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Identification Of Causes and The Existence Of Mercury and Chromium In Sediment and Sea Water In Kendari Bay Sri Damayanty1,a), Muhammad Kamal2, Arief Pawennari Muhammad3 Public Health Department, Faculty of Health Science, Institut Teknologi dan Kesehatan Avicenna a) Corresponding author: damayanty.sri@gmail.com Abstract. Kendari Bay is currently experiencing considerable physical pressure and pollution due to heavy metals. This study aims to determine content of heavy metals mercury and chromium in sediment and sea water in Kendari Bay. This study uses an observational design with a descriptive approach. The study was conducted in April 2019 in five Port areas with three sampling points in each region. Samples taken are sediment and sea water. Samples taken were analyzed by the Atomic Absorbtion Spectrophotometry (AAS) method. The results show that all sampling points at five Ports have been contaminated with mercury and chromium in sediment and sea water. The levels of mercury and chromium have exceeded the quality standards stipulated by Minister of Environment Decree No. 51 of 2004. The highest levels of mercury and chromium in sea water and sediment are highest in the Dermaga Tempat Pendaratan Ikan (TPI). This is due to the dense traffic activity of fishing vessels, residential waste, Hospital waste, hospitality waste, tourist waste, paints on ships, oil spills, rust from shipwrecks, and heavy equipment activities from the construction of the Bahteramas Bridge or the Kendari Bay Bridge. Technology needs to control heavy metal contamination as well as policies and law enforcement regarding activities at sea that have the potential to pollute waters. Keywords: Mercury, chromium, water, sediment, Kendari Bay INTRODUCTION The quality of the sea and coast of Kendari City is currently experiencing considerable physical stress due to land activities. Specifically for the Kendari Bay, the silting rate due to sediment intrusion has resulted in an increase in land area within the gulf body. Garbage mixed with sediment has made the permanent plain which covers ± 25 to 50 ha. Area of Kendari bay in the capital city of Southeast Sulawesi, ¾ (three quarters) is dominated by the coastal area of ??the bay which has a very large pollution potential. This is influenced by the form of a semi-closed bay so that all land activities will lead to the inside of the beach of Kendari bay. Sediment contributions come from activities on the pier in the bay area. Nusantara Port which is visited by large-scale vessels at any time, including the stopover of Pelni ships, KM Tilongkabila that serves the eastern region of Sulawesi Island, Ferry Ports crossing from Kendari City-Wawonii Island, Ocean Fishing Ports and Fishing Boat Landing Ports and marine fishing vessel bases private. Not only causes sedimentation, the presence of the port causes shipping traffic to be crowded. So that oil spills, paints, rust ship walls can be as water pollutants. Other sources of pollution can be identified from various sources including the fishing industry, public port, fishing port, waste from hotel and shop, household waste, mining and various other activities. This condition does not include sources of pollution arising from activities in all watershed that lead to the Kendari bay. The dense activities of the port, domestic waste and the swelling of wastes carried by the flow of several rivers, it is suspected that the sediment and seawater of Kendari Bay have been polluted by heavy metals such as Mercury (Hg) and Chromium (Cr). The Environmental Protection Agency (EPA) has determined that mercury and chromium are metals that are carcinogens in humans. Mercury at high exposure can cause permanent damage of brain, kidney, and fetal. While chromium can cause inflammation of the skin. Long-term exposure can cause damage to the liver, blood circulation, kidneys and nerve tissue, and disorders of the skin (Griswold, 2009). The study, titled Mercury in Marine and Oceanic Waters — a Review, was taken from the Journal of Water Air Soil Pollut, by Barbara Gworek, et al in 2016, explained about mercury in ocean and ocean waters. Mercury contamination in water has become a problem for the environment and human health. In the aquatic

environment, mercury occurs in many forms, which depend on the oxidation reduction conditions. The concentration of mercury in marine waters in various parts of the world has been presented. In the relevant literature, two models describing the fate and behavior of mercury in saltwater reservoirs have been presented, a conceptual model that treats all oceans as one ocean and the Bocean margin model, provided that sea margins manifest themselves as convergence of continents and oceans, which include geological features such as, estuary, inland sea, and continental shelf. These two conceptual models have been summarized in the text. The mercury content in benthic sediments usually reflects the level in the water reservoir, especially in reservoirs located in contaminated areas (mines, metallurgical plants, chemically) (Gworek, 2016). The study, titled Distribution of Heavy Metals in Surface Sediments of the Bay of Bengal Coast was taken from the Journal of Toxicology, by M.Z.H Khan, et al in 2017 about the distribution of heavy metals in sediments on the Coast of Bengal. This study discusses about the concentration of main elements (Si, Al, Ca, Fe, and K) and minor elements (Cd, Mn, Ni, Pb, U, Zn, Co, Cr, As, Cu, Rb, Sr, and Zr) in sediments on Bengal Coast. It was revealed that most trace elements had contaminated the Bengal sea waters carried by river flows were also affected by industrial impacts, shipyards, gas production industry, and urban waste. The concentrations of the heavy metals in sediments generally met international sea sediment quality criteria. However, continuous monitoring of the water quality of Bengal Coast needs to be carried out with a view to minimizing the health risks of population and the adverse impacts on the aquatic ecosystem (Khan, 2017).

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in the aquatic environment, mercury occurs in many forms which depend on the oxidation-reduction conditions.in the intermediate conditions, the alkyl forms of mercury, mehgcl and ethgcl, can most often be found (kabata-pendias and mukherjee 2007; kabata-pendias...

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The research is very important to be carried out, considering the effects of heavy metal contamination and still rarely conducted research on mercury and chromium heavy metal contamination in Kendari Bay. Therefore, by considering the many potential sources of heavy metals pollution, the high sedimentation rate in the Kendari Bay, the ecological cycle of heavy metals contamination for marine biota and the carcinogenic efect of heavy metals in humans, the researchers were interested in measuring the concentration of heavy metals Mercury (Hg) and Chromium (Cr) contained in sediments and sea water in Kendari Bay. METHOD This study used an observational design with a descriptive approach. This study was conducted to determine the content of heavy metals mercury and chromium in sea water and sediments in the waters of Kendari Bay. The study was conducted in April 2019 in area of Kendari Bay. The choice of location based on considerations: a. The coastal area has experienced sedimentation and water pollution from several rivers, one of which is the Wanggu River which provides the largest sedimentation contribution. b. Coastal communities consume marine biota such as various types of fish and shellfish originating from these waters that have been contaminated by heavy metals. The samples were sea water and sediment of Kendari Bay. The sampling point based on the location of source the entry of pollutants into the sea and each point taken 3 points from each station, namely: Station 1: Nusantara Port Station 2: Kendari-Wawonii Ferry Port Station 3: Fish Landing Pier Station 4: Samudera Port Station 5: Private Marine Fishing Vessels Base Sampling of sediments and sea water was carried out 2 times ie morning and evening by utilizing volunteer services. Sediment and sea water samples that have been obtained are then brought to Biology Laboratory of Faculty of Mathematics and Natural Sciences Halu Oleo University for analysis of mercury and chromium content using the Atomic Absorbtion Spectrophotometry (AAS) method. RESULT AND DISCUSSION The quality of the sea and coast of Kendari City is currently experiencing considerable physical stress due to land activities. Specifically for the Kendari Bay, the silting rate due to sediment intrusion has resulted in an increase in land area within the gulf body. Garbage mixed with sediment has made the permanent plain which covers ± 25 to 50 ha. Area of Kendari bay in the capital city of Southeast Sulawesi, ¾ (three quarters) is dominated by the coastal area of ??the bay which has a very large pollution potential. This is influenced by the form of a semi-closed bay so that all land activities will lead to the inside of the beach of Kendari bay. Based on the survey that at the five stations (Port / Pier) and 15 sampling points, show high levels of mercury and chromium both in sea water and sediments. On Table 1, show that the average concentration of mercury in the sea water in Kendari Bay, the highest in area of Fish Landing Pier of 0.0045 ppm in the morning and 0.0040 ppm in the afternoon. While the lowest in the Nusantara Port of 0.0020 ppm in the morning 0.0017 ppm in the afternoon. Likewise, for the average concentration of chromium in sea water, the highest in area of Fish Landing Pier of 0.0074 ppm in the morning and 0.0067 ppm in the afternoon as shown in Table 2. While the lowest was in the Private Marine Fishing Vessels Base of 0,0037 ppm in the morning and 0,0032 ppm in the afternoon. Table 1. Distribution of Mercury in Sea Water of Kendari Bay No Location Sampling I (Morning) Sampling II (Afternoon) Concentration Average Concentration Average 1 Nusantara Port Sampling point 1 0,0020 0,0020 0,0016 0,0017 Sampling point 2 0,0016 0,0015 Sampling point 3 0,0024 0,0020 2 Kendari-Wawonii Ferry Port Sampling point 1 0,0031 0,0031 0,0029 0,0027 Sampling point 2 0,0027 0,0021 Sampling point 3 0,0034 0,0031 3 Fish Landing Pier Sampling point 1 0,0047 0,0045 0,0039 0,0040 Sampling point 2 0,0042 0,0039 Sampling point 3 0,0045 0,0041 4 Samudera Port Sampling point 1 0,0025 0,0021 0,0019 0,0016 Sampling point 2 0,0022 0,0018 Sampling point 3 0,0016 0,0012 5 Private Marine Fishing Vessels Base Sampling point 1 0,0018 0,0022 0,0017 0,0020 Sampling point 2

0,0022 0,0021 Sampling point 3 0,0025 0,0022 Table 2. Distribution of Chromium in Sea Water of Kendari Bay No Location Sampling I (Morning) Sampling II (Afternoon) Concentration Average Concentration Average 1 Nusantara Port Sampling point 1 0,0048 0,0052 0,0038 0,0047 Sampling point 2 0,0052 0,0049 Sampling point 3 0,0057 0,0054 2 Kendari-Wawonii Ferry Port Sampling point 1 0,0055 0,0055 0,0052 0,0052 Sampling point 2 0,0060 0,0057 Sampling point 3 0,0050 0,0046 3 Fish Landing Pier Sampling point 1 0,0078 0,0074 0,0071 0,0067 Sampling point 2 0,0067 0,0062 Sampling point 3 0,0077 0,0069 4 Samudera Port Sampling point 1 0,0040 0,0040 0,0037 0,0036 Sampling point 2 0,0043 0,0036 Sampling point 3 0,0038 0,0034 5 Private Marine Fishing Vessels Base Sampling point 1 0,0033 0,0037 0,0028 0,0032 Sampling point 2 0,0037 0,0032 Sampling point 3 0,0042 0,0036 Table 3 shows the results of survey on sediments. The average concentration of mercury in the sediments were highest in area of Fish Landing Pier of ??1.7768 ppm in the morning and 1.5288 ppm in the afternoon. While the lowest in the Nusantara Port of 0.9716 ppm in the morning and 0.9173 ppm in the afternoon. Similarly, the highest chromium in sediment of Kendari Bay were in the Fish Landing Pier of 4,8900 ppm in the morning and 4,7007 ppm in the afternoon as shown in Table 4. While the lowest were at the Private Marine Fishing Vessels Base of 3.4929 ppm in the morning and 3.3234 ppm in the afternoon.

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Table 3. Distribution of Mercury in Sediment of Kendari Bay No Location Sampling I (Morning) Sampling II (Afternoon) Concentration Average Concentration Average 1 Nusantara Port Sampling point 1 0,9388 0,9716 0,8934 0,9173 Sampling point 2 0,9478 0,9023 Sampling point 3 1,0283 0,9562 2 Kendari-Wawonii Ferry Port Sampling point 1 1,5547 1,5316 1,3870 1,3302 Sampling point 2 1,4541 1,1966 Sampling point 3 1,5861 1,4070 3 Fish Landing Pier Sampling point 1 1,6953 1,7768 1,4682 1,5288 Sampling point 2 1,7644 1,4956 Sampling point 3 1,8708 1,6227 4 Samudera Port Sampling point 1 1,1564 1,1407 1,0987 1,0204 Sampling point 2 1,0732 0,9681 Sampling point 3 1,1924 0,9943 5 Private Marine Fishing Vessels Base Sampling point 1 1,2055 1,1991 1,0206 1,0503 Sampling point 2 1,2768 1,1370 Sampling point 3 1,1149 0,9934 Table 4. Distribution of Chromium in Sediment of Kendari Bay No Location Sampling I (Morning) Sampling II (Afternoon) Concentration Average Concentration Average 1 Nusantara Port Sampling point 1 4,3426 4,4516 4,2071 4,3202 Sampling point 2 4,5827 4,4180 Sampling point 3 4,4295 4,3356 2 Kendari-Wawonii Ferry Port Sampling point 1 4,0783 4,1929 3,9858 4,0172 Sampling point 2 4,2837 4,0877 Sampling point 3 4,2168 3,9782 3 Fish Landing Pier Sampling point 1 4,9268 4,8900 4,6829 4,7007 Sampling point 2 4,9958 4,8258 Sampling point 3 4,7475 4,5933 4 Samudera Port Sampling point 1 3,6714 3,8317 3,5762 3,7518 Sampling point 2 3,9684 3,9024 Sampling point 3 3,8552 3,7768 5 Private Marine Fishing Vessels Base Sampling point 1 3,3791 3,4929 3,2854 3,3234 Sampling point 2 3,4603 3,2067 Sampling point 3 3,6394 3,4781 The survey showed that all sampling points at five Ports / Piers were contaminated with mercury and chromium in sea water and sediments. Based on the Minister of the Environment Decree No. 51/ 2004, that standard quality of sea water for mercury of 0.001 ppm while for chromium of 0.005 ppm. When compared with the survey, it can be stated that the sea waters of Kendari Bay have been polluted by heavy metals mercury and chromium. This is evidenced from all samples at all sampling points showwed concentrations that exceed from standard values ??of the two types of heavy metals. The highest levels of mercury and chromium in sea water and sediments are found in the Fish Landing Pier area. This is due to the dense traffic activity of fishing vessels, there are also Pertamina refueling the ships. Dense settlements, hospitals and hotels also contribute where waste is directly channeled into bay. Paints on ships, fuel oil spills and some shipwrecks also contribute to the high contamination of heavy metals. In general area of Kendari Bay also polluted due to activities throughout the watershed which empties into the Kendari Bay. Coupled with the conditions of sedimentation or siltation of the bay so that it directs the Government to make several Piers for tourism destination. We can see many tourist boats are docked. The construction of the Bahteramas Bridge or Kendari Bay Bridge that connects Old City with Poasia District are also one of the contributors to heavy metal contamination. The construction process which involves heavy equipment that floats above sea within a period of 3 years certainly discharges its waste directly into the sea. Besides that, along the seafront of Kendari Bay which has been designed as an entertainment place also contributes to pollution. Seafront of Kendari Bay is still a favorite areas of tourist that must be visited by both locals and migrants. The hectic activity of visitors every day certainly be the cause of the high generation of garbage thrown away into the sea. Still lacking of public awareness about waste. Inorganic waste such as plastic of food packaging or drinks very visible on the surface of the sea. Water pollution by heavy metals is a worldwide problem caused by bioaccumulation and biomagnification in the food chain and the toxicity of these heavy metal elements. Contamination of sediment with heavy metals is an important environmental problem which has negative consequences for aquatic organisms and human health. Sediment acts as a primary collector of metals in the aquatic environment. Quality of sediment shows the status of

water pollution (Hazrat Ali, 2019). Heavy metals present in water bodies will experience sedimentation and accumulation in sediments. The metal can also accumulate in the body of biota in the waters (including sessile macrozoobenthos), either diffusionly or through the food chain and will eventually reach to humans. This phenomenon is known as bioaccumulation or biomagnification (Ejembi Emmanuel, 2018). Heavy metals concentrations above the threshold can have adverse effects on biota up to humans. Heavy metals in biota with high concentrations have a negative effect on the ecological health of aquatic animals and can contribute to population decline. Heavy metals are neurotoxins in fish species. The interaction of heavy metals with chemical stimuli in fish might interfere with fish's communication to the environment. There have been many findings where heavy metals have an effect body abnormalities on fish. In general, these deformities have a negative effect on fish populations because bodi defects on fish affect the survival, growth, and welfare. Abnormalities on fish function as biomarkers from environments that have been contaminated with heavy metals (Hazrat Ali, 2019). So based on ecological influence, mercury and chromium have a high risk ecological to the surrounding aquatic environment, meaning that the presence of mercury and chromium in sediments clearly affects biota or other organisms in the waters. Many studies showed that the content of heavy metals in sediments always higher than in water and marine biota. This is because heavy metals have a tendency to be suspended at the bottom of the water.

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Pollution of various types of heavy metals has become a major concern because of the toxic effects it can cause. Metal contamination is one of the contaminants that is persistent and can reduce environmental quality. Waste from various activities are discharged through rivers directly into the sea waters, potentially causing environmental pollution, including heavy metal pollution. Several cases of metal poisoning in humans, as a result of pollution have been widely reported and usually occur in communities or residents who live in a polluted environment. That had happened to population in the fishing village, Minamata and population who live along the Jinzu River, Japan (Souisa, 2015). Several studies conducted in Indonesia such as the Tangerang Coastal are classified as moderate to severe polluted due to various industries whose waste has not been well managed. They were identified from water, sediments and shells containing heavy metals based on result of research by Simbolon et al. Other studie in Gresik Coastal by Lestari and Budiyanto show Hg ranges from 0,04 – 0,44 mg/kg, Cu ranges from 23.7 -234 mg/kg, and Pb ranges from 1.74 - 12.7 mg/kg. According to Martin (2009), EPA has determined mercury chloride and methylmercury as carcinogenic compounds in humans. The nervous system is very sensitive to all forms of mercury compounds. High levels of exposure can cause permanent damage to brain, kidneys, and fetal development. Effects on brain function can cause irritability, shame, tremors, changes in vision and hearing, as well as memory problems. Short-term exposure to high levels of mercury vapor can cause lung damage, nausea, vomiting, diarrhea, increased blood pressure or heart rate, skin rashes, and eye irritation. Besides that, mercury is determined as neurotoxican. Outbreaks of methylmercury poisoning have been clearly demonstrated that adults, children and developing fetuses are very at risk from mercury exposure. When mothers with symptoms of nervous system damage give birth to babies with severe disabilities, it becomes clear that the development of the nervous system of the fetus is more susceptible to methylmercury than the nervous system of adults (Martin, 2009). The ability of methylmercury to accumulate in fat tissue and bind to proteins makes it easily accumulated by aquatic biota, can pose a threat to humans and other fish-eating animals. Sediment is a place where mercury settles, and can settle as a poison for aquatic life for a long time (Chipewyan, 2007). In nature, mercury (Hg) is found in the elemental form of mercury (Hg0), monovalent mercury (Hg + 1), and bivalent (Hg + 2). When entering into waters, mercury binds easily to the chlorine present in sea water and forms HgCl bonds. In this form, Hg easily enters plankton and can move to other marine biota. Inorganic mercury (HgCl) will be turned into organic mercury (metal mercury) by the role of microorganisms that occur in sediments at the bottom of the water. Mercury can also be combined with carbon to form organo-mercury compounds. The most common organo-mercury compound is metal mercury produced by microorganisms in water and soil. The microorganisms are then consumed by the fish so that the concentration of mercury in the fish increases (Widowati, 2008). Toxicity of Mercury in humans are distinguished according to the form of Hg compounds, namely inorganic and organic. Hg inorganic poisoning are characterized by symptoms of tremor in adults, then continues with tremors in the facial muscles, which then spread to the fingers and hands. When poisoning continues tremors occur on the tongue, stammering, walking looks stiff and lost balance. In addition to toxicity of inorganic Hg, this form of organic Hg also causes very dangerous toxicity, an example of a case toxicity of methyl mercury is a case of "minamata disease" which afflicts both adults and young children that occurs in Japan (Widowati, 2008). Similarly chromium, can come into all strata of environment, whether in the strata of water, soil or air (atmospheric layer). Chromium that enters the environment strata can come from a variety of sources. But the most common and presumed sources of Chromium input into environmental strata are from industrial activities,

household activities, combustion and fuel mobilization (Palar, 2008). According to Martin (2009), chromium (VI) is a toxic compound, while chromium (III) is an important nutrient in humans. High levels of exposure can cause nasal irritation, nasal ulcers, colds, and respiratory problems such as asthma, coughing, and shortness of breath. While long-term exposure can cause damage to the liver, blood circulation, kidneys and nerve tissue, and disorders of the skin (Martin, 2009). Acute toxicity of Chromium through the digestive tract can cause renal tubular necrosis. Workers in the workplace of the chrome industry show high levels of Chromium in the blood, especially in red blood cells. Digesting foods that contain high levels of Cr (VI) can cause indigestion, in the form of stomach pain, vomiting and bleeding, stomach ulcers, convulsions, kidney damage, and liver, and can even cause death (Widowati, 2008).

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CONCLUSION All sampling points at five Ports / Piers were contaminated with mercury and chromium in sea water and sediments. Based on the Minister of the Environment Decree No. 51/ 2004, that standard quality of sea water for mercury of 0.001 ppm while for chromium of 0.005 ppm. When compared with the survey, it can be stated that the sea waters of Kendari Bay have been polluted by heavy metals mercury and chromium. This is evidenced from all samples at all sampling points showwed concentrations that exceed from standard values ??of the two types of heavy metals. The highest levels of mercury and chromium in sea water and sediments are found in the Fish Landing Pier (TPI) area. This is caused by the dense traffic activities of fishing vessels, there are also Pertamina refueling the ships, residential waste, hospital waste, hospitality waste, tourism waste, paints on ships, oil spills, rust from shipwrecks, as well as heavy equipment activities from the construction of the Bahteramas Bridge or Kendari Bay Bridge that connects Old City with Poasia District, are also as contributor to heavy metals contamination. Technology needs to control heavy metal contamination as well as policies and law enforcement regarding activities at the sea that have potential to pollute waters. ACKNOWLEDGEMENT Thank you to DRPM Kemenristek Dikti for facilitating this research through grants, as well as all parties who could not be mentioned one by one who were heavily involved in this research.

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