Available online at IJMARCC, Website: http://ejournal.undip.ac.id/index.php/ijmarcc
International Journal of Marine and Aquatic Resource Conservation and Co-existence
Research Article, 2 (1): 18-22, October 2017

THE CONCENTRATION OF DISSOLVED PHOSPHATE IN WATER MASS AND SEDIMENT STUDY CASE IN SERANG AND MLONGGO RIVER

Lilik Maslukah, Sri YulinaWulandari and Hasana Kushadi Ratnasari

Departemen Oseanografi, Fakultas Perikanan dan Ilmu Kelautan, Universitas Diponegoro
Jl. Prof. H. Soedarto, S.H, Tembalang Semarang. 50275 Telp/fax (024)7474698
Email: lilik_masluka@yahoo.com

ABSTRACT

Serang and Mlonggo Estuaries are located in the Jepara Regency, Central Java. Serang Estuary is located between Kedungmutih and Kedungmalang Village, while Mlonggo Estuary is located between Slagi and Jambu Village. Citizens around Serang and Mlonggo Estuaries dumped the waterwaste, which taken by rivers into the sea, such as household activity, agriculture, fish farming as well as the rest of the processing. The wastewater contains organic material and nutrients such as phosphate and organic carbon. The purpose of this research are find out the value and distribution of total organic carbon and bioavailable phosphate in sediments also orthophosphate in water. This research was conducted on June 18 – 19th 2016. Primary data in this research were total organic carbon (TOC) andbioavailable phosphate (BAP) from sediments also orthophosphate from water samples. Secondary data of this research were currents velocities, water qualities, bathymetry map. This research used quantitative method. While purposive method was used to determine the location of sampling. The results of the research showed the average value of TOC in sediments in Serang and Mlonggo Estuaries were 19.018% and 10.086%; BAP were 1.35 μmol/g and 0.33 μmol/g; orthophosphate in water were 0.012 ppm and 0.021 ppm. In both areas, the values of TOC and BAP in sediments also orthophosphate in waters the more the marine areas tended to decrease.

Key words: Total Organic Carbon, Bioavailable phosphate, Orthophosphate, Serang Estuary, Mlonggo Estuary

INTRODUCTION

The estuaries and coastal areas that have a high population and human activity. These areas cover 7% of the world's ocean surface and have 30% of total net primary productivity (Durr et al., 2011). Increased human activities of the mainland in the last decade have affected nutrient transportation from the land to the sea, resulted in environmental damage and changes in biogeochemical processes (Halpen et al., 2008; Qu, 2010). One of the areas that more active in biogeochemical processes and more easily affected by human activities is coastal areas in the tropics(Yule *et al*., 2010, Smith *et al*, 2012). It's very sensitive to changes in the natural environment and human activities including land uses, geomorphology evolution (Sia et al., 2012) and deforestation (Meunier et al., 2011).

There are some big rivers in Jepara Regency, among others, Serang andGrenjenganMlonggo rivers. They both have a role to supply freshwater to Jepara Waters. Serangriver has larger in watershedup to 138 km^2, and Grenjengan river has smaller in watershed (14.58 km^2). The difference of watershed existence is probably influence concentrations and supply of nutrient to the estuaries and coastal.

Nutrients commonly be limiting factor are phosphor and nitrogen.The influx of nutrients from the land into the waters through the river has an important role in stimulating biological processes in these waters(Gypens*et al*., 2009), including the increasedgrowth of phytoplankton (Carter*et al*., 2005). The high of nutrient concentrations in water environment have positive and negative impact.Positive impact is with the increase in phytoplankton production will affect fish production (Jones-Lee and Lee, 2005). While negative impact is a decline in dissolved oxygen content and the development of a dangerous kind phytoplankton ao algal (Howart, 2000), and also may change species composition (PRED,2009). This condition is called eutrophication.Tamtanasarit*et al*., (2013) defines that eutrophication is a condition in waters with a very highalgal growth when the nutrient concentration so high, such as phosphate and nitrate.

Their use of land on the mainland as agricultural land and settlements will contribute to the fertility of coastal waters.Based on Thongdonphum's (2014) research, phosphor (P) nutrient was instrumental in determining the growth of phytoplankton, then it can apply for monitoring water quality management. Phospor is very important nutrient in marine ecosystem. Its exsistence was tendto be adsorbed by sediment. Therefore, the presence of phosphor is limited to biology process.Based on the research of Zhang*et al*. (2014), more than 90 % of total phosphorus that is carriedby *run off*to the watersas suspended particulate matter. Then, the material is deposited on bed sediment. The mineral composition have a role in their saving and releasing.

Phosphor in the form of phosphate is rapidly adsorbed very strongly by sediment, especially the surface sediment layer that rich in oxygen (Warnken, *et al*., 2000). Adsoption process also depends on the kind of bed sediments, includes organic content and its clay particle.Dissolved Inorganic Phosphate (DIP) has a very strong ability to bind on the surface of a solid, it makesless available to biological process (Zhang & Huang, 2007). The process of release and re-adsorption of phosphate by sediment is Phosphate cycle in the water. This release through physical and biological processes.In physics, the release process due to resuspension events is caused by wind and tide (Warken*et al*., 2000).

Some studies on the concentration of inorganic phosphate have been carried in the water column in Jepara(Maslukah*et al.*, 2014; Karil*et al,* 2013), however the concentration of inorganic phosphate in sediment haven't done yet.This research was conducted to study the distribution of phosphate nutrient in water column and bed sedimenderive from two different river estuaries, namely Serang and Grenjengan, Mlonggo river estuaries.

MATERIAL AND METHOD

The main matters in this study were bed sediment and water samples which taken from the estuaries of Serang and Mlonggo river, Jepara. The supporting data consist of surface current as oceanography and water quality parameters such as the value of pH, salinity, temperature, dissolved oxygen that were measured in situ. In addition, the environment of sediment parameters were size particle and the content of organic carbon.

The location of water and sediment sampling were determined based on purposive. It meant, sampling station were determined based on the condition which might represented area condition thoroughly (Sugiyono, 2009). There were five stations in each river estuary. The geographic position for each station was shown in 1a. and 1b. figure.

Water samples were taken by water sampler. Then, they were filled into polyethylene (PET) bottle samples and stored in coolbox. Bed sediment samples were taken by grab sampler. The measurement of current as oceanography parameter with Lagrange method.Water quality parameters such as pH, salinity, temperature and dissolved oxygen (DO) were measured in situ by TOA-DKK *water quality checker*

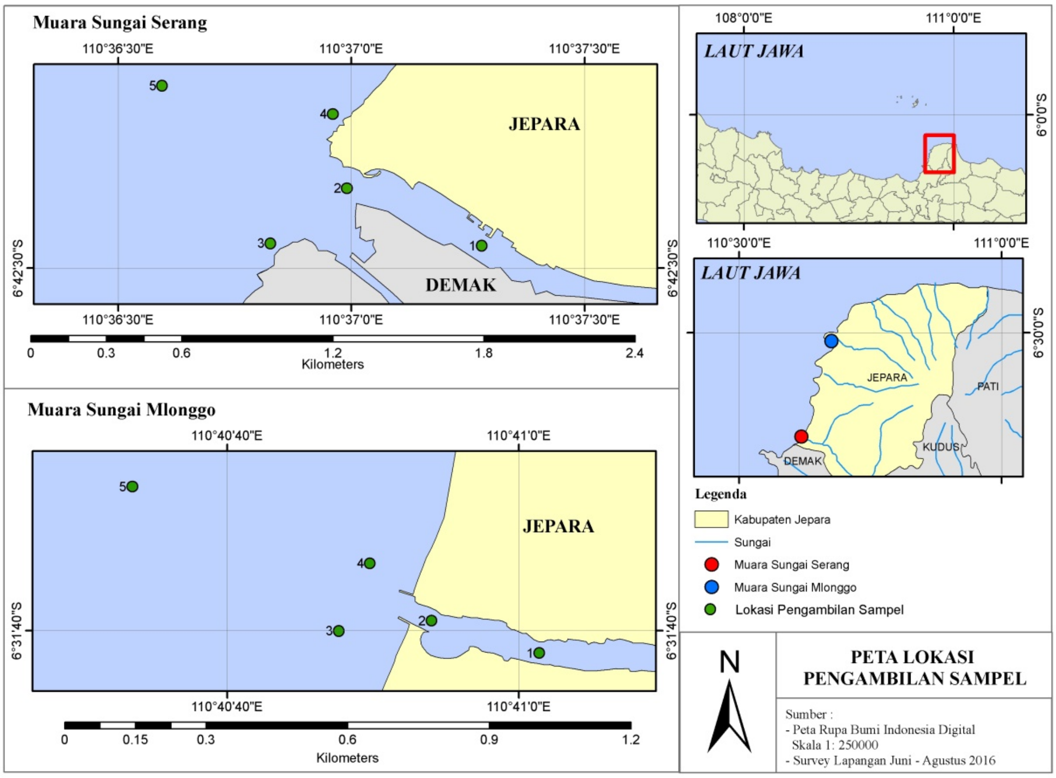

Fig 1.Research location the estuaries of SerangdanGrenjenganMlonggoriver, Jepara

The analysis method of organic carbon total refered to the method of Institute of Marine Organic Geochemistry, Ocean University of China (Meng et al., 2004).The content of total organic carbon was represented by the percentage of lost on ignition (% LOI), and the analysis of the size sediment particles used Buchanan method (1984). The percentage of LOI was calculated with formula:

$$LOI = \frac{beratawal(gr) - beratsetelahpengabuan(gr)}{beratawal(gr)} X100\%$$

The analysis of inorganic phosphate in sample was performed in way : sediment samples were extracted with strong acid (0.5 M HNO_3). After that, the samples were centrifuged, and the result of supernatant was analyzed with standard method of blue phosphomolybden (Liu *et al* 2015, Zhang et al 2014). Then, to read the values of samplesabsorbances by*UV-Vis Shimadzu* Spectrophotometer of 885 nm wavelength . The results werecompared with the values of standard curve. The same method was done on orthophosphate measurement in water.Inorganic phosphate values in sediment was known by using formula:

$$IP = \frac{CxVxFp}{m}$$

where:

IP = inorganik phosphate ($\mu mol.gr^{-1}$)
C = sample concentration (μM)
V = end volume (L)
m =mass of sedimen sample (gr)
Fp = dilution factor (if none,fp=1)

RESULT AND DISCUSSION

Phosphate concentration in water samples was dissolved inorganic phosphate (DIP/Orthophosphate), and phosphate in sediment was identified in the form of inorganic phosphate (IP). The IP concentration in bed sediment in Serang river estuary range from 0.07 – 1.85 µmol.gr^{-1}with mean value 1,35 µmol.gr^{-1}.GrenjenganMlonggo river estuary had ranged value from 0.03 – 0.74 µmol.gr^{-1} with mean value 0.33 µmol.gr^{-1}. Ortofosfat (DIP) concentration inSerang river estuary were ranged from 0.215 – 0.676 µmol.L^{-1}with meanvalue 0.379 µmol.L^{-1} and Mlonggo river estuary were range from 0.368 – 0.985 µmol.L^{-1} withmean value 0.676 µmol.L^{-1} (Figure. 2).

Based on figure 2, the value of inorganic phosphate (IP)content was found to be highest at station 1 and 2 of Serang and Mlonggo river estuaries. The lowest value at station 5.The high value of IP in stations 1 and 2 is due to its location in the river body. It indicated that the source of phosphate at those stations from the land (Liu *et al*., 2004).

Figure 2 also showed that Serang River had a higher total inorganic phosphate (IP) value, compared with Grenjengan, Mlonggo.This was due to different water conditions, such as organic carbon content and grain size distribution in sediments. The watershed of Serang has a wide area of 138 km2, while the Mlonggo River is only 14.58 km^2 (http: // bpsda-seluna. Jatengprov.go.id / database / das.Php). Larger wathershed mightcause the supply of organic matter and phosphate in the Serang River to be higher than the Grenjengan, Mlonggo river (Table 1).The result of Maslukah *et al.* (2016) research stated that the Serangriver supplied 2.15 tons/month of P nutrient.

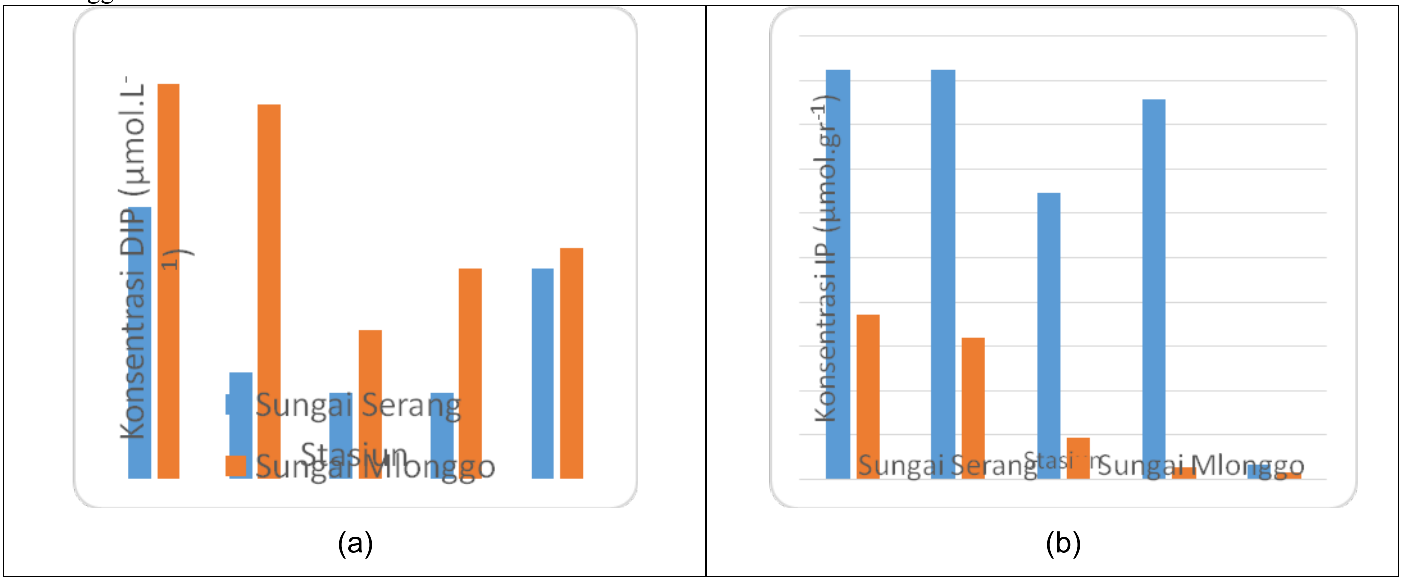

Figure 2.The concentration of dissolved inorganic phosphate (DIP) (a) and inorganic phosphate(IP) (b) in sediments of Serang and Mlonggo river estuaries

Table 1.The result of research in the waters of Serang and Mlonggoriver, Jepara

Location	Stati-on	TOC (%)	Type of Sediment	Current velocity (m.s^{-1})	Temp (˚C)	Salinity (ppm)	pH	DO (mg.L^{-1})
Sungai Serang	1	38.04	*Sand*	0.007	30	21	5.36	4.65
	2	12.68	*Sand*	0.025	31	19.9	5.28	4.8
	3	16.58	*Sand*	0.014	30	25	5.07	4.8
	4	23.75	*Sand*	0.007	29,8	25.5	5.27	4.95
	5	4.04	*Silty sand*	0.031	31	35	5.63	5.01
Sungai Mlonggo	1	9.33	*Sand*	0.033	28	19.5	5.41	5.2
	2	10.18	*Silty sand*	0.008	27,.5	20	5.5	5
	3	10.05	*Sandy silt*	0.008	29	24.5	6.05	4.8
	4	9.64	*Silty sand*	0.013	30	24	6.02	5.15
	5	11.22	*Silty sand*	0.036	31	35.5	6.09	5.2

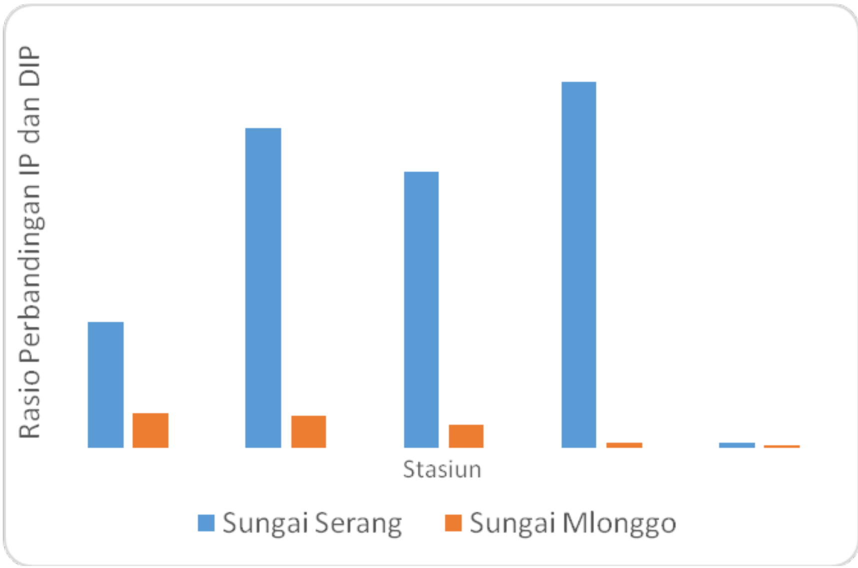

Figure 3.The ratio of total inorganic phosphate (IP) in sediment anddissolved inorganic phosphate (DIP)

Based on figure3., ratio of inorganic phosphate (IP) to dissolved inorganic phosphate (DIP) was high enough. This ratio showed that phosphate concentration in sediment was higher than in water. Thongdonphum*et. al*. (2014) said, that the presence of phosphate in water column was tended to adsorb by sediment. It also explained by Zhang *et.al.* (2014), that more than 90% of total phosphorus was carry by run-off from the river to the coast, that was suspension matter. Then, this matter would be deposite to bed sediment.

Figure 3.also showed that sediment of Serang river had a higher IP to DIP ratio. The high ratio was related to dissolved oxygen value in GrenjenganMlonggo river, which was a little higher than Serang river (Table 1.). The high of dissolved oxygen made phosphate was released from sediment to the water column. Warken*et.al.* (2000) explained that if high enough condition of dissolved oxygen would make phosphate dissolution process by sediment. Besides of dissolved oxygen (DO), the value of total organic carbon (TOC) inSerang river estuary had a role in supporting the high of inorganic phosphate value of sediment.The ranged value of TOC of Serang river estuary was 0.21 – 0.85%. It was higher than the result of research Meng*et al.* (2014), and mud was the dominant fraction. While, compare with the research of Yang et.al., (2016) in Hainan island waters, South China Sea, the value of inorganic phospat of sedimentwas lower. The value was ranged between 7,18 – 14,24 µmol. gr-1.µ. Differences in inorganic phosphate content were suspected due to differences in geographic conditions and land use by different human activities.Besides of human activity, differences in inorganic phosphate content occurred due to differences of using acid to extract sediment. In this research used 0.5 M HNO_3, but Yang et al. (2016) used (1 M HCl). Chloride acid was more strong acid than nitric acid.

The content of dissolved inorganic phosphate (DIP) or orthophosphate in Serang river estuarywas ranged between 0.215 – 0.676 $\mu mol.L^{-1}$, and in GrenjenganMlonggo river estuary was range between 0,0368– 0,983 $\mu mol.L^{-1}$successively. The highest consentration in Serang and Mlonggoriver were found at station 1, and the lowest at station 3 and 4. The chart of dissolved inorganic phosphate (DIP) in Serang and Mlonggo river estuary could be seen at figure 2.DIP concentration ofMlonggo river estuary was higher than ofSerang river estuary. It was due to heavy rain on the previous day. As a result, run-off (rainwater that fell to the ground, was flowing into the river to get to the sea) was happened, and carried material include nutrient from the land to the sea. The presence of storm caused a sediment stirring mechanism, and made nutrients which were deposited onto sediment to be released into the water column. The higher current velocity was measured in GrenjenganMlonggo water (table 1), so that resuspension occurred. Resuspension process could make sediment in the seabed rose to the water column. It maked some element included phosphate rose too. In addition to current parameter, it was predicted that the higher of dissolved oxygen (DO) content in Serang waters played a role in phospate releasing of suspended particle (Warken*et al*., 2000).

CONCLUSION

The average values of inorganic phosphate (IP) in sediment of Serang river estuary up to 1.35 $\mu mol.gr^{-}$ and 0,33 $\mu mol.gr^{-1}$ of GrenjenganMlonggo. While the average values of dissoved inorganic phosphate (DIP) were 0.012 ppm (Serang) and 0.021 ppm (GrenjenganMlonggo), successively. sedangkan inorganic phosphate terlarutberturut-turutsebesar 0,012 ppm dan 0,021 ppm. The distribution of inorganic phosphate concentration in sediment and dissolved inorganic phosphate both in Serang and Mlonggo waters were declined toward the sea.

REFERENCES

Avramidis, P., N. Konstantinos and B. Vlasoula. 2015. Total Organic Carbon and Total Nitrogen in Sediments and Soils: A Comparison of the Wet Oxidation-Titration

Method with the Combustion-Infrared Method. Aglicultural Science Procedia. 4:425-430.

Chiswell, R. 1997. Investigations of the Speciation of Phosphorus in Coastal and Estuarine Waters of the Great Barrier Reef, Using Iron Strips and Colorimetry. Marine Freshwater Research 48:287-293.

Effendi, H. 2003.TelaahKualitas Air bagiPengelolaanSumberDayadanLingkunganPerairan.Kanisius, Yogyakarta.

Emery, W. J. and R. E. Thomson. 1998. Data Analysis Methods in Physical Oceanography. Pergamon Elsevier Science Ltd. USA. 634 p.

Kusumaningtyas, M. A., R. Bramawanto, A. Daulatdan W. S. Pranowo. 2014. KualitasPerairanNatunapadaMusimTransisi.Depik 3(1):10-20.

Madjid. 2007. Dasar-DasarIlmu Tanah. FakultasPertanianUniversitasSriwijaya, Palembang.

Maulana, M. H. 2014. StudiKandunganFosfat Bioavailable danKarbonOrganik Total (KOT) PadaSedimenDasar di Muara Sungai ManyarKabupaten Gresik. Bulletin Oseanografi Marina 3(1):32-36.

McIntyre, A. and A. Eleftheriou. 2005. Methods of Study for Marine Benthos: Third Edition. Blackwell Science Ltd., Oxford, 418 p.

Meng, J. P., Yao, Z. Yua, T. S. Bianchie, B. Zhaoa, H. Pan and D. Lia. 2014. Speciation, Bioavailability and Preservation of Phosphorus in Surface Sediments of the Chanjian Estuary and Adjacent East China Sea Inner Shelf. Estuarine, Coastal and Shelf Science 144:27-38.

Metcalf and Eddy. 2003. Wastewater engineering: Treatment and Reuse Third Edition. McGraw Hill Publication Co.Ltd.China, 1819 p.

Muchtar, M. 2002. DistribusiFosfat Dan Nitrat Di PerairanKalimantanTimur. PusatPenelitianOseanografi-LIPI. Jakarta.

Muslim and G. Jones. 1994. The Variation and Flux of Phosphate, Nitrogen, Silicate and Several Trace Element of Fringing Coral Reef in Nelly Bay in the Central Great Barrier Reef. Paper presented at the Sixth Pacific Congress on Marine Science and Technology, held at James Cook University of North Queensland Townsville, Australia.

PREP (2009). State of the Estuaries Report.Piscataqua Region Estuaries Partnership, Universityof New Hampshire, Durham, NH. Published online:

www.prep.unh.edu/resources/pdf/2009_state_of_the-prep-09.pdf.

Strickland, J. D. H. & T. R. Parsons (1977). *Practical Handbook of Seawater Analysis,* Fisheries

Research Board.

Sugiyono. 2009. MetodePenelitianKuantitatif, Kualitatifdan R&D. PenerbitAlfabeta, Bandung. 333 hlm.

Ulqodry, T. Z. Yulisman, M. SyahdandanSantoso. 2010. KarakteristikdanSebaranNitrat, Fosfat, danOksigenTerlarut di PerairanKarimunjawaJawa Tengah. JurnalPenelitianSains., 13(1): 35-41.

Warnken, K et al. (2000). Benthic Exchange of Nutrients in Galveston Bay.*Estuaries* **23**(5):

647-661.

Yang, Bin, S. M. Liu, Y. Wu and J. Zhang. 2016. Phosphorus Speciationand Availability in Sediments off the Eastern Coast of Hainan Island, South China Sea. Continental Shelf Research 118:111-127

Zhang, J, & X. Huang (2007). Relative importance of solid-phase phosphorus and iron on the sorption behavior of sediments. *Environ. Sci. Technol.* **41**: 2789-2795