

Concentration of dissolved heavy metal around the Rupert waters industrial activity, Malacca Strait

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Abstract. The Rupert Strait is a water area located between Rupert Island and Dumai City. This area is growing rapidly which is characterized by increasing coastal residential areas, commercial centers, industries, ports and also increasing marine transportation. This increase in activity can lead to a decrease in the water quality of the Rupert Strait. This study aims to analyze the water quality of heavy metals Cadmium (Cd), Cuprum (Cu), Lead (Pb), Zinc (Zn) and Nickel (Ni) in the waters of the Rupert Strait. Sampling of surface water using sample bottles was carried out at 9 observation stations from the waters of West Rupert to South Rupert, then testing the water samples in the laboratory. The results of the analysis show that the lead and nickel values still meet the threshold values set by the Minister of Environment No.51 of 2014. A total of 30% of the sample points for cadmium testing water do not meet the quality standards and have been polluted. Meanwhile, the values of cuprum and zinc have exceeded the specified quality standards and have polluted the waters of the Rupert Strait. There is a need for a mechanism from various aspects to maintain water quality that still meets the threshold and certain efforts are needed to reduce heavy metal pollution, namely cuprum and zinc in the waters of the Rupert Strait and its surroundings.

1 Introduction

Heavy metals are metal elements that have density exceeds 5 g/cm³ which are classified as pollutants and are dangerous because they will accumulate in the water column, sediments, organisms and cannot be degraded naturally [1]. Heavy metals are one of the factors in determining the status of water quality [2]. Heavy metal concentrations that have exceeded the threshold will have an impact on the ecosystem around these waters [3], [4]. Cuprum is one of the heavy metal in the water that is needed by the body in the physiological processes of the organism. However, the excess can interfere with health or cause poisoning [5], [6]. Cadmium (Cd) which is also toxic can cause poisoning, health problems and can kill certain biota, for example, crustacean biota will die on exposure to Cd with a concentration of 0.005 – 0.15 ppm [7].

Rupert Strait is a waters located between Dumai City, Sumatra Island and Rupert Island. The strait is a semi-enclosed water which makes the oceanographic conditions of these waters very dynamic depending on external factors that influence it [8]. The Rupert Strait is used as one of the water transportation routes that are widely used by industries in the coastal areas of Riau Province, especially Dumai City and Bengkalis Regency. The Rupert Strait also has high fishery potential, especially red shrimp (*Panaeus monodon*) and white shrimp (*Pennaeus* sp.) to be developed [9]. The high level of human and economic activity in the Rupert Strait has an adverse impact on environmental health,

especially the marine environment [10]–[14]. The Rupert Strait area has different levels of environmental sensitivity according to environmental characteristics. The areas of West and South Rupert, Mampu Island and Lubuk Gaung are areas that are very sensitive to oil pollution. The area has relatively good mangrove vegetation and is a catchment area [15]. In addition, the potential for heavy metal oil pollution is also potential in the Rupert Strait because many of these waters have been converted into berths for commercial ships. Therefore, this study aims to determine the suitability of heavy metals, namely Cadmium (Cd), Cuprum (Cu), Lead (Pb), Zinc (Zn) and Nickel (Ni) in the waters of the Rupert Strait.

2 Material and Method

Water sampling of the Rupert Strait was carried out at 9 observation stations (Table 1) from the waters of West Rupert to South Rupert (Figure 1). 5 water quality parameters of dissolved metals, namely cadmium (Cd), Cuprum (Cu), Lead (Pb), Zinc (Zn) and Nickel (Ni). The water quality data analyzed using the quality standards of the Minister of Environment Decree No. 51 of 2004 [16] to see the suitability of the health of marine waters to biota.

Data collection was carried out when the weather conditions were sunny on August 28 to 30, 2020, for the last 3 (three) days there was no rain and the water sample taken was surface water (<1 meter depth). The test was

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carried out at the Environmental Laboratory of PT. Mutuagung Lestari in Pekanbaru, Riau to obtain water heavy metal values.

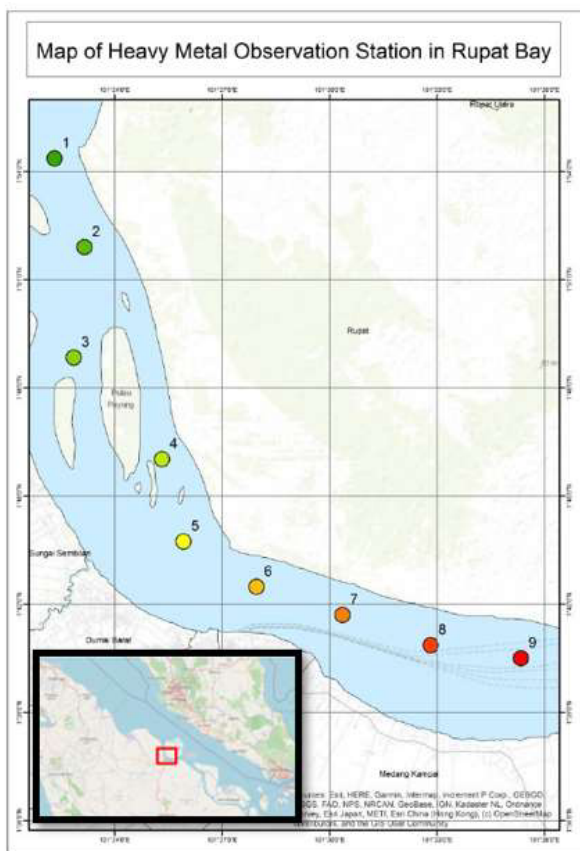


Fig. 1. Observation station map in Rupert Strait.

Table 1. Observation station coordinate.

Station Number	Longitude	Latitude
1	101.372972	1.906833
2	101.386750	1.865472
3	101.381250	1.814917
4	101.422590	1.767140
5	101.432690	1.729470
6	101.466700	1.708330
7	101.506220	1.695470
8	101.547570	1.681680
9	101.589840	1.675250

3 Results and Discussion

The cadmium value in the waters of the Rupert Strait ranges from 0.0001 to 0.021 mg/l. The cadmium value at observation stations 1, 3 and 4 did not meet the marine water quality standard that had been set at 0.001 mg/l. Cadmium values for observation stations 2, 5, 6, 7, 8 and 9 are below 0.0001 mg/l and meet the water quality standards for marine biota (Figure 2).

The main sources of Cd metal contamination are through the earth's layers and human activities [17] such as waste and household waste and fishing activities such as repairing and painting ships [18]. Cd metal can also

come from the activity of giving a protective zinc layer to iron and steel to avoid rust [19]. The activity of giving the coating is mostly found in industrial areas located in coastal areas that are prone to rust. The contamination of Cd sourced from various marine activities is potentially absorbed by marine biota in the form of free ions Cd²⁺. This ion is going to be able to compound with chloride ions within pH 7.0, yielding in 51% CdCl₂, 39 % CdCl⁺, 6 % CdCl₃⁻, and Cd²⁺ complex about 2.5% of total concentration.

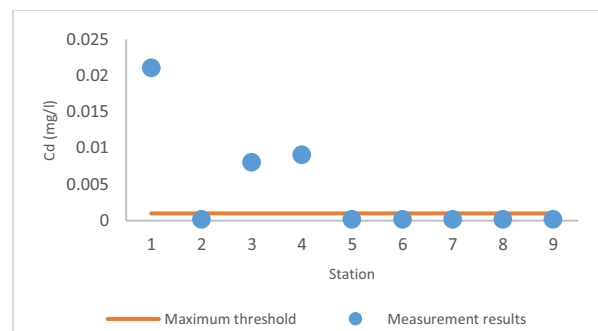


Fig. 1. Cadmium concentration to water quality threshold

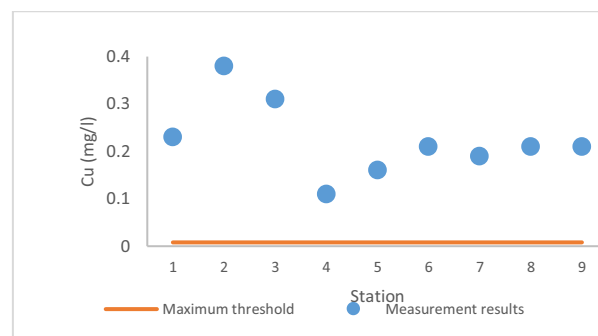


Fig. 2. Cuprum concentration to water quality threshold

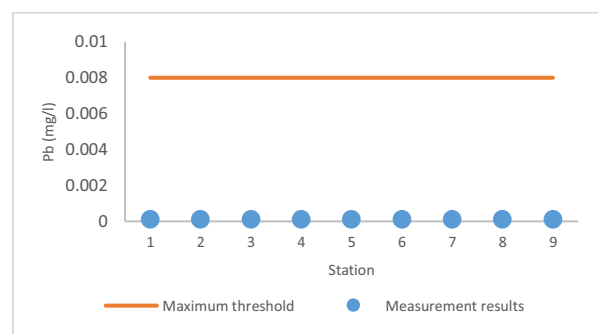


Fig. 3. Lead concentration to water quality threshold

The threshold value for cuprum concentration is 0.008 mg/l. The cuprum value in the Rupert Strait is 0.11 mg/l to 0.38 mg/l, so it exceeds the threshold that has been set for all observation points (Figure 3). The largest values are at observation stations 2 and 3 which are around the northern part of the estuary. These states showed that the Rupert Strait received sufficiently high Cu-contained pollutant. The Rupert Strait, which the center for marine and port activities, has become the source of heavy metals accumulations. Cu is contained within the various paint of the ships serving as an anti-rust paint and antifouling [20]. These materials also contain of Pb compounds such as PbCO₃, Pb white, and Pb₃O₄.

The lead value in the waters of the Rupert Strait is below 0.0001 mg/l and is still below the water quality standard for marine biota of 0.008 mg/l (Figure 4). This result showed that there are no contaminations of lead within the Rupert Strait or perhaps, the device used in the laboratory could not detect the concentration of Pb which the concentration of lead might be tremendously low. Pb is kind of heavy metals that relates to the human health, because it could impact on the large number of mankind toxicities, environmental pollution, and harmful toxic properties [21]. This heavy metal is potentially contained within the marine organisms that often consumed by human [22].

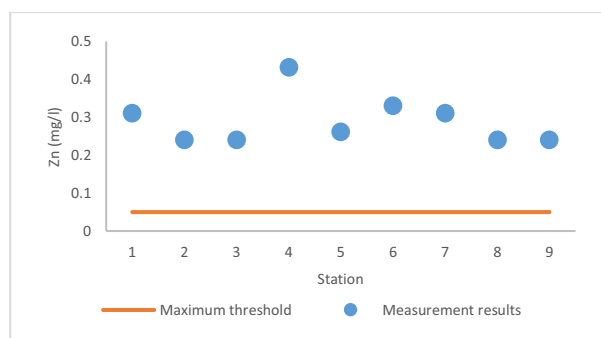


Fig. 4. Zinc concentration to water quality threshold

The zinc concentration in the waters of the Rupert Strait (Figure 5) ranges from 0.24 to 0.43 mg/l. This value exceeds the maximum limit of marine water quality standard of 0.05 mg/l. The high concentration of Zn could be sourced from the presence of Pier, shipping lane, and ship building activities within the Rupert Strait [23]. This metal can threaten the survival ability of local marine biota. Metal distribution in the water environment depends on physiochemical alteration in the water and surface bottom. The precipitation of Zn and other heavy metals is caused by the alkaline pH state in the form of insoluble hydroxides, oxides, and carbonates.

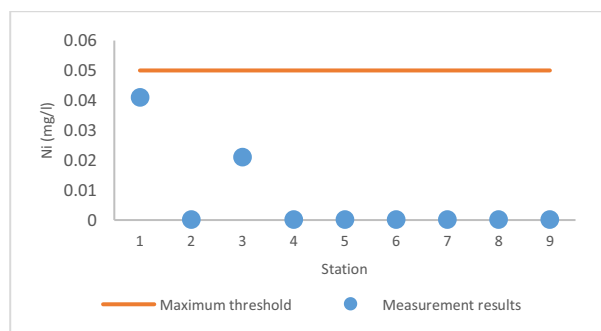


Fig. 5. Nickel concentration to water quality threshold

The nickel concentration in the waters of the Rupert Strait ranges from below 0.0001 to 0.041 mg/l and is still below the maximum water quality standard set at 0.05 mg/l. The highest nickel value is at stations 1 and 3 (Figure 6), while for other observation stations it is below 0.0001 mg/l. These states indicate that the nickel metal does not pollute the Rupert Strait. In the waters, nickels have interacted with organic compounds within the aqueous phase and eventually settled in the

sediment, resulting a high accumulation of nickel in the sea bottom sediment.

4 Conclusion

The values of Lead (Pb) and Nickel (Ni) still meet the threshold values set by the Minister of Environment Decree No. 51 of 2014. As many as 30% of the sample locations for Cadmium (Cd) testing waters do not meet the quality standards and have been polluted. Meanwhile, the values of Cuprum (Cu) and Zinc (Zn) have exceeded the specified quality standards and have polluted the waters of the Rupert Strait.

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