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THE EFFECT OF INDUSTRIAL AND DOMESTIC WASTE POLLUTION ON RESERVOIR WATER QUALITY

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Abstrak. The main function of resevoir is the water resources to support 78 % of drinking water supply needs of Batam Island with the processing capacity amounting to 3000 liter/second. The main problem of reservoir are : (1) industrial waste water from Batamindo Industrial Zone has been extremely polluted with COD conten (134,61 mg/liter) exceeding the Waste Water Quality Standard Group II (80 mg/liter), (2) domestically waste water from domestic activity in Catchment Area has also been extremely polluted with BOD5 conten (58,22 mg/liter) exceeding the Waste Water Quality Standard Group II (50 mg/liter). This research to study influent of industrial waste water and domestically waste water to carrying capacity of reservoir.

Keywords: earthworms; bioporic; ground water; biopore

I. INTRODUCTION

Geographically and economically, Batam Island has a very strategic location. As one of the islands directly bordering Singapore, in its development and expansion, Batam Island has several functions, including as a bonded zone, ship conversion, storage and warehousing area for Indonesian export and import products, industrial development area, and foreign tourist visit area. To support the development and expansion of Batam Island, clean water is needed with a processing capacity of 3850 liters/second which is predicted to be sufficient to meet the clean water needs of 600,000 Batam Island residents. The clean water processing capacity available until 2000 was 850 liters/second, originating from Baloi WTP (30 liters/second), Sei Ladi WTP (240 liters/second), Sei Haapan WTP (210 liters/second), Nongsa WTP (60 liters/second), and Muka Kuning WTP (310 liters/second). Meanwhile, the water requirement of 3000 liters/second comes from Duriangkang WTP. Duriangkang WTP is the largest WTP on Batam Island. The reservoir on Batan Island is an estuary reservoir, which was built by damming the Duriangkang River estuary **[1]**. Almost all of the river body (82%) is affected by the ebb and flow of sea water. Rainwater is the main source of water in the Reservoir. It takes about 3 years to reduce the salinity level in the Reservoir water body, and during that time the reservoir water level increases due to rainwater supply. The reservoir on Batan Island has a very important function for the development and development of Batam Island (including Barelang), because almost all of Batam Island's clean water needs are supplied from the Reservoir which has a WTP with a capacity of 3000 liters/second. Therefore, the uncontrolled entry and inclusion of pollutants (due to the use of industrial and domestic land in the Duriangkang DAS system) into the Reservoir water body is predicted to reduce water quality and at the same time reduce the carrying capacity of the Reservoir. The purpose of the study was to assess the level of industrial wastewater and domestic wastewater pollution in the Duriangkang Reservoir as a result of land use in the Duriangkang DAS system **[2]**.

The definition of a river basin (DAS) is the entire area of authority (regime) of a river that becomes the main drainage channel **[3]**. The definition of DAS is equivalent to the English term drainage basin, drainage area, or river basin **[4]**. So that the DAS boundary is a shadow line along the ridge of a mountain or cliff/hill that separates one flow system from another. From this definition, a DAS consists of two main parts, a catchment area that forms the upstream area and a water distribution area below the catchment area. In its management, DAS should be viewed as a unit of land resources **[5]**. So that wise DAS management should be based on the relationship between human needs and the availability of resources to meet these human needs. Resource management is usually a must when these resources are no longer sufficient for human needs or are abundant. In conditions where resources are insufficient for human needs, DAS management is intended to obtain the best possible benefits in terms of physical, technical, economic, socio-cultural and national security-stability**[6}**. While in conditions where DAS resources are abundant, management is intended to prevent waste. The river, which has a very important role, is currently in a worrying condition because almost all parts of the river have been heavily polluted by waste dumped by the activities of residents/settlements and industry in its watershed **[7]**.

II. RESEARCH METHODS

The research was conducted in Duriangkang Reservoir located on Batam Island, Batam City, Riau Islands Province. The research was conducted in 2002. The data taken were: (1) the area of industrial land and the area of domestic land in the Duriangkang DAS system; (2) the water quality of Duriangkang Reservoir. The influence of industrial waste and domestic waste on the quality of WD water used the "multiple regression" equation. The pollution load from industrial wastewater was calculated based on the COD content (mg/l) in industrial wastewater per unit time (kg.day), and BOD5 (mg/liter) for the pollution load from domestic wastewater per unit time (kg.day) **[8]**. The pollutant load of industrial wastewater and domestic wastewater is calculated based on the equation:

$$BP = Kmi \times DM \times F$$

BP = industrial/domestic wastewater pollution load of product (kg/day)
Kmi = COD (mg/liter of industrial wastewater) BOD5 (mg/liter of domestic wastewater)
DM = industrial/domestic wastewater discharge (l/sec)
F = conversion factor (0.001)

The standard quality of clean water refers to the standard quality stipulated through the Regulation of the Minister of Health of the Republic of Indonesia No. 416/Menkes/Per/IX/1990. The standard quality of industrial wastewater and domestic wastewater refers to the Decree of the Head of OPDIP Batam No. 27/KPTS-Ren/II/1993 concerning Guidelines for Wastewater Quality in the OPDIP Batam Region

III. RESULTS AND DISCUSSION

Liquid waste factor or the amount of liquid waste generated from residential activities (0.80), urban services (0.70), tourism (0.70), public facilities (0.70) from the need for clean water. The industrial wastewater quality parameter used as an indicator of pollution is the COD content. Chemical Oxygen Demand is the amount of oxygen needed to oxidize organic materials contained in water or wastewater using chemicals. COD can be used as one of the measurement parameters for the level of industrial wastewater pollution.

Table 1. Relationship between industrial land use, industrial wastewater and industrial wastewater pollution load in the Duriangkang Watershed system.

Year	1	2	3	4
1	57,54	26,64	18,65	216,90
2	83,01	46,39	32,47	377,63
3	110,40	51,11	35,78	416,13
4	115,50	53,48	37,44	435,44
5	160,20	74,17	51,92	603,84
6	200,80	92,97	65,08	756,90
7	210,30	97,37	68,16	792,72
8	230,40	106,67	74,67	868,43
9	250,60	116,03	81,22	944,61

Source: Data analysis

Description: (1) = Domestic Land Use (ha)
(2) = Clean Water Needs (lt/second)
(3) = Domestic Wastewater (lt/second)
(4) = COD5 Pollution Load (kg/hr)

The study indicated that the COD content of industrial wastewater is directly proportional to the use of industrial land in the Duriangkang Watershed system. The COD content in the period 1st to 9th year ranged from 34.70 mg/liter to 269.40 mg/liter with an average of around 124.61 mg/liter.

Table 2. Relationship between domestic land use, domestic wastewater and domestic wastewater pollution load in the Duriangkang Watershed system.

Year	1	2	3	4
1	70	29,51	23,61	148,44
2	140	58,94	47,15	237,17
3	160	67,36	53,89	271,08
4	230	96,83	77,46	389,64
5	320	134,72	107,78	540,55
6	500	210,50	168,40	847,09
7	640	269,44	215,55	1084,26
8	780	328,38	262,70	1321,43
9	860	362,06	289,65	1457,00

Source: Data analysis

Description: (1) = Domestic Land Use (ha)
(2) = Clean Water Needs (lt/second)
(3) = Domestic Wastewater (lt/second)
(4) = BOD5 Pollution Load (kg/hr)

The domestic wastewater quality parameter used as an indicator of pollution is the BOD5 (biological oxygen demand) content, which is the amount of dissolved oxygen needed by microorganisms to oxidize organic materials in wastewater biologically. The study indicated that the BOD5 content of domestic wastewater is directly proportional to domestic land use in the Duriangkang Watershed system. In the period 1st to 9th year, the BOD5 content in domestic wastewater in the Duriangkang Watershed system ranged from 24.80 mg/liter to 93.40 mg/liter with an average of around 52.66 mg/liter.

Industrial wastewater produced is greatly influenced by the area of land use and the need for clean water **[9]**. In the decade from 1 to 9, there has been an increase in industrial land use which has driven the increasing need for clean water. Land use in year 1 (57.54 ha) required clean water of 26.64 liters/second and industrial wastewater produced of 18.65 liters/second. In year 5 (160.20 ha) the need for clean water was 74.17 liters/second and industrial wastewater produced of 51.92 liters/second. While in year 9, industrial land use increased to 250.60 ha and the need for clean water increased to 116.03 liters/second, and the wastewater produced was 81.22 liters/second. Based on predictions of industrial land use in the Duriangkang watershed system, it shows that the increasing use of industrial land in the Duriangkang watershed system will cause an increase in the pollution load produced by industrial wastewater. The use of industrial land in the Duriangkang watershed system in year 1 resulted in a pollution load of 216.90 kg COD/day (78.08 tons COD/year), in year 5 resulted in a pollution load of 603.84 kg COD/day (217.38 tons COD/year), and in the next 9 years the use of industrial land increased to 200.60 ha and the resulting pollution load became 944.61 kg COD/day (340.08 tons COD/year). In year 19, the prediction of industrial land use will reach around 571.95 ha and the resulting pollution load is predicted to increase to 2162.06 kg COD/day (778.32 tons COD/year).

Table 3. Relationship between domestic land use, domestic wastewater and domestic wastewater pollution load in the Duriangkang Watershed system.

Year	Industrial Land Use (ha)	Water Containment Load Industrial Waste (kgCOD/hari)
1	57,54	216,90
2	83,01	377,65
3	110,40	416,13
4	115,50	435,44
5	160,20	603,84
6	200,80	756,90
7	210,30	792,72
8	230,40	868,43
9	250,60	944,61
10	301,50	1138,40
11	331,55	1252,14
12	361,60	1365,88
13	391,65	1479,62
14	421,70	1593,36
15	451,75	1707,10
16	481,80	1820,84
17	511,85	1934,58
18	541,90	2048,32
19	571,95	2162,06

The industrial wastewater pollution load generated from industrial land use activities in the Duriangkang Watershed system if discharged directly into the Duriangkang Reservoir water body, this condition will cause accumulation of pollutants from industrial wastewater in the Duriangkang Reservoir. If technical efforts (engineering) through the construction of an industrial waste treatment plant are not carried out, then the industrial wastewater pollution load will sooner or later become a potential source of pollution that causes the decline in the water quality of the Duriangkang Reservoir. From the description above, it shows an indication that the increasing pollution load discharged into the reservoir water body is predicted to reduce the ability of the Duriangkang Reservoir water body to neutralize the pollutant load from industrial wastewater discharged into the Duriangkang Reservoir water body.

The need for clean water on domestic land in this study is to meet the need for clean water for the residential sector, urban services, tourism, and public facilities. The need for clean water in the 1st year was 29.51 liters/second to meet the need for clean water on domestic land of 70 ha. in the 5th year land use increased to 320 ha and the need for clean water increased to 134.72 liters/second, while in the 9th year domestic land use became 860 ha and the need for clean water increased to 362.06 liters/second. In this study, the domestic wastewater factor or the amount of liquid waste generated is 0.80 which is produced from activities in the residential sector4. From the assumption that the domestic wastewater factor (F = 0.80), then the domestic wastewater produced from domestic land use activities in the Duriangkang DAS system in the in the 1st to 9th year decade showed an increase, namely from 23.61 liters/second (1) to 107.78 liters/second (5). Meanwhile, in 5 year, domestic wastewater produced from domestic land use activities (settlements, urban services, tourism, and public facilities) was 289.65 liters/second.

Table 4. Relationship between domestic land use, domestic wastewater, and domestic wastewater pollution load in the Duriangkang Watershed system.

Year	Domestic Land Use (ha)	Domestic Wastewater Containment Load (kgBOD5/Domestic Wastewater Containment Load)
1	70,00	148,44
2	140,00	237,17
3	160,00	271,08
4	230,00	389,64
5	320,00	540,55
6	500,00	847,09
7	640, 00	1084,26
8	780,00	1321,43
9	860,00	1457,00
10	872,10	1476,50
11	959,21	1624,05
12	1046,32	1771,60
13	1133,43	1919,15
14	1220,54	2066,70
15	1307,85	2214,25
16	1394,76	2361,80
17	1481,87	2509,35
18	1568,98	2656,90
19	1656,09	2804,45

Domestic land use in the Duriangkang Watershed system in 1st year (70.09 ha) produced domestic waste of 23.61 liters/second with a pollution load of 148.44 kg BOD5/day. The pollution load from domestic wastewater showed an increase, in 1996 the domestic land used was 320 ha and the pollution load produced was 540.55 kg BOD5/day, while in in the 9th year the domestic land used in the Duriangkang Watershed system became 860 ha and produced a domestic wastewater pollution load of 1321.43 kg BOD5/day. In 19 years to come, domestic land use in the Duriangkang watershed system is predicted to increase to 1656.09 ha and the resulting pollutant load is predicted to be 2804.45 kg BOD5/day. The increasing domestic wastewater pollution load is closely related to the increasing domestic wastewater discharge produced. Based on the results of the study, it shows that the increasing domestic wastewater discharge is closely related to the increasing demand for clean

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water. From these conditions, it can be indicated that the increasing domestic wastewater pollution load is closely related to the increasing domestic land use with various activities in the Duriangkang watershed system.

IV. CONCLUSION

Industrial wastewater from industrial land use and domestic wastewater from domestic land use in the Duriangkang watershed system are potential sources of pollution that reduce the carrying capacity of the Duriangkang Reservoir. The COD content in industrial wastewater ranges from 34.70 mg/liter to 269.40 liters/second, while the BOD5 content of domestic wastewater ranges from 24.80 mg/liter to 93.40 mg/liter with an average of 52.66 mg/liter. This condition indicates that industrial wastewater and domestic wastewater have been heavily polluted because they have exceeded the quality standards for Class II wastewater. To protect the carrying capacity of the Duriangkang Reservoir from the input or inclusion of industrial wastewater and domestic wastewater, it is necessary to build an Industrial Wastewater Treatment Plant and a Domestic Wastewater Treatment Plant from the Batamindo Industrial Area. take firm action and impose sanctions on violations of spatial planning, especially in the use of industrial land and domestic land in the Duriangkang watershed system.

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