Journal of Coastal Development
Volume 14, Number 2, February 2011 : 168 : 171

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

Original Paper

IMPACT OF HEAVY METALS CONTAMINATION ON THE BIODIVERSITY OF MARINE BENTHIC ORGANISMS IN JAKARTA BAY

Noverita Dian Takarina and Andrio Adiwibowo

University of Indonesia, Depok, 16424, West Java, Indonesia

Received : July, 12, 2001 ; Accepted : January, 12, 2011

ABSTRACT

Alteration of land is continuing to increase inorganic matter to marine ecosystems and reduce marine biodiversity. Therefore, we investigated the interplay among land use and heavy metal (Cr, Cu, Pb, Zn) inputs from 8 rivers of Jakarta Bay to the benthic biodiversity. At current time, land uses surrounding Jakarta Bay are fulfilled with industrial activity, settlement, and agriculture. Total concentration of Cr, Cu, Pb, and Zn were determined using the Atomic Absorption Spectrometry in order to assess and compare contamination levels among land use types. Results showed that the average concentrations of heavy metals in sediment were generally higher in river-mouth received water from industrial than those in agriculture. Those land use related metal pattern were also reflected in the benthos diversity. Macrobenthic community diversity decreased when inputs of organic matter increased. Decreases in macrobenthic diversity were mainly linked to an increasing abundance of species with specific functional traits, specifically deposit–feeding polychaetes. Our finding confirmed that land use in the form of industrial areas were potential to produce toxic material to ecosystems. Therefore, we recommend that the development need to consider the allocation of physical infrastructure particularly near waterways.

Keyword : heavy metals ; contamination ; biodiversity ; benthic organisms ; Jakarta bay

Correspondence : +62811101630 **:** email : takarinanoverita@hotmail.com

INTRODUCTION

Jakarta Bay can be considered as one of threatened marine ecosystems. Numbers of rivers from lands are flowing to this area. Along that waterways, landuses are dominated by anthropogenci activities, for instance industry and housing. As a consequence, the river systems receive numerous influx, include heavy metal. Takarina (2008) reported Cr, Cu, Pb, and Zn in sediments of river Angke , Ciliwung, Sunter, Cakung, and Bekasi values have exceeded the Canadian Standard for Contaminated Sediments. The recorded values were (24- 290 ppm), (63- 157 ppm), (28- 198 ppm), and (150- 910 ppm), respectively.

Concentration of metals in sediments can expose and deliver threats to the ecosystems in the futures. Most of the marine organisms are living and even consume sediments. This organism known as macrozoobenthos. Based on feeding mechanisms, this group consists of deposit and plankton feeder. Therefore, metas concentration in sediments can be transferred into other organisms and food chain. The problem lies if the benthos consumed by human and can posses serious threat to health.

Nowadays, most of the growing research in Indonesia is only focus in the concentration of metals in sediments and organisms. Likewise, impact of metals content on the biodiversity of marine resources, which in macrozoobenthos, are still poorly documented. Since macrozoobenthos, for instance, Polychaeta, Mollucs, and Crustacea, in Jakarta Bay have been utilized within aquaculture and fisheries industries, thus information of sustainaibility of metals on the marine resources related to the magnitude of metal contents is vital. Therefore, the purpose of this study was to identify

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

correlation of heavy metals (Cr, Cu, Pb, and Zn) fluctuation on the number of species and invidual of macrozoobenthos in the waters of Jakarta Bay. Moreover, the benefits of this research are:
The data obtained can be basic information (basic database) of Macrozoobenthos biodiversity in Jakarta Bay waters.
Investigating the impact of metal fluctuation on biodiversity
The co-relationships between metal fluctuation and biodiversity then will be calculated to develop mathematic model in order to predict metal accumulation in environment.

MATERIALS AND METHODS

Study Area

Jakarta Bay is located between longitude of 106°42'45" E and latitude of 6°13'10" S in Java Island, Indonesia. Most of the bay's area has a depth ranging between 5 to 30 meters. Eight sampling stations were chosen to reflect anthropogenic activities and land uses at 8 rivermouths in Jakarta Bay. They were Dadap, Kamal, Cengkareng Drain, Angke, Ciliwung, Sunter, Cakung, and Bekasi, respectively (**Fig.1**). Each rivermouth has different type of land uses, they were agriculture, domestic, and industry.

Field Sampling

Macrozoobenthos samples were collected from sediments from 2 primary locations, first from P. Penjaliran, represented pristine sites and second from Jakarta Bay represented polluted sites. They were Cengkareng Drain, Angke, Ciliwung, Sunter, Cakung, Dadap, Kamal, and Bekasi, respectively. In each location, sediments collected from bottom by using *Ekman Grab.* Samples from fields then preserved and stored in cooler box and freezer at 4°C. For identification purposes, sediments were sieved by using USA Standard Testing Sieves sizing 4 mm; 2.36 mm; 1.70 mm, 1.18 mm and 600 µm. Organims retained in sieve identified under binoculer microscope and the species name determination guided by A monograph on the Polychaeta of Southern Africa Part 1 and Part 2. *Trustees of the British Museum* (*Natural History*).

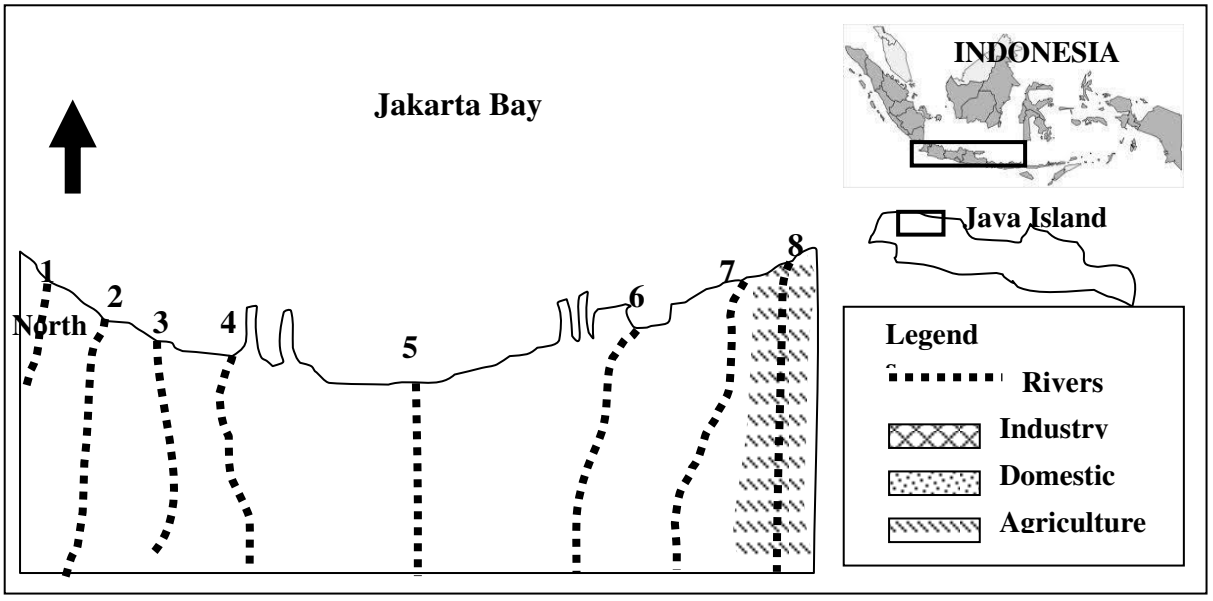

Fig. 1. Map of Jakarta Bay Showing 8 Sampling Stations, Rivers, and Land Uses (1 : Dadap, 2 : Kamal 3 : Cengkareng Drain, 4 : Angke, 5 : Ciliwung, 6 : Sunter, 7 : Cakung, and 8 : Bekasi)

Procedures

Measurement of metal content on sediments and biota based on AAS Methods. The samples then preserved by 70% alcohol and dried for 2-3 hours at 105 °C. Dry samples destructed by 4 ml HNO_3 and 2 ml $HClO_4$ solutions. The samples were heated above the hot plate for 1-2 hours (until the solution volume shrank to 1-3 ml). Then add double distilled water as much as

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

1-2 ml and cooled at room temperature. Samples were chilled filtered using Whatman filter paper No. 40, and the filtrate collected in a test tube. Then, into the filtrate added to double distilled water until the volume of sample solution to 7 ml. Furthermore, a test tube containing the sample solution mixed sample solution and vortexed. Samples then ready for the heavy metals content (Cu, Cr, Pb and Zn) analysis by using Shimadzu AAS AA-6300.

RESULTS AND DISCUSSION

Polychaetes Biodiversity

Fig. 2. shows Polychaete Biodiversity (H') and Cu, Cr, Pb, Zn concentration in sediments according to various land uses in Jakarta Bay. In general, Cu and Cr in sediments were high in industrial area and low in agricultural area (Taboada-Castro, *et al.,*1998). Moreover, both metals were negatively correlated with organism biodiversity. For instance, high Cu-Cr content in Kamal have caused Polychaete H' very low. In contrats, low Cu- Cr contents in Bekasi have caused Polychaete H' very high. Similarly, Pb and Zn in sediments were high in industrial area and low in agricultural area. Furthermore, both metals were negatively correlated with organism biodiversity. For instance, high Pb-Zn content in Kamal have caused Polychaete H' very low. In contrast, low Pb-Zn content in Bekasi have caused Polychaete H' very high. It can be concluded that increasing metal content (Cu, Cr, Pb, Zn) in industrial areas have caused Polychaete biodiversity declined (Baker & Yousef, Bu Olayan & Thomas, 2005).

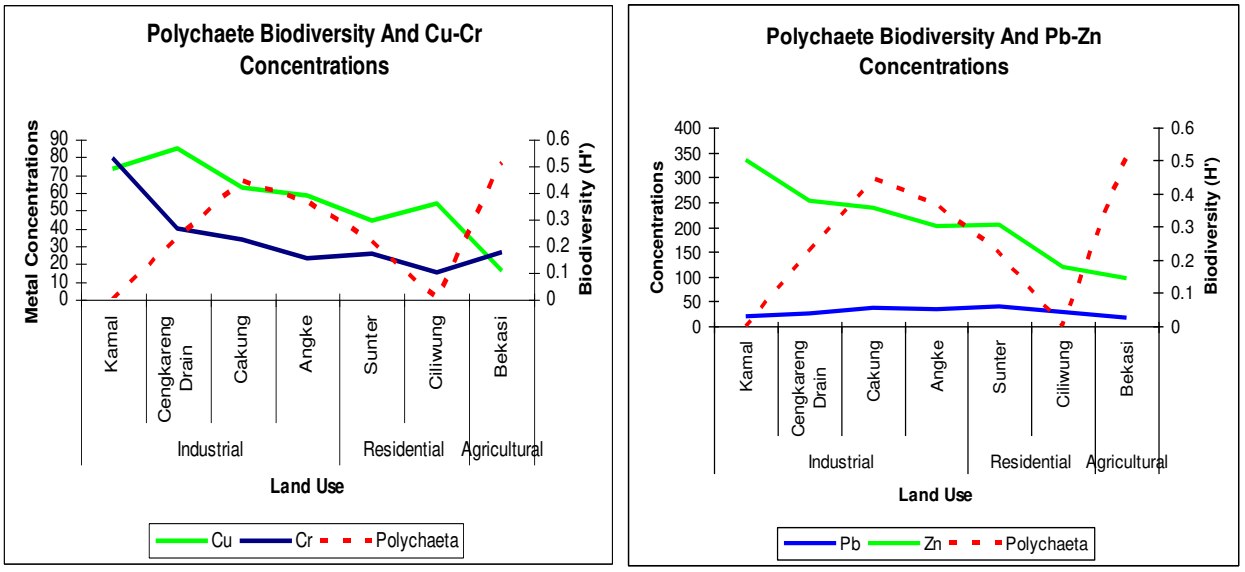

Fig. 2. Polychaete Biodiversity and Cu, Cr, Pb, Zn Concentrations in Jakarta Bay

Molluscs Biodiversity

Fig. 3 shows Molluscs Biodiversity (H') and Cu, Cr, Pb, Zn concentrations in sediments according to various land uses in Jakarta Bay. In general, Cu and Cr in sediments were low in agricultural area and high in industrial area (Jordao**,** *et al.,* 1997). Moreover, organisms biodiversity were negatively correlated with both metals organisms . For instance, Molluscs H' were very low resulted from high Cu- Cr contents in Kamal. In contrast, Molluscs H' were very high resulted from low Cu- Cr contents in Bekasi. Similarly, Pb and Zn in sediments were high in industrial area and low in agricultural area. Furthermore, both metals were negatively correlated with organisms biodiversity. For instance, low Pb-Zn contents in Bekasi have caused Molluscs H' very high. In contrats, high Pb-Zn contents in Kamal have caused Polychaete H' very low. It can be concluded that increasing metal contents (Cu, Cr, Pb, Zn) in industrial areas, respectively, have caused Molluscs biodiversity declined (Ali & Fishar, 2005, Olomukoro & Azubuike. 2009, Poulton, *et al.,* 1995).

ISSN : 1410-5217
Accredited : 83/Dikti/Kep/2009

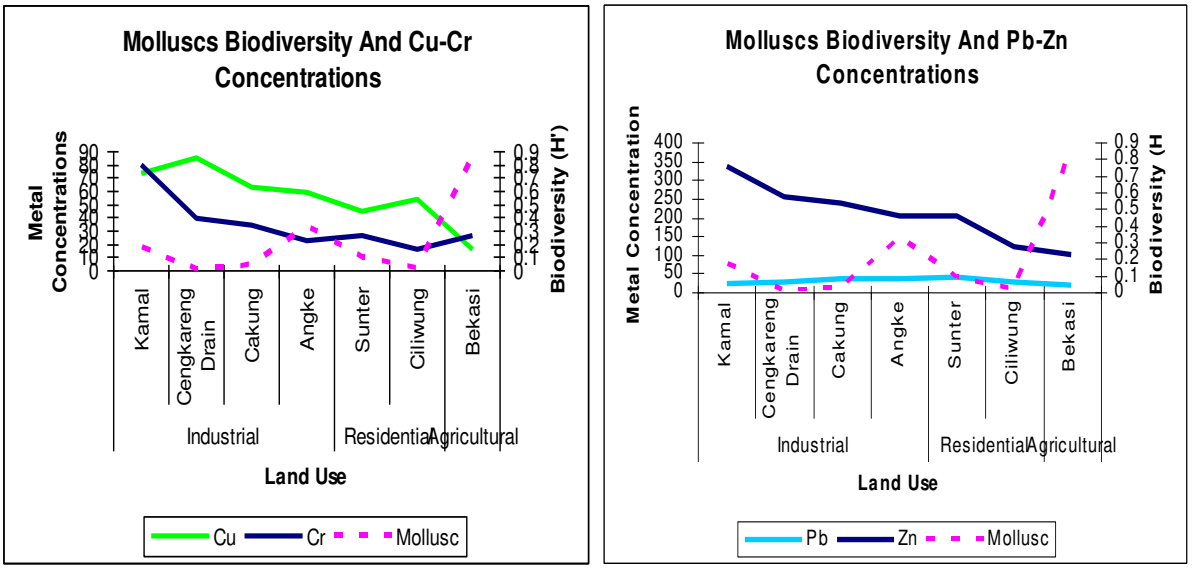

Fig. 3. Molluscs Biodiversity and Cu, Cr, Pb, Zn Concentrations in Jakarta Bay

CONCLUSIONS

The present study revealed the significance impact of metal contents (Cu, Cr, Pb, Zn) on each common benthic species inhabits Jakarta Bay. Types of land use are the key factor that determines type and metal contents on the sediments of aquatic ecosystems. As a results, land use pattern also contributes to the marine organism biodiversity. For instance, industrial area land use produce high quantity of heavy metals compared to other land uses. Hence, as a consequence, it will affect and reduce biodiversity, mainly benthos.

REFERENCES

Ali and Fishar. 2005. Accumulation of trace metals in some benthic invertebrate and fish species relevant to their concentration in water and sediment of Lake Qarun, Egypt. *J.Aq.Res.* 31(1) : 289-301

Baker, D.M. and Y.A.Yousef. 2001. Metal Accumulation and Impacts on Benthic Organisms in Detention Pond Sediments

Bu Olayan, B.H. and B.V. Thomas. 2005. Validating species diversity of benthic organisms to trace metal metal pollution in Kuwait Bay, of the Arabian Gulf. *App. Ecol. and Env. Res.* 3(2): 93-100

Jordao, C.P., J.L.Pereira, and G. N. Jham. 1997. Chromium contamination in sediment, vegetation and fish caused by tanneries in the State of Minas Gerais, Brazil. *The Sci.Tot. Env.* 207 : 1-11

Olomukoro, J. O. and C. N. Azubuike. 2009. Heavy Metals and Macroinvertebrate in Bottom Sediment of Ekpan, Nigeria. *J. O. Biol. Sci.* 2(1) : 301-314

Poulton, P. C., D. P. Monda, D. F. Woodward, M. L. Wildhaber, W. G. Brumbaugh, 1995. Relationships between benthic community structure and metal concentrations in aquatic macroinvertebrates: Clark Fork River, Montana

Taboada-Castro, M.M., M.L. Rodriguez-Blanco, M.T. Taboada-Castro, 1998. The role of different soil management on the distribution of heavy metals in surface waters.

Takarina, N.D. Yasman, Sunardi, A. Reza. 2008. Spesiasi logam beratdi sedimen muara dan perairan Teluk Jakarta. *Jurnal Kimia Lingkungan* 9(2) : 153-160