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A BASELINE STUDY OF WATER QUALITY IN BRONDONG- LAMONGAN ESTUARY TO SUPPORT THE COASTAL ZONE MANAGEMENT.

Johan Risandi[1*], Rudhy Akhwady[2]
*[*1, 2] Pusat Pengembangan dan Penelitian Sumber Daya Laut dan Pesisir Gedung II Balitbang KP lt .5. Jl. PasirPutih I Ancol Jakarta*

Corresponding Author:-
Email: *johanrisandi@gmail.com*

Abstract:-

Water quality information is one of theimportantfactors for coastal zone management. The sources of pollution may come from industrial, agricultural and domestic which are daily discharged mainly into rivers and end up in the ocean. This paper evaluates water quality parameter from the estuary of the main river flowing aroundLamongan, i.e. theBrondongriver. There were three categories of water parameters identified from the collected water samples, viz. physical, chemical andbiological concentration. Those water samples were analysed in the laboratory, and the results were then comparedtothe minister of environment's regulation for seawater quality standard. The result showedthe water quality of the estuary is still in relatively good condition. However, some water quality parameters were out of the standard. For example, Dissolved Oxygen in both rivers was below 5. Nutrient (i.e. Nitrate) concentration was above the permitted limit of 0.008 mg/L. The samples taken from the rivers also were considered to be safe from pathogen due to thevery low presence of Total Coliform. This study output will be a baseline frame for future studies. Further, the information will be used to verify a water quality model developed for the area.

Keywords:- *Water quality, Surabaya, estuary.*

INTRODUCTION

Today, environmental quality is declining that threaten the survival of human life and natural ecosystem. In estuary and coastal area, the polluted watercomes from human activities has become a major environmental problem in recent years.The waste from industry, household and agriculture is mainly discharged into rivers which end up in the ocean. The waste, e.g. nutrient, leads to serious problems for example eutrophication and mass marine biota deaths in many coastal zones (Nixon, 1995; Newton et al., 2003; Wu et al., 2010).

Accordingly, information about water quality in an estuary or coastal area is very crucial. The information can be an input for the decision makers, i.e. the governments, to identify sources and the type of pollution. The change of water quality will affect the implemented strategies for managing the area. Some policies will probably be applied bythe governments, to sustain or even to improve the environment.

However, there is a lack of information on water quality in some area. This willimply to the lack of estimation the environmental change, which in the end, the governments will face some problems to identify, and further to determine the steps to improve it. Therefore, water quality investigations are undertaken to provide information on the condition of water bodies. The study to examine the areais needed for the first time,and the result becomes "a benchmark" for the upcoming investigations. In this state, the environment is considered to be no disturbance (Australian and New Zealand Environment and Conservation Council and theAgriculture and Resource Management Council of Australia and New Zealand, 2000).

The study was aimed to collect and present baseline data on physical and chemical water quality in Brondong estuary-East Java. Water qualityindicators were assessed against ageneric safe threshold which is set by the Indonesian government.

Methods.

Brondong estuary is located in Lamongan, East Java. The estuary is theend of the Brondong river system which is part of the Bengawan Solo Watershed. The estuary presents a great variety of ecosystem. Howeverthe River is influenced by domestic waste and agriculture which in the end affects the water quality of the estuary. The studywas carried by performing a field measuring campaign to collect water samples from the study area. Water samples were collected in November 2015, and the studied parameters are mainly divided into three main categories, i.e. physical, chemical and biological (see the list of parameters in Table 1). There were 5 locations selectedaround the mouth of the river (see Fig 1).Some parameters were analysed in-situ using measuring devices. Water temperature and Dissolved Oxygen (DO) information were collected from a DO meter.The pH values were obtained using a pH meter. ASecchi-disk was used to measure the water transparency or turbidity. During the measurement, the smell of water and the existence of oil on the surface was also inspected visually.

Table 1. The surveyed parameters

No.	Categories	Parameters
1.	Physical:	Temperature, Transparency/Clarity, Turbidity, Smell, Oil, Total Suspended Solid (TSS)
2.	Chemical	pH, Dissolved Oxygen (DO), Salinity, BOD5, Ammonia (NH_3-N), Nitrite (NO_2-N), Ortho Phosphate (PO_4-P), Sulphide (H_2S), Total Phenol, Surfactant (Detergent)
3.	Heavy Metal	Cadmium (Cd), Copper (Cu), Lead (Pb), Zinc (Zn), Nickel (Ni), Arsenic (As).
4.	Biological	Total Coliform

Meanwhile, the other parameters were analysed in a laboratory. Water was sampled at 1 m depth from the surface using a Nansen bottle. The samples were then preserved in cool boxes of 4˚C and analysed in a laboratory. Ammonia, Nitrate, Phenol, Surfactant, Phosphate and heavy metal concentration in the water samples were analysed with Atomic Absorption Spectroscopy method. In addition, the other parameters, i.e. TSS and oil, salinity, Sulphide, oil, turbidity, and BOD5 were analysed using gravimetry, argentometric, iodometry,turbidimetry andWinkler methods respectively.The Biological aspect, i.e. Total Coliform, was determined by multi-tube fermentation method. The results of the survey were compared to the Indonesian Minister of Environment's regulation about seawater quality standard (KeputusanMenteriNomor 51 Tahun 2004 tentang Baku Mutu Air Laut).

Fig 2. Location of water sampling

Result

A summary of the analyses of the water quality of Brondong Estuary is given in Table 2. The results showed that the estuary was physically in good condition as the surveyed parameters were below the limit permitted by the Indonesian government. The transparency is inversely related to the turbidity. The higher the turbidity reflects the decrease of the transparency. The highest turbidity value was the BR3 point which was located in front of the mouth of Brondong River. River discharge transports sediment from upstream to an estuary (Van Rijn, 1993). This is confirmed by the highest value of TSS concentration obtained in the BR3 point. The above mutual influence parameters are indicators of coastal and estuarine waters.

Coastal and estuary with bad condition, i.e. high degree of TSS-turbidity and low clarity, is usually affected by unnatural, that is to say, anthropogenic activities. This condition may generate significant changes in theecosystem. For example,a reduction of light penetration into water column for supporting photosynthesis that leads to algal bloom or low concentration of DO which endangers the ecosystem (Bramha et al., 2011).TSS would affect marine organisms like problems to fish and crustacean respiratory system (e.g. Pyle and Lemkuhl, 2002).

The seawater temperature at all surveyed points was stable at 25˚C which is considered to be temperature for the tropical ocean (Johnson and Sie, 2010). Further, the visual observation during the campaign confirmed that the estuary was free from oil slick. Not only reducing light intensity, oil slick also affects the aesthetics. In an extreme condition like oil spill from tankers, coastal and estuary environments will create serious problems. For examples the death of marine mammals, seabirds and vegetation (AMSA, n.d.). Table 2. The results of water quality monitoring

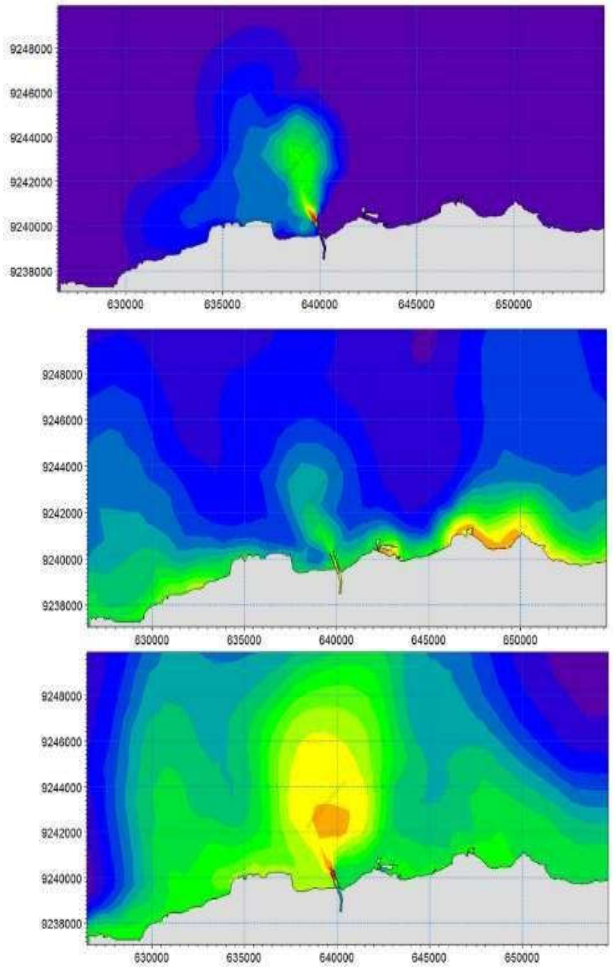
Parameters	Unit	BR1	BR2	BR3	BR4	BR5	Limit
Physical							
Transparency	M	4.5	8	4	6	7	coral>5, seagrass>3
Smell	-	-	-	-	-	-	no smell
TSS	mg/L	14	12	16	14	14	Coral 20, mangrove 80, seagrass 20
Temperature	˚C	25	25	25	25	25	Natural
Oil on water surface	-	-	-	-	-	-	no oil
Turbidity	NTU	1.57	0.79	3.51	1.81	1.06	<5
Chemical							
pH	-	7.85	7.95	7.9	7.95	7.95	7-8.5
Salinity	Ppt	29.6	29.6	29.7	29.6	29.7	Natural
Total Ammonia	mg/L	Nd	Nd	Nd	nd	nd	0.3
Sulphide	mg/L	nd	Nd	Nd	Nd	nd	0.01
DO	mg/L	4.8	3.8	4.2	4.6	5.2	>5
BOD5	mg/L	2	8	8	6	2	20
Phenol	mg/L	Nd	Nd	Nd	Nd	nd	0.002
Nitrate	mg/L	0.13	0.03	0.06	Nd	nd	0.008
Surfactant	mg/L	2.16	2.65	2.46	2.54	2.27	2.27
Oil and fat	mg/L	1	1	2	2	1	1
Phosphate	mg/L	0.7	0.9	0.46	0.35	0.39	0.39
Bacteriology							
Total Coliform	MPN/100 mL	40	70	40	70	40	1000

nd* not detected

The chemical water quality showed some parameters, i.e. pH, Total Ammonia, salinity, Sulphide, BOD_5 and Phenol concentrations were in good condition. Some of those parameters could not be detected which presumably caused by their very low concentration. However, the other parameters exceeded the prescribed limit. The DO concentration was slightly below the standard at most observed points except BR5 located far from the mouth of the river, ranging from 3.8-5.2 mg/L. Nitrate, Surfactant, oil and fat, as well as Phosphate concentration were also higher than the standard at some points. The high concentration of Nitrate and Phosphate in the water samples could come from the residue of fertilizer. The fertilizer comes from agriculture activities in Bengawan Solo watershed. The high concentration of Nitrate and Phosphate may contribute to the high concentration of algae. Surfactants are found in the forms of soap, detergents or other cleaning agents. The source of surfactant in the estuary may come from domestic activities discharged to the river. Similar to surfactant, oil and fat content in the water also possibly come from domestic activities and water mode of transport e.g. ships (Direktorat Pesisir dan Lautan, 2015).

The degree of BOD_5ranged from 2-8 mg/L; that was lower than the prescribed standard of 20 mg/L. However, water quality with those values is still considered to be moderately polluted. Rivers with good water quality should have BOD_5 value below 1 mg/L (Clair *et al*, 2003). Higher BOD5 was found nearby the mouth of the river. Moving further from the mouth of the river, the value of BOD5 decreased which indicates the river discharge was one of the pollutant sources. The samples taken from the rivers also were considered to be safe from pathogen due to the very low presence of Total Coliform, ranging from 40-70 MPN/100ml.Coliform bacteria consist of several genera belonging to Family *Entero bacteri aceae*. High levels of faecal coliform in the water or biotas may cause typhoid fever, hepatitis, gastroenteritis, dysentery and eat infection if human consumes them. Further, the concentration of this bacteria increases due to the presence of wastewater and septic system, animal wastes, run-off, high temperature and nutrient-rich water (Philminaq, n.d).

Current work focuses on the development of numerical models for assessing the distribution of chemical parameters on Brondong coastal area (Fig 2). The result of this study will be used to verify the result of the models. The information obtained from the models would be very useful for the decision makers to improve coastal management of the area.
BOD



Nitrate

Fig 2. Snapshot of water quality distribution based on the result of numerical simulation for some parameters, i.e. BOD, DO and Nitrate concentration.

Conclusion

The results indicate that Brondong estuary condition is relatively good based on physical and chemical parameters. In term of coastal zone management, the location could be suitable for economic activities, e.g. port or mariculture activities. However, the decision on the use of the area for those specific purposes should also consider other factors, especially its carrying capacity. Further, there must be further study using additional parameters other than only rely on water quality result to determine its suitability. Some of them are hydro-oceanography and socioeconomic.

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