concentration of heavy metal Copper (Cu) on water and its bioaccumulation in green mussel (*P. viridis*) in Ujung Pangkah waters, Gresik District. This research will be conducted from June to August 2017. The method used in this research is descriptive method. Sampling of seawater and mussel by purposive sampling. Cu heavy metal content in Ujung Pangkah waters, Gresik District has 0.003 – 0.006 ppm in July and 0.002 – 0.006 ppm in August. That value is still safe below predetermined quality standards. The results of heavy metal measurement test in shellfish has 0.159 to 0.69 ppm in July and 0.162 – 0.71 ppm in August. The high concentrations of Cu heavy metals in Ujung Pangkah waters are simultaneous to the bioaccumulation concentration in the green mussel. The higher concentration in the waters, the higher the bioaccumulation in the green mussels. And vice versa. The distribution of Cu heavy metal concentration at point 4 is the highest. While at point 1 has the lowest Cu heavy metal concentration.

Keywords: Copper, Bioaccumulation, Green Mussel, Heavy Metal, *Perna viridis*.

INTRODUCTION

The waters of Ujung Pangkah of Gresik District is the downstream of Bengawan Solo. So that the northern waters of Gresik District accommodate various types of compounds derived from industrial waste along the river and tributaries. Ujung Pangkah Coastal Area, Gresik District is a quite large producer of green shells (*Perna viridis*). Based on the data of fisherman catch from the Marine and Fisheries Office of Gresik [1], in 2013 obtained results in September reached 240 tons. However, contamination occurring in aquatic environments has become one of the main factors that may inhibit the survival of green mussels [2]. This type of shellfish is a typical type of organism that can accumulate heavy metals, and shells have low mobility. The adaptation, presence of heavy metals in the organism are thought to represent the existence of heavy metals contained in their habitat [3]. However, some study showed that the increased Cu concentration will decreasing the level of filtration of green mussels simultaneously [4], even mortality [5].

The dangers of heavy metal accumulation will not only affect the shells, but the organisms above the trophic level will also affect in humans where the effects of poisoning can be caused, among others, disruption of the kidney system, digestive gland or resulting in the fragility of the bone [6]. Heavy metals can cause special effects in living organisms, such as Minamata disease, cleft lip, nervous system damage, birth defects, carcinogenicity, and disruption of the immune function. Thus it can be said that all of the heavy metals can be toxic which will poison the living body when accumulated in the body for a long time [7].

There are some heavy metals that were found exceed the standard quality of one of the metal content of Copper (Cu), i.e. It reach 0.218 $mg.L^{-1}$ while quality standard [8] is equal to 0.02 $mg.L^{-1}$. Green mussel (*P. viridis*), which dominates the territorial waters of Ujung Pangkah, Gresik allegedly affected by heavy metal pollution. So it will also affect the levels of Copper (Cu) bioaccumulation in the body of green shells (*P. viridis*). This research is aimed to analyze the concentration of heavy metal Copper (Cu) on water and its bioaccumulation in green mussel

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(*P. viridis*) in Ujung Pangkah waters, Gresik District.

MATERIALS AND METHODS

This research was conducted from June to August 2017 in Ngemboh Village, Ujung Pangkah Sub-district, Gresik District. We used descriptive method. Sampling of Heavy metal parameter data on water and green mussel was done by ex-situ.

Determination of Sampling Point

Sampling locations were determined based on difference of land use using Global Positioning System (GPS) as many as five sampling spot that showed at Figure 1. Sampling spot 1 located in an area near the Dalegan coast with coordinates 60 53' 57, 7" S and 1120 29' 45, 4" E. Sampling spot 2 located in a residential area with coordinate 60 53' 59, 5" S and 1120 30' 12, 8" E. Sampling spot 3 located in an industry area of shipbuilding and repair with coordinate 60 53' 20, 1" S and 1120 29' 42, 9" E. Sampling spot 4 located in near waste area of river ngimbo with coordinate 60 53' 16, 2" S and 1120 29' 49, 4" E. Sampling spot 5 located in near Bengawan Solo river estuary wint coordinate 60 53' 57, 1" S and 1120 29' 36, 0" E.

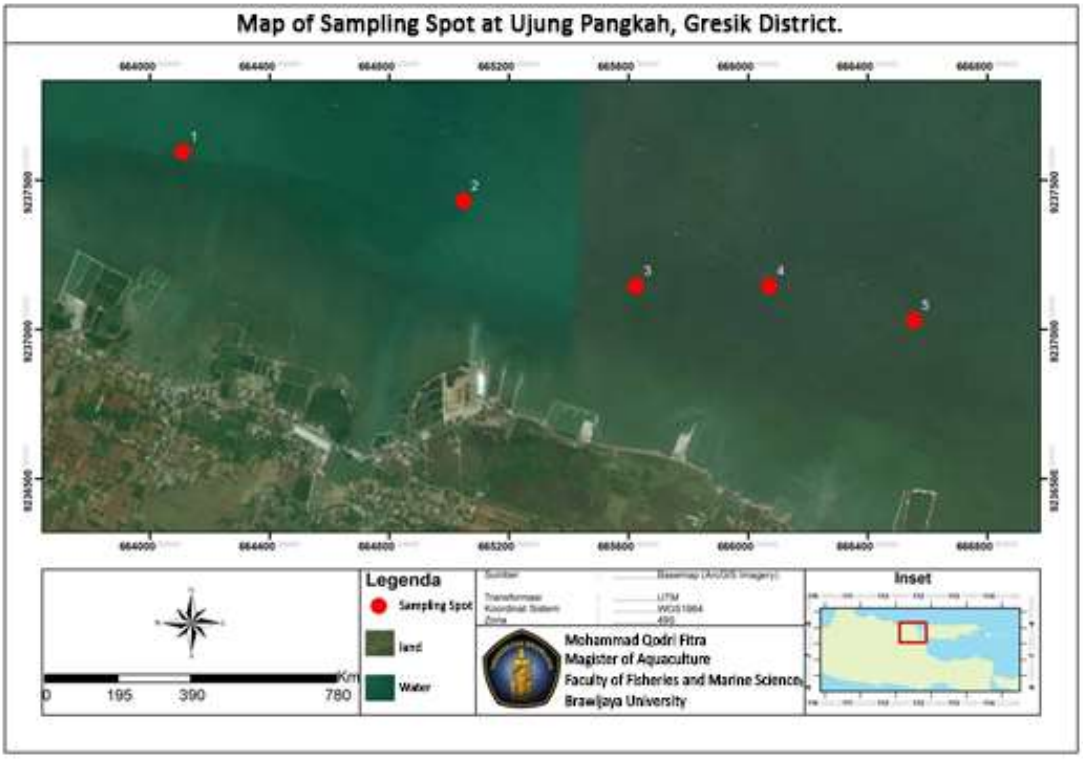

Figure 1. Sampling Spot at Ujung Pangkah, Gresik District

Sampling Procedure

Sampling was done by taking samples of sea-water and mussels (*P. viridis*) to determine the concentration level of heavy metal content Cu from each sampling point. It then used to determine the distribution of heavy metal content in Ujung Pangkah water.

Sampling Analysis

Measurement of sample in this research is done by two way, i.e. directly (*in situ*) in field and indirectly (*ex situ*) or analyzed in the laboratory. Physical and chemical parameters consist of temperature, DO, pH and salinity which will be used as research supporting data. Physical and chemical parameters of the waters are measured directly. Analysis of Cu heavy metals concentration in water and mussel samples was conducted in laboratory using Atom Absorbtion Spectrophotometer (AAS) method. The analysis was conducted in Laboratory of Chemistry, Department of Chemistry, University of Brawijaya.

RESULT AND DISCUSSION

Heavy Metal Cu Concentration on Water

The result of Cu level analysis at Ujung pangkah water location in July has the highest value at the sample point 3 and point of sample 4, while the Cu with the lowest value found at point 1. Cu content can be seen in Figure 2.

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The high Cu content at sample point 3 and 4 is caused by the estuary of Bengawan Solo River and adjacent to the ship painting factory so that in this region, the value of Cu heavy metals is still below the standard quality threshold. The lowest Cu concentration at sample point 1 is due to the fact that it is far from factory activity and also the activity of the fisherman so that the Cu heavy metal content in this area is low.

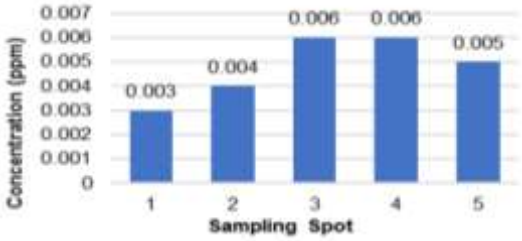

Figure 1. Concentration of Cu in Water on July 2017

The content of heavy metal Cu in Ujung Pangkah waters in August can be seen in Figure 3. The content of heavy metal Cu in waters with the highest value is at sample point 4 and lowest at sample point 1.

The highest value is at sample point 4, this is because it is adjacent to the activities of the ship repair factory and the surrounding fisherman activities. While the lowest heavy metal content of Cu at the sample point 1 due to the area far from the activities of fishermen and factory activities.

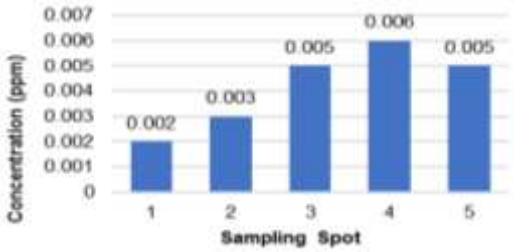

Figure 2. Concentration of Cu in Water on August 2017

Heavy metals entering the natural waters will become part of the water and sediment suspension system through the process of absorption, precipitation, and ion exchange [4]. At the sample points 3 and 4, high Cu values are thought to be caused by a number of community activities that produce Cu wastes. The main source of Cu heavy metals is the activities of fishing boats or ports, disposal of household waste and copper industry waste [9].

Distribution of Heavy Metal Copper (Cu)

Based on Figure 2, analysis of the distribution of Cu proceed to the analysis of Geographic Information Systems (GIS) so that the output obtained is made in the form of a map. The resulting map can be seen in Figure 4.

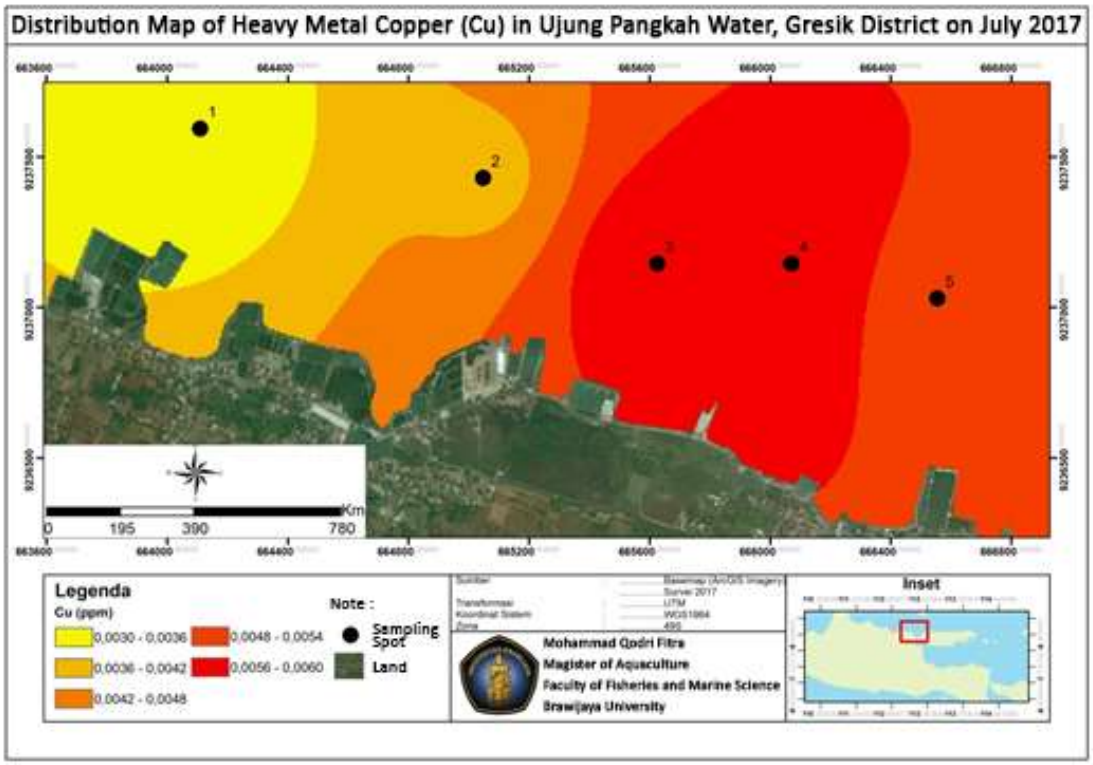

Figure 3. Distribution Map of Heavy Metal Copper (Cu) in Ujung Pangkah Water on July 2017

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In the map, it can be seen that the distribution of Cu heavy metals in Ujung Pangkah waters, Gresik District in July the highest Cu content value is at the sample points 3 and 4. While the lowest Cu content is obtained at sample point 1.

From the data of heavy metals in the waters in Figure 3, we obtained a map of the results of heavy metal distribution that can be seen in Figure 5. The distribution of Cu heavy metal concentration at point 4 is the highest. At the sample points 3 and 5 are the points containing the second highest heavy metal contamination. While at point 1 has the lowest Cu heavy metal concentration compared to the other point.

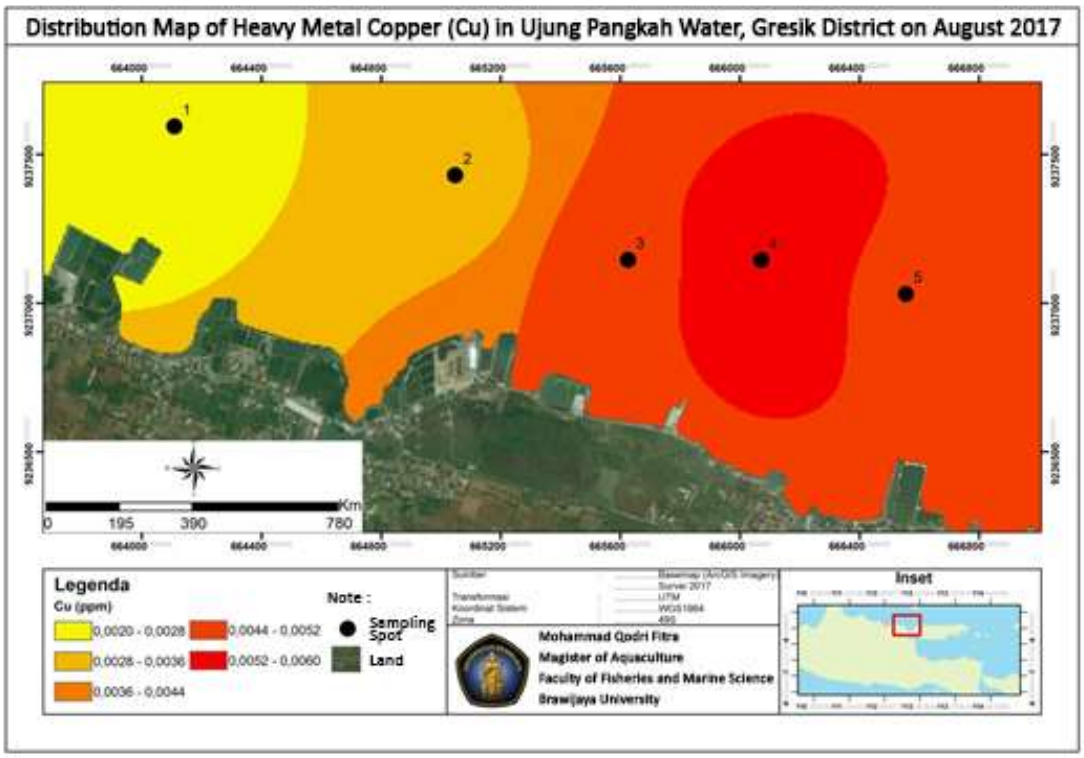

Figure 4. Distribution Map of Heavy Metal Copper (Cu) in Ujung Pangkah Water on August 2017

Heavy Metal Cu in Green mussel (*Perna viridis*)

Green mussel (*P. viridis*) is a filter feeder organism because of its ability to get food by filtering the water around the place of life. Bivalves are commonly used as test organism for heavy metal content due to its filterer and sedentary filter. The concentration data of Cu heavy metals on green mussel in July can be seen in Figure 6 and August in Figure 7.

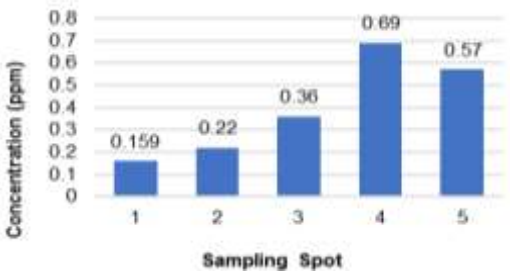

Figure 5. Heavy metal Cu in Green Mussel (*P. viridis*) on July 2017

Based on the graph above, the heavy metal content of Cu in green mussel in July ranged from 0.159 ppm - 0.69 ppm where the highest value of the content obtained at the sample point 4. This is because the location at the point of sample 4 adjacent to the activity of the plant and river estuary Bengawan Solo so the level of pollution is higher. While the lowest value is at the point of sample 1 where the location is far from the activities of fishermen and industrial activities.

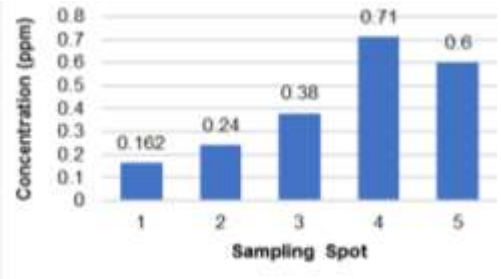

Figure 6. Heavy Metal Cu in Green Mussel (*P. viridis*) on August 2017

The content of Cu heavy metals in green shells in August ranged from 0.162 ppm - 0.71 ppm with the highest value being at sample point

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4. This is the same as the graph in July that the highest value of Cu heavy metal on green shells is also at the sample point 4. While the lowest Cu value in the waters is at the point of sample 1 where July is also the lowest value obtained at sample point 1.

Heavy metals that enter into the waters can be accumulated by the animal body one of them bivalves [6]. The concentration value of Cu heavy metal in green shells is proportional to Cu concentration in the waters at the same point. This means that the accumulation of heavy metal Cu in the waters will affect the level of accumulation in the body of green kerrang. The higher Cu content in the waters then the Cu levels in the body kerrang will also increase and vice versa. Heavy metals in seashells other than from sea water also come from food then undergo biomagnification [7].

Correlation Analysis

The content of heavy metals in green shells (*P. viridis*) is relatively higher when compared with heavy metal content in the waters. The result of Pearson correlation analysis show perfect correlation (Table 1).

Table 1. Correlation analysis of metallothionein (MT) on Water and Mussel in July 2017

		MTMussel	MTWater
MTMussel	Pearson Correlation	1	.772
	Sig. (2-tailed)		.126
	N	5	5
MTWater	Pearson Correlation	.772	1
	Sig. (2-tailed)	.126	
	N	5	5

Table 2. Correlation analysis of metallothionein (MT) on Water and Mussel in August 2017

		MTMussel	MTWater
MTMussel	Pearson Correlation	1	.926*
	Sig. (2-tailed)		.024
	N	5	5
MTWater	Pearson Correlation	.926*	1
	Sig. (2-tailed)	.024	
	N	5	5

This indicates that the rate of accumulation of green shells against heavy metals is quite high. Heavy metals entering the aquatic environment will undergo precipitation and then be absorbed by the shells present in the waters. Shellfish is one of the most efficient biota in accumulating heavy metals [9]. This is because the shells that live in the waters move very slowly, and the food is a detritus, so the chances of entering heavy metals into the body is very large. Heavy metal concentrations are high in water, there is a tendency for heavy metals concentrations to be high in the sediments, and the accumulation of heavy metals in demersal animal bodies is also higher [10].

CONCLUSION

The high concentrations of Cu heavy metals in the Ujung Pangkah waters are directly proportional to the bioaccumulation concentration of Cu in the green mussel. The higher concentration in the waters, the higher the bioaccumulation in the green kerrang, and vice versa. The distribution of Cu heavy metal concentration at point 4 is the highest. While at point 1 has the lowest Cu heavy metal concentration.

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