# Heavy Metal (Pb and Cu) and Bacterial Contamination in Mudskipper, Eeltail Catfish and Mud Clam at Kuala Tambangan Mangrove Ecosystem, South Kalimantan

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**Abstract.** Heavy metal content (Pb and Cu) in waters and sediments from the Kuala Tambangan mangrove ecosystem, South Kalimantan was above the standard of Minister Environment of the Republic of Indonesia in 2004. Lead content in waters is reached 0.128 mg/L and Cuprum at 0.444 mg/L, but in the sediments is increased dramatically almost 10 times (17,426 mg/gr for Lead and 20,576 mg/gr for Cuprum. The highest content of Lead (0.128 mg/L) was found in the estuary while for Cuprum (0.444 mg/L) found in the interior. The highest value of Lead (17,426 mg/gr) and Cuprum (20,576 mg/gr) for sediments were found in the estuary. Lead content in eeltail catfish and mud clam is can not be detected, but for Mercury (0.1601 mg/kg in eeltail catfish and 0.2653 mg/kg in mud clam) is above the standard of ISO 2354.6-2016. The Total Plate Count values of inhabitants fauna in mangrove ecosystems were below the standard of SNI 2332.3-2015. A qualitative test for *Escherichia coli*, *Salmonella*, and *Vibrio cholera* presents shows a negative value (<3 APM/g). Coliform quantitative test is above the standard of quality (43 APM/gr in eeltail catfish and 150 APM/g in mud clam). The presence of parasites was not found on all samples.

## 1 Introduction

Coastal pollution has been increasing significantly over the recent years and found expanding environmental problems in many developing countries. Pollution of water is one of the areas of major concern to coastal and estuarine environments. There are several forms of disturbance, amongst which chemical pollution associated with industrial production and high levels of urbanization are both major concerns [1]. Related to this matter, Kuala Tambangan mangrove ecosystem in South Kalimantan Province is one of the areas that is receiving anthropogenic pressure due to the rapid degradation of the coastal environment and impacts are felt including the displacement of settlements, gardens, and ponds, as well as damage to the shoulder of the road [2].

In the mangrove area, many different animals have developed various ways of protection from hanging environmental conditions and pollution. This indicates that a variety of fish species can use mangrove areas for foraging, i.e. feed on amphipods, isopods, crabs, snails, insects, spiders, copepods, shrimp, and organic matter [3]. Mudskippers are one of the fish which live on the mudflats associated with mangrove shores [3]. Mudskippers value for ecotoxicological studies and it's recognized as a potential bioindicator in environmental monitoring and assessments of coastal waters and tropical or subtropical soft-bottom intertidal systems [4]. Other animals such as eeltail catfishes and mud clams are two of the most potentially consumed of mangrove biota. But for catfishes need some special treatment regarding the poisons. The mud clam is chosen as the only example of this type of clam found in the waters of Kuala Tambangan. Besides it, this mollusk can be used as bioindicators for water pollution due to their habitat and their way of life [5].

Related with consumption of fishery products, the quality and safety is very important and needs to be considered, because it involves domestic and foreign consumer confidence in the products produced [6]. The cause of the insecurity of a product to be consumed is due to the presence of compounds or chemicals, microorganisms and dangerous physical contaminants that are not required to have their existence or the amount exceeds the stipulated provisions [7]. If fish that have been contaminated by heavy metals (Pb and Cu) are consumed, it will potentially cause various diseases both short and long term, depending on the concentration and condition of the patient [8]. And much of the work on metals focused on measurements in biota and sediments [9].

The current information on the various fauna such as reptiles, mammals, invertebrates, and fishes in Asia's mangrove ecosystem is not sufficient. In the future, more research is required to determine the various aspects of fauna such as species richness, diversity, distribution and the association of fauna with water quality, food resources and habitats to explore the ways and means to conserve the fauna in and around mangrove areas [10]. Thus research on heavy metal pollution and the presence of bacteria in several types of biota inhabiting mangrove ecosystems is an important effort to realize sustainable management of biodiversity of mangrove forests. Besides, this also needs to be done to monitor the level of security of these waters for the consumption of marine fishery products by local communities.

This study purpose is to detect the heavy metals presence of Lead (Pb), Cuprum (Cu), and Mercury (Hg) in water bodies and sediments and also the presence of

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bacteria in three types of animals (mudskipper, eeltail catfish, and mud clam) especially inhabit mangrove ecosystems in Kuala Tambangan Village, South Kalimantan Province.

## 2 Methods

The research was conducted for four months from June until September 2019. Sampling location doing in the Kuala Tambangan mangrove ecosystem of South Kalimantan Province (Figure 1). The present of mangrove forest in Kuala Tambangan Village stands on 20 hectares square area (2 square kilometers). It's covering Kuala Tambangan and release to the estuary in the middle of the Java Sea. Boundary area in the north is oil palm plantations, wherein the east is tropical forests and the east side to the west is the orchard. Timpakul is one kind of fish found in the mangrove ecosystem and familiar with a name mudskipper. There are two species of mudskipper at the Kuala Tambangan mangrove ecosystem, ~~ie~~ *Periopthalmodon schlosseri* and *Boleopthalamus boddarti* [11]. Observations results from [12] research show a value percentage of about ± 71.11% for *Boleophthalmus boddarti* dominance and attendance in the Kuala Tambangan mangrove ecosystem.

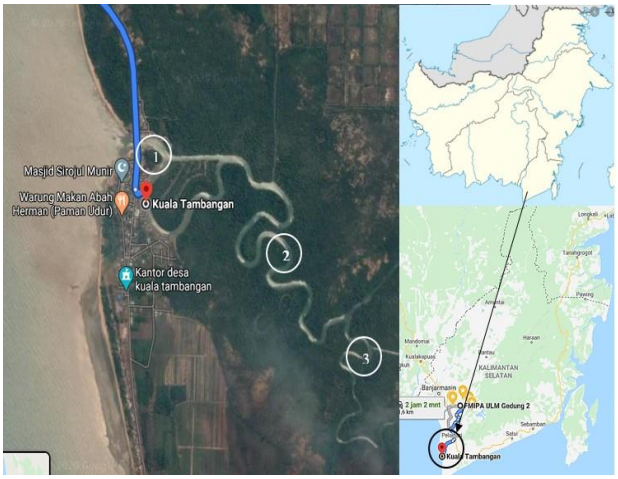


**Figure 1.** Sampling location at the three points (inner, center, and outer) of Kuala Tambangan Mangrove Ecosystem, in South Kalimantan Province, Indonesia.

Sampling was carried out discrete from three stations of Kuala Tambangan mangrove ecosystem, representing by name: inner, center, and outer (estuary) areas with a distance between stations is 700 meters. The types of samples taken were mudskipper, eeltail catfish, mud clam, waters, and sediments. The parameters observed were heavy metals (Pb and Cu) were test based on parameters from [13] and [14]. Water quality (degree of acidity (pH), dissolved oxygen (DO), and nutrients (organic matter content) as well as quantitative (TPC) and qualitative (*E. coli* and *Salmonella*) data of bacteria. Heavy metal residues, water quality, and nutrients are compared with standards set by the Ministry of Environment in 2004 on water quality management and water pollution control. Quantitative and qualitative analysis of bacteria (*E. coli* and *Salmonella*) ~~data~~ were compared to the threshold value set by the Food and Drug Monitoring Agency (BPOM-RI) based on SNI 2332.6-2015.

## 3 Results and Discussion

### 3.1 Heavy metal contents (Pb and Cu) in waters

The results of heavy metal analysis concentration showed that in the waters, the level of Lead (Pb) is reached 0.11 - 0.128 mg/L and higher concentration in Cuprum (Cu) at a value between 0.028 - 0.444 mg/L. The highest content of the Lead (Pb) (0.128 mg/L) was found in the outer part (estuary) while for Cuprum (Cu) the highest value (0.444 mg/L) was in the inner part. The comparison value of heavy metal contents (Pb and Cu) in waters from the Kuala Tambangan mangrove ecosystem can be seen in Figure 2.

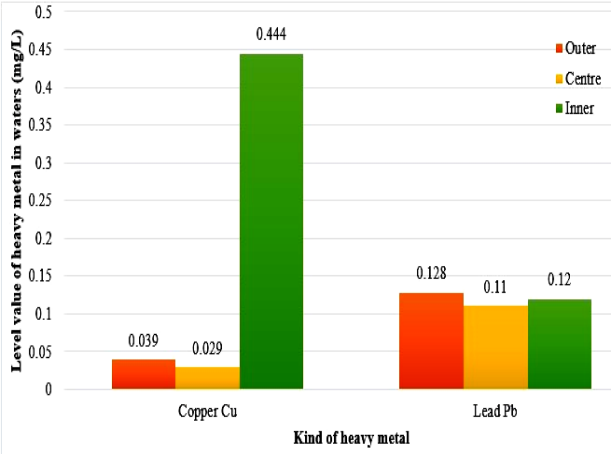


**Figure 2**. Comparison value of heavy metal contents (Pb and Cu) in waters from the Kuala Tambangan mangrove ecosystem.

The value of lead (Pb) contents from waters in this research (0.11 - 0.128 mg/L) had surpassed the standard of water quality according to the Decree Minister of Environment Law No. 51 in 2004 years, that the permissible threshold of heavy metals (Pb) is 0.008 mg/L. But this value is smaller than the results of the research study from [15] in Demak waters adjacent to the port of Tanjung Emas Semarang. His result said that the Pb in the waters is ranged from 0.6037 to 0.6647 mg/kg and in the sediment ranged from 0.563 to 0.6823 mg/kg.

### 3.2 Heavy metal contents (Pb and Cu) in Sediments

In our observation, heavy metal contents in the sediments have dramatically increased almost 10 times. For example in this observation, concentration of Lead (Pb) in the sediments has been value between 9,106 - 17,43 mg/kg and Cuprum (Cu) about 14,284 - 20,576 mg/kg. The highest value of Lead (Pb) and Cuprum (Cu) was found in the outer part (estuary) of Kuala

Tambangan mangrove ecosystem with their respective levels are 17,426 mg/kg and 20,576 mg/kg (Figure 3).

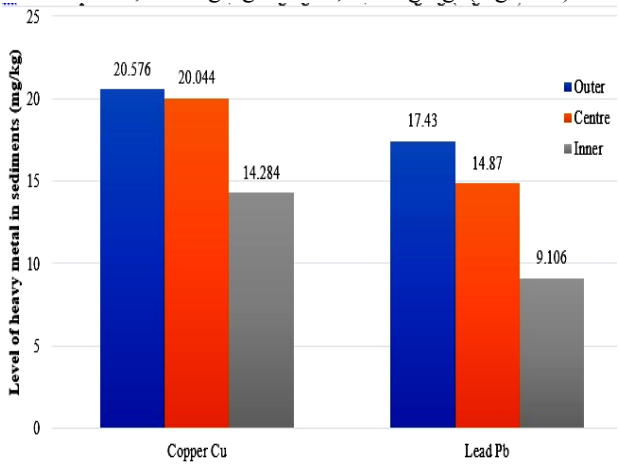


**Figure 3**. Comparison value of heavy metal contents (Pb and Cu) in sediments from the Kuala Tambangan mangrove ecosystem.

On the other hand, The average value of heavy metal content (Pb and Cu) both in waters and sediments were shown varying values and it has shown pollution because its value is above the provisions stipulated by the Minister of the Environment, the Republic of Indonesia in 2004. This results of research compared with the results of [16] research about Pb metal content in sediment in around *Sonneratia alba* and *Rhizophora apiculata* exhibited the highest concentrations of 1.9129 mg/kg and 1.7965 mg/kg, respectively.

Meanwhile, the lowest was in around mangrove from species *Avicennia marina* with a Pb concentration of 0.7259 mg/kg. Among the three species of mangrove, *A. marina* roots indicated the highest Pb concentration (0.2857 mg/kg). It means that *A. marina* was more effective in reducing the contaminant material of the metal Pb. Its significantly ($p < 0.05$) higher metal concentrations of all metals were also found at Remis of the intertidal mudflat area of Selangor state, West Coast of Peninsular Malaysia [17].

### 3.3 Heavy metal content in mudskipper, eeltail catfish, and mud clam

The heavy metal content of Mercury (Hg) is successfully detected using methods. And the value is above the standard of ISO 2354.6-2016. For mudskipper, the value is ± 0.1601 mg/kg and highest in mud clam as much as ± 0.2653 mg/kg. Unfortunately for Lead (Pb) in mudskipper and mud clam, it can not be detected (Figure 4.).

Mudskippers are very sensitive to the ambient environment and this potential would be beneficial for new researches on this species especially its ecological importance in detecting pollution levels in coastal water ecosystems. Using these organisms as a bioindicator of pollution environmental quality program could be established [4]. Uly's study (2011) on sembilang fishes in Belawan waters of North Sumatra found that the value has passed the maximum allowable threshold (>0.3 mcg/g) based on SNI-7387-2009, with a lead concentration of 0.4676 ± 0.0205 mcg/g, whereas for the rate for cadmium is still below the threshold (<0.1 mcg/g).

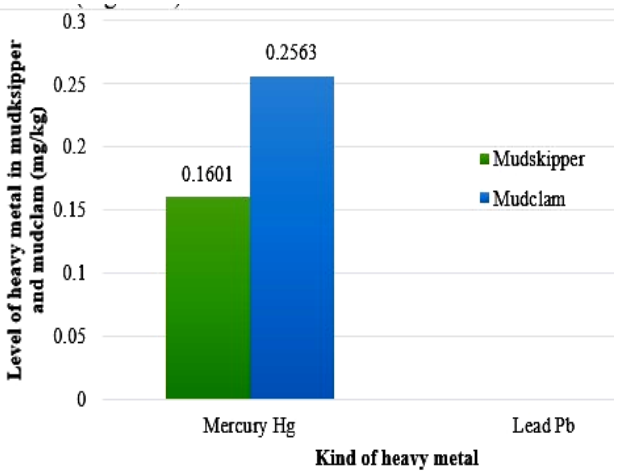


**Figure 4**. Comparison value of heavy metal contents (Hg and Pb) in mudskipper and mud clam from the Kuala Tambangan mangrove ecosystem.

Generally, metal distribution between different tissues of mudskipper varied with scales being highly accumulative of Zn, Cd, and Pb, while for Cu, the highest mean concentrations were found in the liver. The lowest mean concentrations of Zn, Cu, and Cd were found in the muscles except for Pb, which was lowest in the liver. This study suggests that mudskippers can be potential biomonitoring organisms for heavy metal bioavailability and contamination of intertidal coastal mudflats. The concentrations of Cd and Pb were slightly above the acceptable limits of Malaysian and European food safety guidelines [17].

Research from [9] found that heavy metal measurements in fish, bivalves, and shrimp indicate no contamination of these resources by metals. However, contamination by Cd and Pb was noted in some littoral shore mollusks such as *Thais* sp. as well as rock oysters (*Saccostrea* sp.) which may be due to non-anthropogenic sources. The source of Pb pollution was thought to be derived from the use of leaded petrol. Metal levels in sediments of the Malacca Strait and the South China Sea were generally similar to global shale values.

### 3.4 Nitrite and nitrate value

Following Figure 5, it's known that the average value of nitrite in waters of Kuala Tambangan mangrove ecosystem is varied between 0.039 - 0.259 mg/L. Meanwhile, for nitrate value, it lies in the range of rate between 0.039 until 0.259 mg/L with the highest value can be found in the inner part of the mangrove ecosystem (Figure 5.).

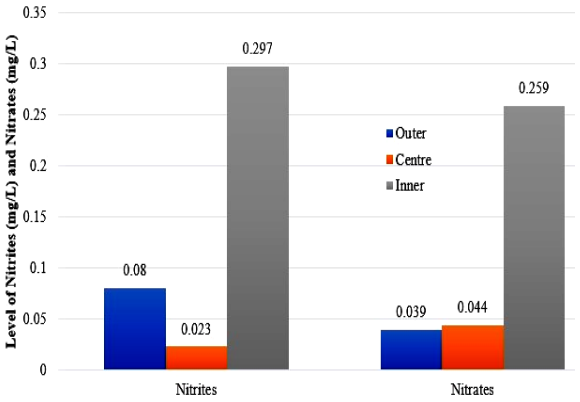


**Figure 5**. Comparison value of nitrite (mg/L) and nitrate (mg/L) from the Kuala Tambangan mangrove ecosystem.

Nitrite levels in the mangrove waters of the Kuala Tambangan mangrove ecosystem show the value is above the maximum threshold quality standard for nitrite content calculated as N according to Government Regulation No. 82 of 2001 concerning the management of water quality and control of water pollution which is equal to 0.06 mg/L. As for the nitrate content, the value still meets the specified quality standard of 20 mg/L [18].

As for the evaluation results, when compared with research from (Hendrawati, Prihadi, & Rohmah, 2008) the nitrate levels are higher than the levels indicated by the ponds not polluted (0 - 0.22 mg / L) and lower than the nitrite levels in polluted ponds (0-27.86 mg / L). As for nitrate levels in the mangrove ecosystem in the Village of Kuala Tambangan show values higher than the area of polluted ponds (0 - 1.7 mg / L) or ponds not polluted (0 - 0.3 mg / L) along the Porong river.

### 3.5 Value of turbidity and pH

Based on the test results of turbidity value from the water of the Kuala Tambangan mangrove ecosystem, it's known that the range of values is between 0.75 until 23.9 NTU (the highest in the inner part). Then the pH value lies in the range of 6 until 7.42 (also the highest in the inner part) as shown in Figure 6.

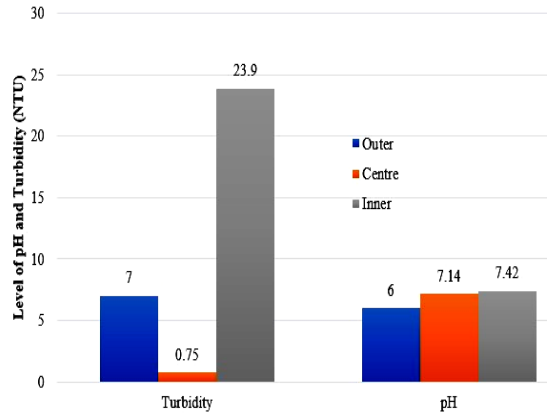


**Figure 6**. Comparison value of pH and turbidity (NTU) from the Kuala Tambangan mangrove ecosystem.

The pH value from this measurement is within the recommended range of Government Regulation No. 82 of 2001 concerning water quality management and water pollution control, which is 6.9 for class I-III water and 5.9 for class IV water [18]. When turbidity is compared with the results study of (Rahmawati & Retnaningdyah, 2015) in Karangploso Subdistrict, Malang Regency, the turbidity value from this study was lower (0.73-23.9 NTU), because, in Ngenep, PraNyolo, Umbulan, Balittas, Lowoksari, and Soko springs of Malang Regency has values ranging from 104.83 mg / L - 134.56 mg / L. This range of values is still normal and suitable for the life of aquatic organisms, which is 20 - 300 mg / L. Meanwhile, when it compared with a survey from [19] the value of turbidities nearest River Basin (Kusan watershed = 94-> 1000 NTU, Satui watershed = 67-366 NTU, and Batulicin watershed = 10-244 NTU) is also still lower.

### 3.6 Total Plate Count for the bacteria identification

Total Plate Count (TPC) values found in three inhabitants biota (mudskipper: *Periophtalmodon schlosseri* and *Bolephthalmus boddarti*, eeltail catfish: *Paraplotosus albilabris* and mud clam: *Polymesoda erosa*) in mangrove ecosystems were below the standard quality standard of SNI 2332.3-2015. It's about 950 colonies/gr on mudskipper, 100 colonies/gr on eeltail catfish, and the highest on mud clam (24,300 colonies/gr) (Figure 7.).

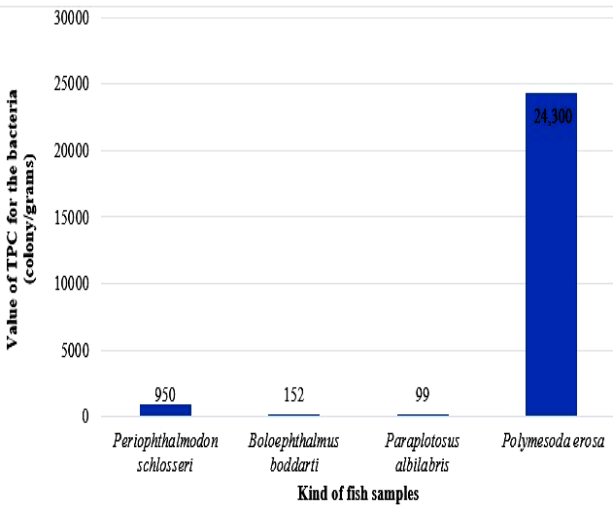


**Figure 7**. Comparison value of total plate count for the bacteria identification from the Kuala Tambangan mangrove ecosystem.

When compared with Government Regulation No. 82 of 2001 concerning water quality management and water pollution control, the total bacterial colony values from this study are still below the standard rules. It is known that the allowable total value of coliforms for conventional drinking water treatment is <10000 ml / 100 ml (President of the Republic of Indonesia, 2001).

Fish have a high enough water content, so fish is a suitable medium for the life of spoilage bacteria or other

microorganisms. This causes fish to decay very quickly [20]. The total coliform content in Kaliyasa River, Cilacap Regency is 85 number of colonies/100 ml, does not meet the quality standard that is (50 number of colonies/100 ml). The high content of total coliform in the Kaliyasa River is due to many residents who live along the banks of the Kaliyasa River and dump their feces directly into the river [21].

### 3.7 Qualitative test for the bacteria

Qualitative test for the presence of *Escherichia coli*, *Salmonella*, and *Vibrio cholera* shows a negative value (<3 AMP/g) in all test of animals. Coliform quantitative test shows that the value is above the standard of quality (43 APM/gr in eeltail catfish) and the highest (150 APM/g) in mud clam. And the last, the presence of parasites based on SNI 2332.6-2015 was not found on all samples. Calculation number of bacteria in mudskipper from the Kuala Tambangan mangrove ecosystem shown in Figure 8.

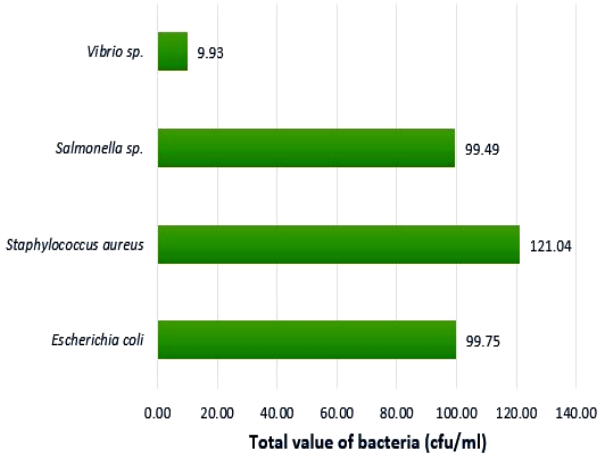


**Figure 8**. Comparison value number of bacteria in mudskipper from the Kuala Tambangan mangrove ecosystem.

This value (attendance of bacteria in mudskipper) is lower when compared with the results study of (Hafiz, Feliatra, & Nursyiwani, 2019). He has recorded that the number of *E. coli* bacterial colonies on the skin of mudskipper. Its value ranged from 2.93 × 104 to 1.1 × 105 CFU / ml, while the digestive organs ranging from 7.4 × 103 to 1.1 × 105 CFU/ml.

## 4 Conclusion

The average value of heavy metal content (Pb and Cu) both in waters and sediments were shown varying values and it has shown pollution because its value is above the provisions stipulated by the Minister of the Environment, the Republic of Indonesia in 2004. Heavy metal of Lead (Pb) in eeltail catfish and mud clam is also can not be detected, but for Mercury (Hg) is successfully detected above the standard of ISO 2354.6-2016. Total Plate Count (TPC) values in three biotas that inhabitants of mangrove ecosystems were below the standard quality standard of SNI 2332.3-2015. Qualitative test for the presence of *Escherichia coli*, *Salmonella*, and *Vibrio cholera* shows a negative value (<3 AMP/g) in all test of animals.

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## References

1. A.H. Bu-Olayan and B. V. Thomas, "Trace metals toxicity and bioaccumulation in Mudskipper Periophthalmus waltoni Koumans 1941 (Gobiidae: Perciformes)," *Turkish J. Fish. Aquat. Sci.*, ***8***(2): 215–218, (2008)
2. E. Iriadenta, "Degradasi Komunitas Mangrove Kalimantan Selatan Akibat Proses Desalinasi Perairan Pesisir," *Fish Sci.*, ***3***(5): 64, (2016)
3. A. Sasekumar, V. C. Chong, M. U. Leh, and D'Cruz, "Mangroves as a habitat for fish and prawns," *Hydrobiologia*, ***247***, 195–207, (1992)
4. A.A. Ansari, S. Trivedi, S. Saggu, and H. Rehman, "Mudskipper : A biological indicator for environmental monitoring and assessment of coastal waters," *J. Entomol. Zool. Stud.*, ***2***(6): 22–33, (2014)
5. J.T. Murtini and R. Peranginangin, "Full Paper," *Kandung. logam berat pada kerang kepah (Meritrix meritrix) dan air laut di Perair. Banjarmasin*, ***1***(1): i–iv, (2017)
6. J.T. Murtini, Y. Yennie, and R. Peranginangin., "Kandungan Logam Berat pada Kerang Darah di Perairan Tanjung Balai dan Bagan Siapiapi," *J. Penelit. Perikan. Indones. Ed. Pasca Panen. Badan Ris. Kelaut. dan Perikanan, Dep. Kelaut. dan Perikan.*, **9**(5): 77-84., (2003)
7. H.E. Irianto and A. Purnomo, "Keamanan Konsumsi Produk Perikanan," *War. Penelit. Perikan. Indones.*, ***6***(2): 2–8, (2000)
8. Sutrisno, S. Koesoemadinata, and I. Taufik, "Tingkat Pencemaran Logam Berat Pada Ekosistem Waduk," *J. Ris. Akuakultur*, ***2***(1): 103–115, (2007)
9. N.A.M. Shazili, K. Yunus, A. S. Ahmad, N. Abdullah, and M. K. A. Rashid, "Heavy metal pollution status in the Malaysian aquatic environment," *Aquat. Ecosyst. Health Manag.*, ***9***(2): 137–145, (2006)
10. M.N. Rajpar and M. Zakaria, *Mangrove Fauna of Asia*, no. December, (2014)
11. H.B. Sabatano, "Bioakumulasi logam berat timbal (Pb) dan kadmium (Cd) pada organ timpakul Periopthalmodon schlosseri dan Boleopthalamus boddarti Desa Kuala Tambangan," Banjarbaru, (2018)
12. A. Kadarsah and I.O. Susilawati, "Kajian kelimpahan dan morfologi ikan Timpakul (famili Gobiidae) pada dua tipe ekosistem mangrove yang berbeda," *Al-Azhar Indones. Seri Sains Dan Teknol. ISSN 2355-8059*, ***5***(1): 43–49, (2019)
13. Badan Standarisasi Nasional, "Cara Uji Timbal (Pb) secara Destruksi Asam dengan Menggunakan

Spektrofotometer Serapan Atom (SSA)," Jakarta, (2004)
14. Badan Standarisasi Nasional., "Cara Uji Tembaga (Cu) secara Destruksi Asam dengan Menggunakan Spektrofotometer Serapan Atom (SSA)," Jakarta, (2004)
15. A. Tjahjono and D. Suwarno, "The spatial distribution of heavy metal lead and cadmium pollution and coliform abundance of waters and surface sediment in demak," *J. Ecol. Eng.*, ***19*** (4): 43–54, (2018)
16. D.A.J. Selanno, J.W. Tuahatu, N.C. Tuhumury, and G.I. Hatulesila, "Analysis of Lead (Pb) Content in the Mangrove Forest Area in Waiheru District, Ambon," *Aquat. Sci. Technol.*, ***3***(1): 59, (2014)
17. M. . Ikram, A. Ismail, C. . Yap, and A. A. . Azwady, "Levels of heavy metals (Zn, Cu, Cd, and Pb) in mudskippers (Periophthalmodon schlosseri) and sediments collected from intertidal areas at Morib and Remis, Peninsular Malaysia," *Toxicol. Environ. Chem.*, ***92***(8: 1471–1486, (2010)
18. Presiden Republik Indonesia, *Peraturan Pemerintah Republik Indonesia nomor 82 tahun 2001 tentang pengelolaan kualitas air dan pengendalian pencemaran air*. Indonesia, (2001)
19. Pemerintah Kabupaten Tanah Bumbu, *Buku data status lingkungan hidup daerah Kabupaten Tanah Bumbu Tahun 2009*. Batulicin, (2009)
20. E. Afrianto and E. Liviawaty, *Pengawetan dan pengolahan ikan*. Yogyakarta: Penerbit Kanisius, (1989)
21. E. B. Sasongko, E. Widyastuti, and R. E. Priyono, "Kajian Kualitas Air Dan Penggunaan Sumur Gali Oleh Masyarakat Di Sekitar Sungai Kaliyasa Kabupaten Cilacap," *J. Ilmu Lingkung.*, ***12***(2): 72, (2014)